DFS (Dynamic Frequency Selection)
Introduction and Test Solution

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Agenda

• Introduction to DFS
• DFS Radar Profiles Definition
• DFS test procedure and measurement requirements
• DFS standard operation procedure from Agilent
5 GHz Unlicensed Spectrum Band Benefits

- Less congested and interferences compared with 2.4 GHz band
- More channels and wider network bandwidth than 802.11n
- Lower power consumption resulting from faster transmission like 802.11ac
- WLAN growth driven by integration in more devices, enterprise adoption, offload data from cellular network, HD media sharing and streaming etc.

http://www.5gwifi.org/
Global 5 GHz WLAN Channelization

Weather or Military Radar

IEEE channel#
40 MHz
80 MHz
160 MHz

US

Europe & Japan

China

HARDWARE + SOFTWARE + PEOPLE = INSIGHTS

DFS Introduction and Test Solution
## Global 5 GHz Spectrum Management

<table>
<thead>
<tr>
<th>Frequency MHz</th>
<th>UNII Band</th>
<th>WLAN Channel</th>
<th>USA</th>
<th>Europe</th>
<th>Japan</th>
<th>China</th>
</tr>
</thead>
<tbody>
<tr>
<td>5170-5250</td>
<td>UNII-1</td>
<td>36-48</td>
<td>Indoor</td>
<td>Indoor</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>5250-5350</td>
<td>UNII-2</td>
<td>52-64</td>
<td>DFS/TPC</td>
<td>Indoor/DFS/TPC</td>
<td>DFS/TPC</td>
<td>DFS/TPC</td>
</tr>
<tr>
<td>5490-5725</td>
<td>UNII-2e</td>
<td>100-140</td>
<td>DFS/TPC</td>
<td>DFS/TPC</td>
<td>DFS/TPC</td>
<td>No (In Study)</td>
</tr>
<tr>
<td>5735-5835</td>
<td>UNII-3</td>
<td>149-165</td>
<td>Yes</td>
<td>DFS/TPC</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

### Unlicensed National Information Infrastructure (U-NII) includes:
- **UNII Low (UNII-1):** 5150 MHz to 5250 MHz. Indoor use only. Power limit to 50 mW.
- **UNII Middle (UNII-2):** 5250 MHz to 5350 MHz. Both outdoor and indoor. Power limit to 250 mW.
- **UNII World (UNII-2e):** 5470 MHz to 5725 MHz. Both outdoor and indoor. Power limit to 250 mW.
- **UNII Upper (UNII-3)**: 5725 to 5825 MHz. Both outdoor and indoor. Power limit to 1W.
DFS (Dynamic Frequency Selection) Definition

• DFS is a feature that monitors the spectrum and selects a frequency for operation that is not already in use to avoid causing interference to radio transmissions such as weather or military radar.

• DFS is imposed by International Telecommunication Union (ITU) for devices operating in the 5GHz UNII band, where the radar systems are guaranteed to have spectrum protection.

• If the device detects that a radar is present, it must either select an alternative channel or enter a “sleep mode” if no channels are available.

• The DFS measurement procedure includes technical requirements, radar test waveforms, test procedures determined by regulatory agencies FCC, ETSI, Japan MIC, Korean and China MIIT
Global DFS Regulations

- **USA’s FCC (Federal Communications Commission)**
  - FCC Part 15 Subpart E
    - For 5250 – 5350 MHz and 5470 – 5725 MHz bands

- **Europe’s ETSI (European Telecommunications Standards Institute)**
  - ETSI EN 301-893 v1.7.1
    - For 5150 MHz to 5350 MHz (In-Door) and 5470 MHz to 5725 MHz
  - ETSI EN 302-502 v1.2.1
    - For 5.8 GHz band (5725 MHz to 5875 MHz)

- **Japan’s MIC (Ministry of Internal Affairs and Communications)**
  - Japan MIC
    - With all FCC type and add 2 more short pulses

- **China MIIT announced the 5150-5350 MHz Band for WLAN**
  - 5250-5350 MHz band should use DFS and TPC. If no TPC support, the EIPR and max power spectral density should be 3 dB lower.

- **Korea Standard**
  - Defined Type 1-4 Radar profiles
Agenda

• Introduction to DFS

• **DFS Radar Profiles Definition**

• DFS Test procedure and challenges

• DFS Standard Operation Procedure from Agilent
DFS Radar Profiles

A Radar Profile describes the RF and time domain characteristics of a given radar signal type, where the types are defined by the various government communications agencies

**Time Domain characteristics:**

- Radar Pulse width (sec) and Pulse repetition Frequency (Hz) or Pulse Repetition Interval (sec)
- Number of pulses per radar burst
- Number of radar bursts

**Frequency domain characteristics:**

- Burst Center Frequency (Hz): For a single-burst profile, this is always fixed. For multi-burst frequency hopping profiles, this will change from burst to burst
- Chirp Bandwidth (Hz): Pulse may have a linear frequency modulated chirp (change in instantaneous frequency) over a certain bandwidth.
Time Domain View of a Radar Profile

- **Power (dBm)**
  - Pulse Width ('On' time)
  - Pulse Width ('Off' time)
  - Pulse Repetition Interval (PRI)
  - Total Burst Time
  - Burst Start Time
  - Burst Stop Time
  - B0 Width
  - B1 Width
  - B2 Width
  - BN-1 Width
  - Inter-Burst Spacing, B0 to B1
  - Inter-Burst Spacing, B1 to B2
  - Total Profile Time
  - Profile Start Time
  - Profile Stop Time
FCC Radar Test Waveforms (Short Pulse)
(Version FCC-06-96)

6.1 Short Pulse Radar Test Waveforms

Table 5 – Short Pulse Radar Test Waveforms

<table>
<thead>
<tr>
<th>Radar Type</th>
<th>Pulse Width (μsec)</th>
<th>PRI (μsec)</th>
<th>Number of Pulses</th>
<th>Minimum Percentage of Successful Detection</th>
<th>Minimum Number of Trials</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1428</td>
<td>18</td>
<td>60%</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>1-5</td>
<td>150-230</td>
<td>23-29</td>
<td>60%</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>6-10</td>
<td>200-500</td>
<td>16-18</td>
<td>60%</td>
<td>30</td>
</tr>
<tr>
<td>4</td>
<td>11-20</td>
<td>200-500</td>
<td>12-16</td>
<td>60%</td>
<td>30</td>
</tr>
<tr>
<td>Aggregate (Radar Types 1-4)</td>
<td></td>
<td></td>
<td></td>
<td>80%</td>
<td>120</td>
</tr>
</tbody>
</table>

- Th
- Type 1-4 is made up of multiple pulse but only contain a single burst
- A minimum of 30 unique waveforms are required for each of Types 2 – 4.
- The DFS Radar Profile Generator provides this randomness requirement with a push of a button to create multiple waveforms.
FCC New Short Pulse Radar Type 1 defined in FCC-13-22

### Table 5 - Short Pulse Radar Test Waveforms

<table>
<thead>
<tr>
<th>Radar Type</th>
<th>Pulse Width (μsec)</th>
<th>PRI (μsec)</th>
<th>Number of Pulses</th>
<th>Minimum Percentage of Successful Detection</th>
<th>Minimum Number of Trials</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>1428</td>
<td>18</td>
<td>See Note 1</td>
<td>See Note 1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>Test A: 15 unique PRI values randomly selected from the list of 23 PRI values in Table 5a. Roundup ( \left\lfloor \frac{1}{360} \right\rfloor \times \left( \frac{19 \times 10^6}{PRI_{μsec}} \right) )</td>
<td>60%</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test B: 15 unique PRI values randomly selected within the range of 518-3066 μsec, with a minimum increment of 1 μsec, excluding PRI values selected in Test A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1-5</td>
<td>150-250</td>
<td>23-29</td>
<td>60%</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>6-10</td>
<td>200-500</td>
<td>16-18</td>
<td>60%</td>
<td>30</td>
</tr>
<tr>
<td>4</td>
<td>11-20</td>
<td>200-500</td>
<td>12-16</td>
<td>60%</td>
<td>30</td>
</tr>
<tr>
<td>Aggregate (Radar Types 1-4)</td>
<td></td>
<td></td>
<td>80%</td>
<td>120</td>
<td></td>
</tr>
</tbody>
</table>

**Note 1:** Short Pulse Radar Type 0 shall only be used for the channel availability and detection bandwidth tests. It should be noted that any of the radar test waveforms 0 – 4 can be used for the channel availability and detection bandwidth tests.

- Old FCC Type 1 is defined as New Type 0. Fixed Pulse Width, PRI and Number of Pulses, mainly used as Reference like ETSI.
- New FCC Type 1 is defined as the table, which has 15 unique PRI pre-defined and the remaining pulse PRI are selected within the range.
FCC Waveforms (Long Pulse)

Table 6 – Long Pulse Radar Test Waveform

<table>
<thead>
<tr>
<th>Radar Type</th>
<th>Pulse Width (μsec)</th>
<th>Chirp Width (MHz)</th>
<th>PRI (μsec)</th>
<th>Number of Pulses per Burst</th>
<th>Number of Bursts</th>
<th>Minimum Percentage of Successful Detection</th>
<th>Minimum Number of Trials</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>50-100</td>
<td>5-20</td>
<td>1000-2000</td>
<td>1-3</td>
<td>8-20</td>
<td>80%</td>
<td>30</td>
</tr>
</tbody>
</table>

Most difficult profile to pass, since every parameter is random, either from burst to burst or within a given burst
- Number of bursts is random, but profile is always 12 seconds long
- Pulse width, chirp BW, and number of pulses are random from burst to burst
- PRI is random within a given burst, implying that pulses are not evenly spaced within a burst

DFS Introduction and Test Solution
FCC Waveforms (Frequency Hopping Pulse)

Table 7 – Frequency Hopping Radar Test Waveform

<table>
<thead>
<tr>
<th>Radar Type</th>
<th>Pulse Width (μsec)</th>
<th>PRI</th>
<th>Pulses per Hop</th>
<th>Hopping Rate (kHz)</th>
<th>Hopping Sequence Length (msec)</th>
<th>Minimum Percentage of Successful Detection</th>
<th>Minimum Number of Trials</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>1</td>
<td>333</td>
<td>9</td>
<td>0.333</td>
<td>300</td>
<td>70%</td>
<td>30</td>
</tr>
</tbody>
</table>

Multi-burst profile, where the only change from burst to burst is the center frequency

• Overall hop frequency range is from 5.250 – 5.724 GHz, with 1 MHz channel spacing (or equivalently 475 center frequencies). 100 frequencies are randomly selected (100 hops * 3 msec/hop = 300 msec total profile time)

• From the random frequency list, it is acceptable to only generate pulses at frequencies that are within the channel bandwidth of the UUT, since out of band pulses won’t be detected.
Introduction to DFS

DFS Radar Profiles Definition

DFS Test procedure and measurement requirements

DFS Standard Operation Procedure from Agilent
# FCC DFS Test Requirements:

## Prior to Transmission:

<table>
<thead>
<tr>
<th>DFS Requirements Prior to Use of Channel</th>
<th>Master</th>
<th>Client (w/o radar detection)</th>
<th>Client (w/radar detection)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Non-Occupancy Period</strong></td>
<td>Yes</td>
<td>Not required</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>DFS Detection Threshold</strong></td>
<td>Yes</td>
<td>Not required</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Channel Availability Check Time</strong></td>
<td>Yes</td>
<td>Not required</td>
<td>Not required</td>
</tr>
<tr>
<td><strong>Uniform Spreading</strong></td>
<td>Yes</td>
<td>Not required</td>
<td>Not required</td>
</tr>
<tr>
<td><strong>U-NII Detection Bandwidth</strong></td>
<td>Yes</td>
<td>Not required</td>
<td>Yes</td>
</tr>
</tbody>
</table>

## In-Service:

<table>
<thead>
<tr>
<th>DFS Requirements During Operation</th>
<th>Master</th>
<th>Client (w/o radar detection)</th>
<th>Client (w/radar detection)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DFS Detection Threshold</strong></td>
<td>Yes</td>
<td>Not required</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>U-NII Detection Bandwidth</strong></td>
<td>Yes</td>
<td>Not required</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Channel Closing Transmission Time</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Channel Move Time</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
FCC DFS Test Specification

• Detection Threshold Requirements:

<table>
<thead>
<tr>
<th>Maximum Transmit Power (eirp)</th>
<th>Value (see note)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 200 milliwatt</td>
<td>-64 dBm</td>
</tr>
<tr>
<td>&lt; 200 milliwatt</td>
<td>-62 dBm</td>
</tr>
</tbody>
</table>

Note 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna
Note 2: In the proposed test procedures an additional 1dB has been added to the amplitude of the test transmission waveforms to account for variations in measurement equipment.

• Channel Shutdown Requirements:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-occupancy period</td>
<td>30 minutes</td>
</tr>
<tr>
<td>Channel Availability Check Time</td>
<td>60 seconds</td>
</tr>
<tr>
<td>Channel Move Time</td>
<td>10 seconds</td>
</tr>
<tr>
<td>Channel Closing Transmission Time</td>
<td>200 ms + an aggregate of 60 milliseconds over remaining 9.8 seconds</td>
</tr>
<tr>
<td>U-NII Detection Bandwidth</td>
<td>Minimum 80% of the UNII 99% transmission power bandwidth</td>
</tr>
</tbody>
</table>
Detection Bandwidth

• Set the UUT up as a standalone device (no associated Client or Master, as appropriate) and no traffic.

• Generate a single radar Burst Type 1 Short Pulse at center frequency of operating channel, and note the response of the UUT. Repeat for a minimum of 10 trials.

• Starting at the center frequency of the UUT operating Channel, increase/decrease the radar frequency in 1 MHz steps, repeating the test.

• Record the highest frequency (denote as $F_H$) and lowest frequency (denote as $F_L$) at which $\geq 90\%$ of radar bursts are detected. Detection Bandwidth $= F_H - F_L$

• Pass criteria: Detection Bandwidth is at least 80% of the U-NII 99% transmission power BW for operating channel.

• Note: No transmission can be detected by a spectrum analyzer in this case, so UUT must be able to indicate successful detection of radar signal.
Detection Bandwidth (FCC as example)

99% Bandwidth ~ 16.48MHz, 16.48MHz x 80% ~ 13.18MHz. FH - FL should > 13.18MHz, use Type 1 radar with Minimum 90% detection rate.

Test Channel: 5300MHz

<table>
<thead>
<tr>
<th>Radar Frequency (MHz)</th>
<th>DFS Detection Trials (1= Detection, 0= No Detection)</th>
<th>Detection Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5290</td>
<td>1 1 1 1 1 0 0 0 0 0</td>
<td>0</td>
</tr>
<tr>
<td>5291 (FH)</td>
<td>1 1 1 1 0 0 0 0 0 0</td>
<td>100</td>
</tr>
<tr>
<td>5292</td>
<td>1 1 1 1 1 1 1 1 1 1</td>
<td>100</td>
</tr>
<tr>
<td>5293</td>
<td>1 1 1 1 1 1 1 1 1 1</td>
<td>100</td>
</tr>
<tr>
<td>5294</td>
<td>1 1 1 1 1 1 1 1 1 1</td>
<td>100</td>
</tr>
<tr>
<td>5295</td>
<td>1 1 1 1 1 1 1 1 1 1</td>
<td>100</td>
</tr>
<tr>
<td>5296</td>
<td>1 1 1 1 1 1 1 1 1 1</td>
<td>100</td>
</tr>
<tr>
<td>5297</td>
<td>1 1 1 1 1 1 1 1 1 1</td>
<td>100</td>
</tr>
<tr>
<td>5298</td>
<td>1 1 1 1 1 1 1 1 1 1</td>
<td>100</td>
</tr>
<tr>
<td>5299</td>
<td>1 1 1 1 1 1 1 1 1 1</td>
<td>100</td>
</tr>
<tr>
<td>5300</td>
<td>1 1 1 1 1 1 1 1 1 1</td>
<td>100</td>
</tr>
<tr>
<td>5301</td>
<td>1 1 1 1 1 1 1 1 1 1</td>
<td>100</td>
</tr>
<tr>
<td>5302</td>
<td>1 1 1 1 1 1 1 1 1 1</td>
<td>100</td>
</tr>
<tr>
<td>5303</td>
<td>1 1 1 1 1 1 1 1 1 1</td>
<td>100</td>
</tr>
<tr>
<td>5304</td>
<td>1 1 1 1 1 1 1 1 1 1</td>
<td>100</td>
</tr>
<tr>
<td>5305</td>
<td>1 1 1 1 1 1 1 1 1 1</td>
<td>100</td>
</tr>
<tr>
<td>5306</td>
<td>1 1 1 1 1 1 1 1 1 1</td>
<td>100</td>
</tr>
<tr>
<td>5307</td>
<td>1 1 1 1 1 1 1 1 1 1</td>
<td>100</td>
</tr>
<tr>
<td>5308</td>
<td>1 1 1 1 1 1 1 1 1 1</td>
<td>100</td>
</tr>
<tr>
<td>5309 (FH)</td>
<td>0 0 0 0 0 0 0 0 0 0</td>
<td>0</td>
</tr>
<tr>
<td>5310</td>
<td>0 0 0 0 0 0 0 0 0 0</td>
<td>0</td>
</tr>
</tbody>
</table>

Detection Bandwidth = FH - FL = 5309MHz - 5201MHz = 18MHz
EUT 99% Bandwidth = 16.48MHz
UNII Detection Bandwidth Min. Limit = 16.48MHz x 80% = 13.184MHz
CAC Testing

– Measure with spectrum analyzer: Zero span, 3 MHz RBW and 3 MHz VBW on the Channel occupied by the radar with a 2.5 minute sweep time

1. Initial Availability Check at power-up: This test does not use any Radar Waveforms and only needs to be performed one time. The UUT should not transmit any beacon or data transmissions until at least 1 minute after the completion of the power-on cycle.

2. A single Burst of one of the Short Pulse Radar Types 1-4 will commence within a 6 second window starting at T1 (after power up).

3. A single Burst of one of the Short Pulse Radar Types 1-4 will commence within a 6 second window starting at T1+ 54 seconds.
CAC Testing: Initial Availability Check

After UUT power on (time T1 to finish the necessary firmware operation process, declared by customer), verify that UUT does not begin any transmission for at least 60 seconds (CAC time).
CAC Testing: Burst at Beginning of CAC Time

1. Trigger the type 1 radar within first 6 seconds of CAC time (after power-up).
2. Verify detection of radar burst.
3. Verify that no UUT transmissions occurred 2.5 minutes after the radar Burst has been generated.

- **UUT power On finished**
- **Send type 1 Radar within 6 seconds after end of power-on time (Customer provides the timing information)**

![Diagram showing CAC testing](image-url)
CAC Testing: Burst at End of CAC Time

1. Trigger the type 1 radar within last 6 seconds of CAC time (after power-up); this is beginning at T1 + 54 seconds.
2. Verify detection of radar burst.
3. Verify that no UUT transmissions occurred 2.5 minutes after the radar Burst has been generated.
In-Service Monitoring

- Stream the MPEG test file from the Master Device to the Client Device on the test Channel for the entire period of the test. (FCC provides the file)

- At time $T_0$ the Radar Waveform generator sends a Burst of pulses for one of the Short Pulse Radar Types 1-4.

- Observe the transmissions of the UUT from the end of the radar Burst on the Operating Channel ($T_1$) for duration greater than 10 seconds. Measure and record the transmissions from the UUT during the observation time (Channel Move Time). Measure and record the Channel Move Time and Channel Closing Transmission Time if radar detection occurs.

- When UUT is operating as a Master Device, monitor the UUT for more
In Service Testing Results (Non-Occupy Period)

SA sweep time 2200sec (30 min.s + pre-trigger time)

No new communication in 2200s.
DFS Timing Sequence Test Procedure

1. CAC, 60 Sec.
   - System starts up, selects a channel and monitors for radar
   - No traffic on channel during CAC
   - Radar signals on the channel
   - Data traffic on channel

2. Chan Move, 10 Sec.
   - System detects radar on the selected channel and initiates a move to another channel
   - Control transmissions to close the channel
   - No traffic on channel during CAC
   - Data traffic on channel

3. Non-Occupy, 30 Min.
   - Non occupancy period – the original channel cannot be used
   - No traffic permitted during non-occupancy period
   - System selects another channel and monitors for radar
   - No traffic on channel during occupancy check
   - Data traffic on the new channel

0a: Detection Threshold: -62 dBm or -64 dBm
0b: Detection bandwidth: 80% of the 99% transmission power bandwidth
1: Channel availability check time
2a: Channel move time
2b: Channel closing transmission time: \( \Sigma t_1 \ldots t_n \)
3: Non-occupancy period
Agenda

• Introduction to DFS

• DFS Work Flow and Radar Profiles

• DFS Test procedure and challenges

• DFS Standard Operation Procedure from Agilent
DFS Testing Procedure (S.O.P.) from Agilent

**DFS Testing Steps:**

1. Setting Test Set Signal Path Configuration
2. Calibrate and Verify (DUT site corrected power)
3. Connect DUT (Master) into transfer mode
4. Testing Detection Bandwidth (Debug Mode)
5. Testing Statistical Performance Check (Debug Mode)
6. CAC Testing (Non-Debug Mode)
7. In-Service Mode testing (Non-Debug mode)
8. Non-Occupancy testing (Non-Debug mode)
7.2.1 Setup for Master with injection at the Master

UUT Received Radar in -62 dBm

~ 70dB Loss

~ 30dB Loss

~ 70dB Loss

Figure 2: Example Conducted Setup where UUT is a Master and Radar Test Waveforms are injected into the Master
Typical setup configuration

802.11a Master

802.11a Client

Control PC

Cable/adapter Set

Splitter/Attenuators package

UUT

Client

DFS Introduction and Test Solution
Calibrate and Verify

Vector Signal Source

Power Splitter or Combiner

~70 dB Attenuation

Spectrum Analyzer

10dB ATT

30dB ATT

30dB ATT

10dB ATT

Client
Setting Test Set Signal Path Configuration

Vector Signal Source

Power Splitter or Combiner

Spectrum Analyzer

~70 dB Attenuation

10dB ATT

UUT (Master)

Client

HARDWARE + SOFTWARE + PEOPLE = INSIGHTS
DFS Radar Profiles Signal Generation

- Agilent N7607B Signal Studio for DFS Radar Profiles
  - HW platforms: EXG, MXG-A/B, ESG, PSG signal generators
- Main features
  - Support Radar profiles defined by FCC, ETSI, Japan MIC and Korea DFS standard: pulsed, chirped, frequency hopping
  - In band Frequency hopping (implemented in baseband)
- Implementation
  - Use marker file to control RF blanking for pulse signal generation: no special pulse modulation capability needed in signal generator
  - Use sequences for repeatable patterns to save memory
- Not compatible with waveform 5 pack/50 pack licenses: use of sequences makes it difficult to configure tests
N7607B Signal Studio for Radar Profiles Key Features

- ETSI Radar Test Signals
  - ETSI EN 301-893 v1.7.1
  - ETSI EN 802 502 V1.2.1
- Japan MIC Radar Test Signals: 5250-5350 MHz Band & 5470-5725 MHz Band
- Controllable number of trials and waveform generated for each trial is unique.
- Randomized sets of radar parameters can be regenerated.
- Sequence approach is used to save memory and for fast waveform generation and downloading
- Using RF blanking for pulse signal generation
- Trials can be controlled from GUI one by one.
- Parameters for each burst will be shown.
- Some parameters are editable and settings can be saved/loaded.
- Provide .NET API for programming
N7607B Signal Studio for WLAN Update

- Enhancement in V2.0.0.1: Jan. 2015
- Add new FCC Type 1 radar profile support defined in FCC-13-22 version
- Add Type 1-3 fixed radar profiles and Type 4 hopping radar profiled defined in Korean DFS standard
- Add fixed frequency Type 1-6 radar profiles and frequency hopping radar profiles Type 1-2 defined in ETSI 302 502 Version 1.2.1
- Support mixed radar profiles generation
- Support customer defined trial interval time after each Trial
- Support download all trials at one time with unique trial names
DFS Solution Signal Demo FCC – Type 1 (Short Pulse)

- FCC Type 1 as shown in N7607B

FCC Type 1 Pulses shown in Spectrum Analyzer
- Zero span
- 8 MHz RBW
- 30 ms sweep time
- 18 pulses shown with equal power
### DFS Solution Signal Demo FCC – Type 5 (Long Pulse)

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<th>Number of Bursts</th>
<th>Burst Period (s)</th>
<th>Waveform Length (s)</th>
<th>Burst ID</th>
<th>Burst Offset (us)</th>
<th>Pulse Width (us)</th>
<th>Chirp Width (MHz)</th>
<th>Number of Pulses per Burst</th>
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- FCC Type 5 Long Pulse generated by N7607B with detailed parameters shown in the table.
- Each burst is unique with random burst offset, pulse width, chirp width, number of pulses and PRI for each pulse. All parameters are within the range as FCC regulation defined.
DFS Solution Signal Demo FCC – Type 5 (Long Pulse)

FCC Type 5 Long Pulses shown in Spectrum Analyzer
- Zero span
- 8 MHz RBW
- 15 sec sweep time
- 15 bursts shown
DFS Solution Signal Demo FCC – Type 5 (Demod)

FCC Type 5 Long Pulses shown in Spectrum Analyzer with 89601B VSA SW
- Analog Demod: FM
- Trace A: spectrum
- Trace B: waveform envelop
- Trace C: FM Demo waveform

Frequency Spectrum

Waveform Envelop

FM demodulated waveform
DFS Solution Signal Demo FCC – Type 6 (Frequency Hopping Pulses)

- Channel bandwidth is 160 MHz which can be user-defined
- 100 hopping frequencies are randomly selected from the 5.250 GHz to 5.724 GHz.
- Only pulses in blue color are generated in the waveform because they are hopping inside the band of UUT.
DFS Solution Signal Demo FCC – Type 6 (Hopping)

FCC Type 6 Hopping Frequency Pulses shown in Real-time SA
- Span: 160 MHz
- Sweep time: 3 ms
- Frequency is hopping and radar signals hop inside the UUT bandwidth will be detected and shown in the Spectrogram
In Service Testing Results
(Channel moving time & Channel closing time)

Record trace from Signal Analyzer for analysis using offline tool

Limit 10 seconds (Pass)
Limit 260 ms (Fail)
Thank you!