Elliott Laboratories Presents

Dynamic Frequency Selection Requirements

An overview of radar detection requirements for wireless devices operating in the 5 GHz band (with emphasis on the new FCC rules)

Presented January 31, 2007

Agenda

- Definition of Dynamic Frequency Selection (DFS)
- Origins of DFS Requirements in USA and EU
- Overview of Current Standards in USA, EU
- Affected Product Types and Device Classifications
- Basic DFS Testing Requirements & Terminology
- Using Test Labs and TCBs for DFS Compliance
- The FCC submittal process
- Q&A Session

Dynamic Frequency Selection

A channel allocation scheme that dynamically selects and/or changes the operating frequency to avoid interfering with (or interference from) other systems

- For this webinar
  - Evaluation of DFS capabilities of 5GHz WLAN devices
  - Primarily concerned with avoiding causing interference to other systems
  - Does not address Transmit Power Control or Uniform Channel Loading requirements

Background History

- Worldwide, the frequency bands 5250 – 5350 and 5470 – 5725 MHz are used by radar systems
- The same frequency bands (or subset(s) thereof) were allocated to unlicensed WLAN devices
- The European Union addressed potential interference issues to existing radar systems in the standard EN 301 893 V1.2.3 by requiring DFS
  - The evaluation of DFS was based on the ability for a system to be capable of detecting three radar types
  - Became a harmonized standard in
  - The latest version (EN 301 893 V1.3.1) adds other radar types
  - Supersedes V1.2.3 as of March 31st 2008

(Note that not all EU countries have adopted the allocation)

Background History(US)

- The FCC allocated 5150 – 5350 MHz for unlicensed devices (U-NII, FCC Part 15 Subpart E)
- Pressure to open up 5470 – 5725 MHz spectrum to match that being opened in other geographies for 802.11a
  - Band already assigned to the Department of Defense (DoD) for radar systems
  - DoD would only permit the allocation of the band if the systems employed DFS
  - DFS evaluation had to demonstrate that systems would be capable of responding to all of DoD radar systems
  - DFS requirements extended into the previously non-DFS 5250 – 5350 MHz sub-band

Background History(US)

- Project Team established to develop test requirements and methods
- Comprised of representatives from
  - DoD
  - FCC
  - Wireless manufacturing industry (predominantly 802.11a)
  - Testing laboratories

Background History(US)

- Problems with defining the different radar types to be used during the evaluations
  - DoD had a need to keep the actual radar signatures confidential
  - Made it difficult to determine what would be "representative"
  - Did not want devices to detect specific patterns, rather be capable of responding to a wide variety of signals
    - Addressed by incorporating a randomizing element into the various radar types

Background History(US)

- Problems with defining the different radar types to be used during the evaluations
  - Expanded the 1us and 2us pulse width of the EN 301 893 V1.2.3 standard to widths exceeding 20us
    - The > 20us pulse width caused concerns with industry because of the similarity to the width of 802.11 packets
    - After working on detection algorithms agreement reached
  - Requirement for simulation of frequency-hopping radar
    - Cost of test equipment became an issue
    - Worked on alternate simulation methods

Background History(US)

- Bench tests by the NTIA and NIST evaluated the test methods on several sample systems
- DoD did live trials on the same systems with real radar
- Results of both tests gave confidence in the proposed requirements and methods
- FCC released requirements and methods in the second quarter of 2006
  - Report and order FCC-06-96A1
  - FCC Part 15.37 (l)
  - Rules apply NOW to all unlicensed devices certified after July 20 2006
  - Products certified before July 20 2006 will need to be re-certified (for DFS) if they are to be sold after July 20, 2007

Background History

- Other countries are including DFS requirements into their rules for WLANs in the 5250 – 5350 / 5470 – 5725 MHz bands
  - Japan (5250 – 5350 MHz allocation)
  - Australian standard AS/NZS 4268:2003 + A1:2004
  - Canada RSS 210
    - Canadian rules still have to define test methods and radar types for evaluating master devices
    - Certification bodies **cannot** be used for master devices at this time as radar types/test methods not defined in RSS 210

Background History

- DFS requirements expanded to other frequency bands
  - EN 302 502 standard for licensed devices operating in the 5725 to 5850 MHz band (not harmonized)

What does DFS Require ?

- A system that requires DFS needs to be capable of avoiding interfering with radar systems by
  - Verifying a channel is free of radar before using it
  - Monitoring for radar once a channel is in use and vacating the channel if radar is detected
  - Remaining off of a “radar” channel
  - Loading channels equally (Uniform Loading)
  - Transmitting only the power required (Transmit Power Control) for successful communications

How is DFS Implemented ?

- Channel Availability Check
  - System selects a channel to use
  - Cannot transmit on the channel until it has been monitored for the *channel availability check time* to verify no radar devices are present (above the threshold level)
  - If radar is detected
    - Do not use the channel
    - Avoid using/selecting the channel for the non-occupancy period
    - Select another channel and start again

How is DFS Implemented ?

- In service monitoring
  - Monitor the channel being used
  - If radar is present above the threshold level
    - Vacate the channel within the *channel move time*
    - During the channel move time, limit total duration of transmissions to less than the *channel closing transmission time*
    - Not use the channel for the non-occupancy period

How is DFS Implemented ?

- Non Occupancy Period
  - If radar is detected on a channel the system cannot use the channel for the non-occupancy period
- Radar Detection Bandwidth
  - System shall be capable of detecting radar across the same bandwidth as the system's transmitted signal bandwidth

Typical System

- A typical system, such as an 802.11a network, consists of
  - Master device
  - Client device(s)
    - Some “Client” devices have “Ad Hoc” capabilities
- Other systems may use a different topology

DFS Device Classifications

- Master Device
  - Device that controls a network
    - Devices under its control (client, aka slave) cannot transmitting unless authorized by the master
    - Clients are associated with a master device
  - Must be able to detect radar
    - Prior to starting on a frequency (channel start-up)
    - While communicating (in-service)
  - Maintains a database of “radar channels”
    - Cannot use those channels for the non-occupancy period

DFS Device Classifications

- Master Device
  - On detecting radar must
    - Tell all associated clients to stop within the channel move time
    - Select a new channel

DFS Device Classifications

- Client Device (Infrastructure Mode)
  - Cannot initiate communication, can only transmit when authorized by a master
  - Must be able to clear a channel when commanded by a master device
  - Active scanning not allowed – passive scanning only
- Ad Hoc mode
  - Mode that supports client-client initiated communication
  - Requires devices that support this mode to have the same attributes as a master device

DFS Device Tests

Test	Master	Client
Non-occupancy period	X	-
Detection probability / threshold	X	-
Channel Availability Check	X	-
Detection Bandwidth	X	-
Channel move / closing transmission time	X	X

DFS – Simulated Radar Signals

- To evaluate DFS a system is subjected to a simulated radar signal
- The radar signal consists of a series (burst) of pulses
- The main parameters for the signals are
  - Width of each pulse
  - Time between each pulse (pulse repetition interval, pri)
  - The total number of pulses
  - The amplitude of the pulse
  - The modulation of each pulse, if any
- Regulations for specific geographic regions could have different waveforms (we'll look at EN and FCC)

FCC Simulated Radar Signals

- The FCC evaluation of DFS includes a total of 6 different radar signals
- The detection of the radar signals is evaluated over a number of trials (minimum of 30 for each radar type)
  - The “probability” of detection is calculated by dividing the number of successful detections by the total number of trials
- Apart from radar types 1 and 6, the pulse width, number of pulses and pri are listed as a range
  - The test is performed by selecting, at random, a value within the range (step intervals of 0.1us for width; 1us for interval; 1MHz for FM chirp and 1 for number of pulses)
  - For parameters with a range, each trial uses a different signal

FCC Simulated Radar Signals

Radar signals 1 through 4

Fixed Frequency Radar Type	Pulse Width (µsec)	PRI (µsec)	Number of Pulses per burst	Minimum Probability of detection for the U-NII Device
1-Fixed	1	1428	18	60%
2- Variable	1-5	150-230	23-29	60%
3- Variable	6-10	200-500	16-18	60%
4- Variable	11-20	200-500	12-16	60%
Average detection probability for types 1 - 4				80%

FCC Simulated Radar Signals

Radar Signal 5

(Long Pulse Radar Test Waveform)

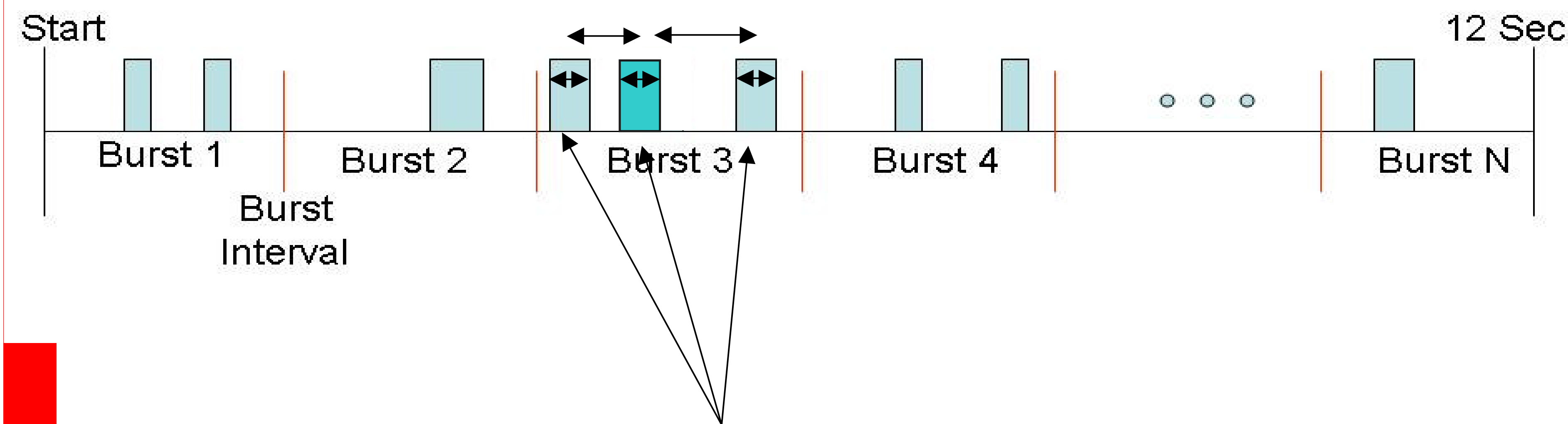
- This consists of a 12 second-long waveform with multiple different bursts.

Pulse Width (µsec)	PRI (µsec)	Chirp Width (MHz)	Number of Pulses per burst	Number of Bursts	Minimum Probability of detection
50 - 100	1000 - 2000	5 - 20	1 - 3	8 - 20	80%

FCC Long Duration Waveform

- The 12-second waveform is split into n equal intervals, where n is the number of bursts.
  - For 10 bursts, the interval is 1.2s
- Each burst is located within each interval
- Each burst has different
  - Pulse width , pulse modulation, number of pulses
- Within an individual burst
  - pulses have the same width
  - pulses have the same modulation
  - the interval between pulses is different
  - the first pulse appears at a random time in the burst’s interval

FCC Long Duration Waveform Example



Burst 3 has 3 pulses

Each pulse has the same width and the same chirp

The interval between from pulse 1 to 2 is not the same as pulse 2 to pulse 3

FCC- Frequency Hopping Radar

Pulse Width (µs)	Pulse Repetition Interval (pri) (µs)	#Pulses per Frequency Hop	Hopping Sequence Length ms	Hopping rate	Minimum Probability of detection
1	333	9	300	333 Hz	70%

- Radar hops over the entire frequency range 5250 – 5724 MHz (each channel = 1MHz = 475 channels)
- The radar hops across the 475 channels in a random manner without using the same channel twice
- The 100 channel sequence is applied ONLY if it includes one or more frequencies that fall in the detection bandwidth of the device under test

EN 301 893 Simulated Radar Signals

- The EN 301 893 v1.3.1 includes 6 different radar signals
- The detection of the radar signals is evaluated over a number of trials (minimum of 10 for each radar type)
  - The "probability" of detection is calculated by dividing the number of successful detections by the total number of trials
  - The standard requires probability to be evaluated during in-service monitoring AND CAC tests
- Apart from radar type 1, multiple pulse widths and repetition rates are listed
  - One value for each parameter is selected at random for each trial

EN 301 893 V1.3.1
Simulated Radar Signals

Fixed Frequency Radar Type	Pulse Width (µsec)	PRF (pps)	Number of Pulses per burst	Minimum Probability of detection
1-Fixed	1	750	15	60%
2- Variable	1,2,5	200,300,500, 800, 1000	10	60%
3- Variable	10,15		15	60%
4- Variable	1,2,5,10,15	1200, 1500, 1600	15	60%
5- Variable	1,2,5,10,15	2300, 3000, 3500, 4000	25	60%
6- Variable 5MHz chirp	20,30	2000, 3000, 4000	20	60%

Other DFS Requirements

Parameter	FCC	EN 301 893 V1.3.1
Non Occupancy Period	At least 30 minutes	
Channel Availability Check Time	At least 60 seconds (Note: Canada, Australia require CAC for the **5600-5650 MHz** sub-band to be 10minutes)	
Channel Move Time	No more than 10 seconds	
Channel Closing Transmission Time	200ms at the start of the channel move time, no more than 60ms during the remaining 9.8s	no more than 260ms
Radar Detection Bandwidth	≥ 80% of the 99% signal bandwidth	No requirement
Detection Threshold	-62dBm / -64dBm	-62dBm / -64dBm
Traffic during testing	Specified MPEG file and codec (~40%)	30%

- CAC for EN 301 893 is valid for 24 hrs.
- For FCC the CAC must be performed immediately before the channel is used
- Above 200mW eirp the lower detection threshold is required

DFS Testing

- Evaluation of the DFS performance is done to a system with a master and a client device
- Channel availability check and non-occupancy period is done to just the master device (radar detection device)
- In service monitoring and the associated measurements for channel move and channel closing are done to the combination

DFS Tests – Basic Configuration

- The basic elements of the test system are
  - Radar generator
    - Capable of reproducing the various radar waveforms required to evaluate DFS performance
  - Field monitoring system
    - Capable of measuring radar signal level at EUT
    - Frequency selective
    - Capable of providing timing information relative to the radar burst
      - Ideally timing resolution can resolve a single transmitted packet over a 20-second period
      - Capable of measuring over periods up to 30 minutes

DFS Tests – Basic Configuration

- Radar generator
  - Basic rf generator with pulse modulator and pulse generator for most radar types
  - High performance generator required for modulated and long duration waveform
  - Frequency hopping capability may be a challenge
    - Refer to alternative test method described in FCC R&O that avoids using a frequency agile generator
- Field monitoring system
  - Spectrum / Vector analyzer may work
  - Can use a DSO connected to the IF output of the analyzer to increase resolution

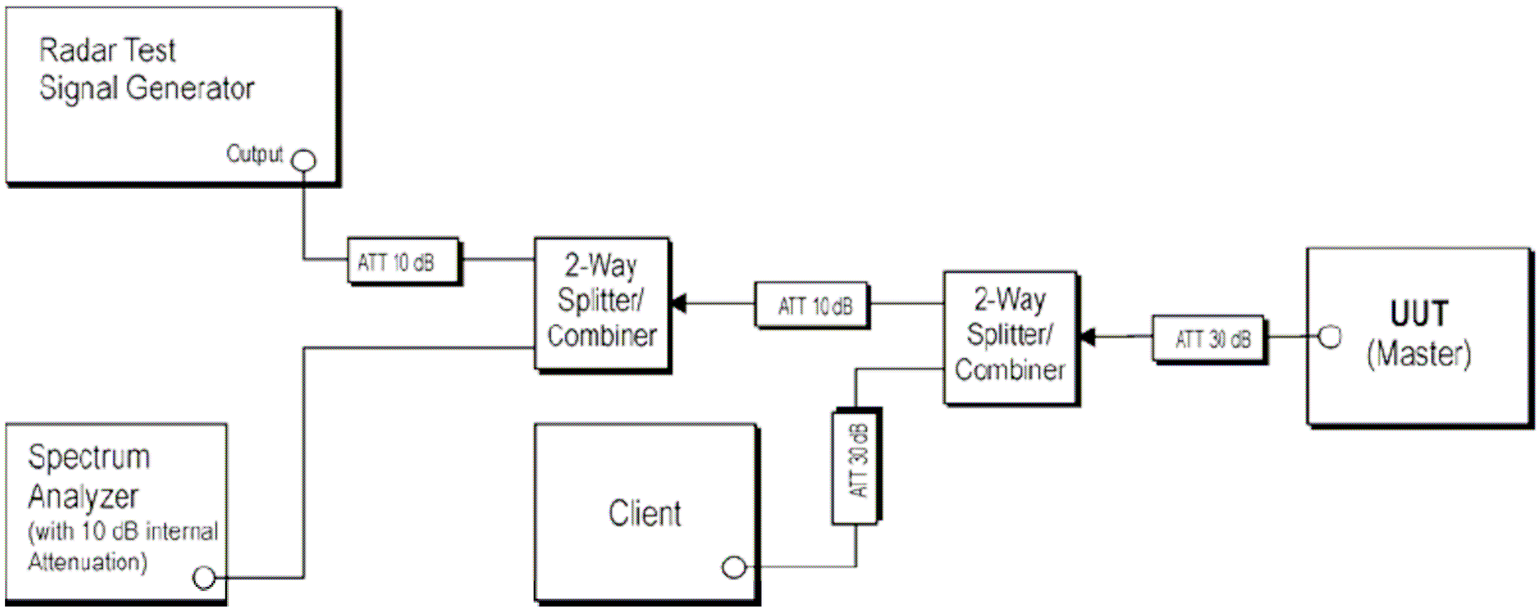
DFS Tests – Basic Configuration

- Software (or manual programming ?)
  - Generates the random patterns
  - Programs test equipment
  - Performs/facilitates timing measurements
  - Records the results for each test
    - Radar parameters
    - Radar signal level
    - Detection (yes/no)

DFS Tests – Basic Configuration

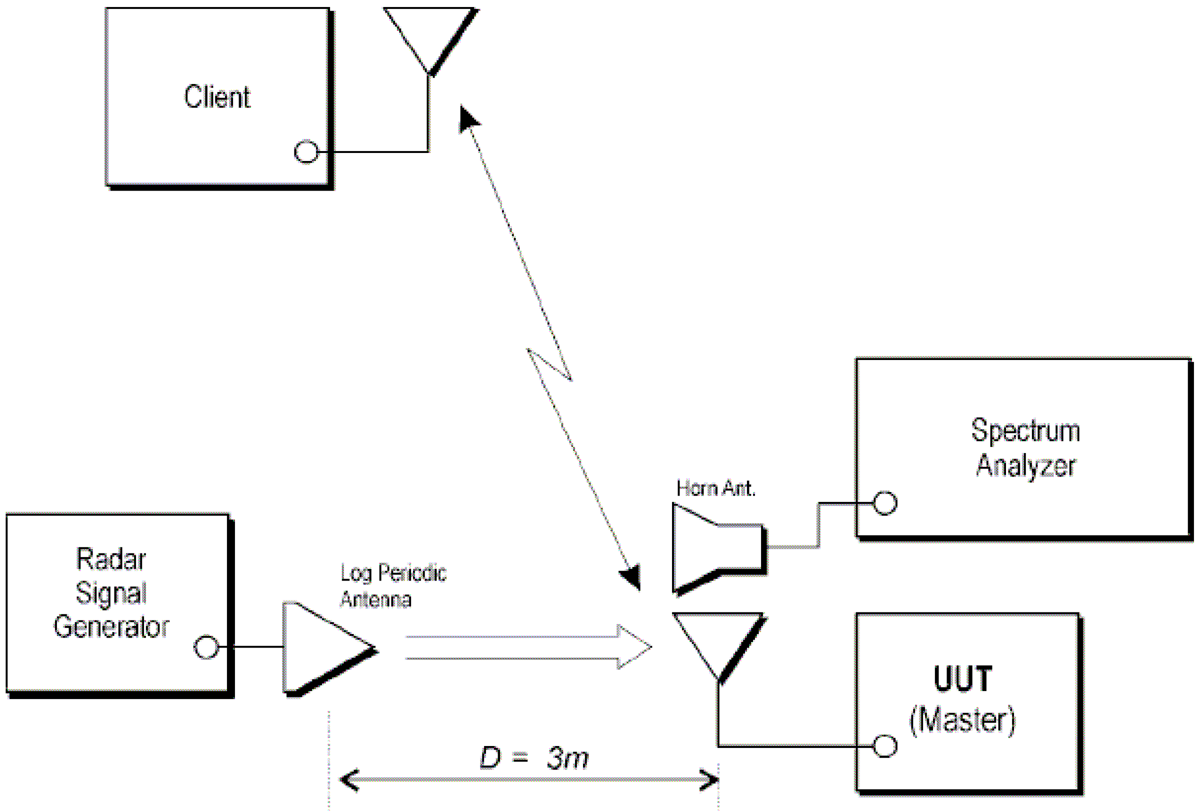
- To perform a test the simulated radar signals are applied to the master device
  - Signals can be radiated
    - Master device is configured with its lowest gain antenna
    - Client device is configured with an antenna
  - or conducted
    - Master and client are connected to test system via couplers
    - Master and client need to have co-axial adapters on their rf ports to connect to the test equipment

DFS Conducted Test Method



- Attenuator values may be modified to improve signal levels at the analyzer
- Splitters / combiners could be replaced with directional couplers

DFS Radiated Test Method



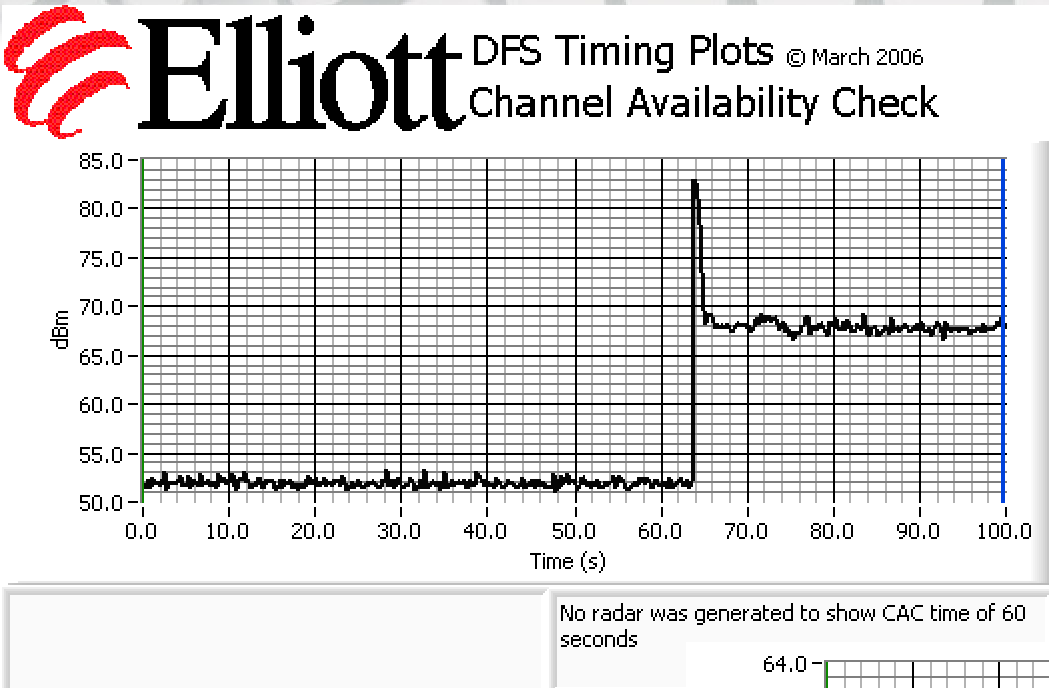
- Play with location of monitoring antenna to obtain best signal levels for CAC and In-Service monitoring

CAC Tests

- A plot is made showing the channel from the point the system is powered on to the just after the first transmission
- The test is repeated with a radar signal applied within the first 6 seconds of the start of the CAC
  - If the system cannot report the start of the CAC then the start of CAC is assumed to be 60 seconds before the first transmission
  - Plot should show the radar signal and no transmissions from the device

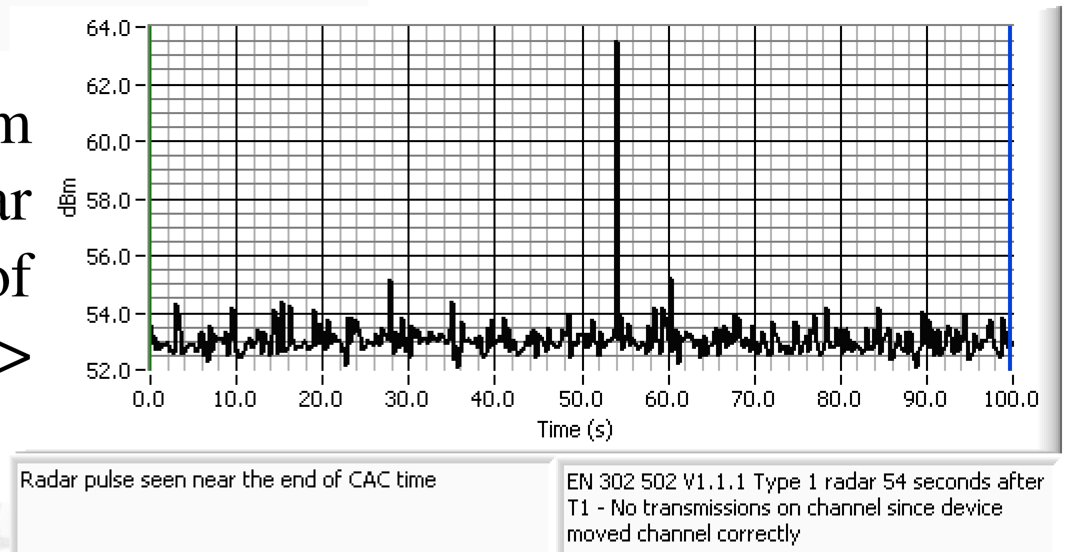
CAC Tests

- The test is repeated with a radar signal applied in the last 6 seconds of the CAC
  - If the system cannot report the start of the CAC then the start of CAC is assumed to be 60 seconds before the first transmission
  - Plot should show the radar signal and no transmissions from the device
- Radar Waveforms:
  - FCC test method only uses the type 1 waveform (assumes same algorithm used for CAC and In-Service monitoring)
  - EN 301 893 V1.3.1 wants the CAC to be evaluated with each radar waveform



<= Plot showing system starting 60 seconds after start of CAC

Plot showing no system transmissions with radar signal in last 5 seconds of CAC =>



Detection Bandwidth Tests

- Only required by the FCC
  - Only uses the type 1 waveform
  - Has to be performed on the same channel
  - Has to be performed for each channel bandwidth setting of the EUT
- The master device is operational but with no associated client devices
- Radar is applied at the center frequency (*fc*) of the channel in use ten times at (or below) the threshold level
  - Device is expected to detect 90% (9 of 10)

Detection Bandwidth Tests

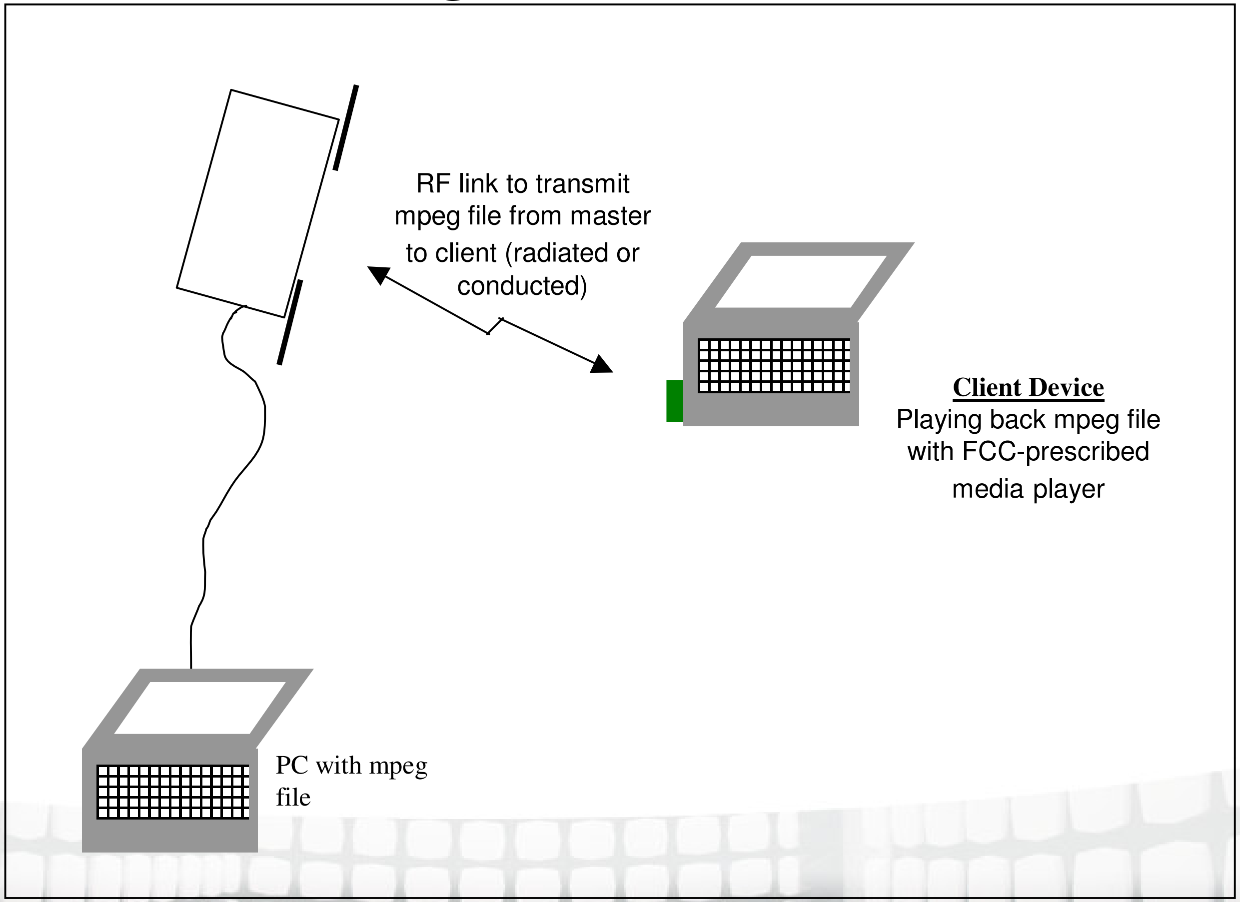
- Frequency of the radar is incremented by 1MHz and test repeated until device fails to detect 90%
- Frequency is the decremented from *fc* in 1MHz steps until device fails to detect 90%
- The frequency range over which 90% of the radar signals are detected is the radar detection bandwidth
- Has to be greater than 80% of the 99% power bandwidth of the EUT's transmitted signal

In-Service Monitoring Tests

- Tests performed with master device associated with a client device
  - EN 301 893 v1.3.1 requires transmissions from master to slave to occupy the channel at least 30% of the time
  - FCC method uses a specific mpeg file that is streamed from master to client device
    - Client device uses specific codec/media player
    - Expects to load the channel 40% of the time
  - FCC require the use of an ***FCC-approved*** master device when evaluating a client device
- Two tests are performed – probability of detection and channel move

In-Service Monitoring Tests

- Master- client configuration



In-Service Monitoring Tests

- What if I cannot use the FCC file transfer ?
  - Client device or complete system may not support windows media player
  - Need to use a method of data transfer to load the channel ~ 40% of the time
    - If your system does not support that level of activity you will need to justify using a lower occupancy
    - Generate an even channel utilization
    - Avoid using transfers that can buffer data – this can lead to high- and low- traffic patterns
- Need to have the proposed data transfer reviewed and okayed by the FCC

In-Service Monitoring Tests

- Probability of detection
  - Each radar type is applied at (or below) the threshold level
    - 20 times (for EN 301 893)
    - 30 times (FCC)
  - Probability is calculated by dividing number of detections by number of trials
  - Test mode recommended (see later slide)
  - Typically performed in one of the bands with spot checks for threshold in the other band(s)
    - Assumes same detection algorithm used in all bands

In-Service Monitoring Tests

- Channel move time / channel closing transmission time
  - For FCC measurements are made for radar types 1 and 5
  - For EN 301 893 v1.3.1 measurements are made with radar type 1
  - The master device is configured to operate in its normal mode
  - After traffic has been established at the required load on the channel the radar signal is applied
  - The monitoring system captures the radar signal and the channel traffic

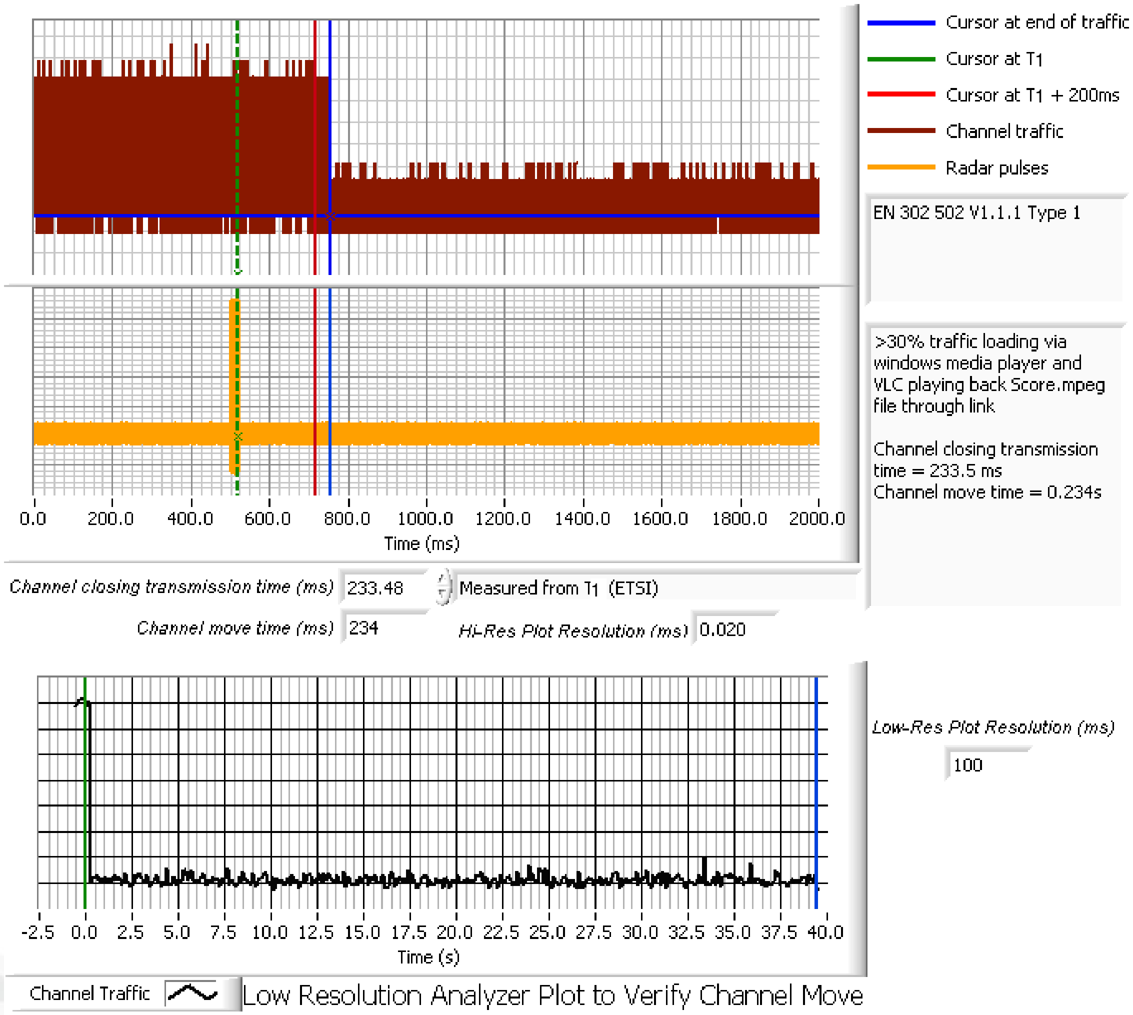
In-Service Monitoring Tests

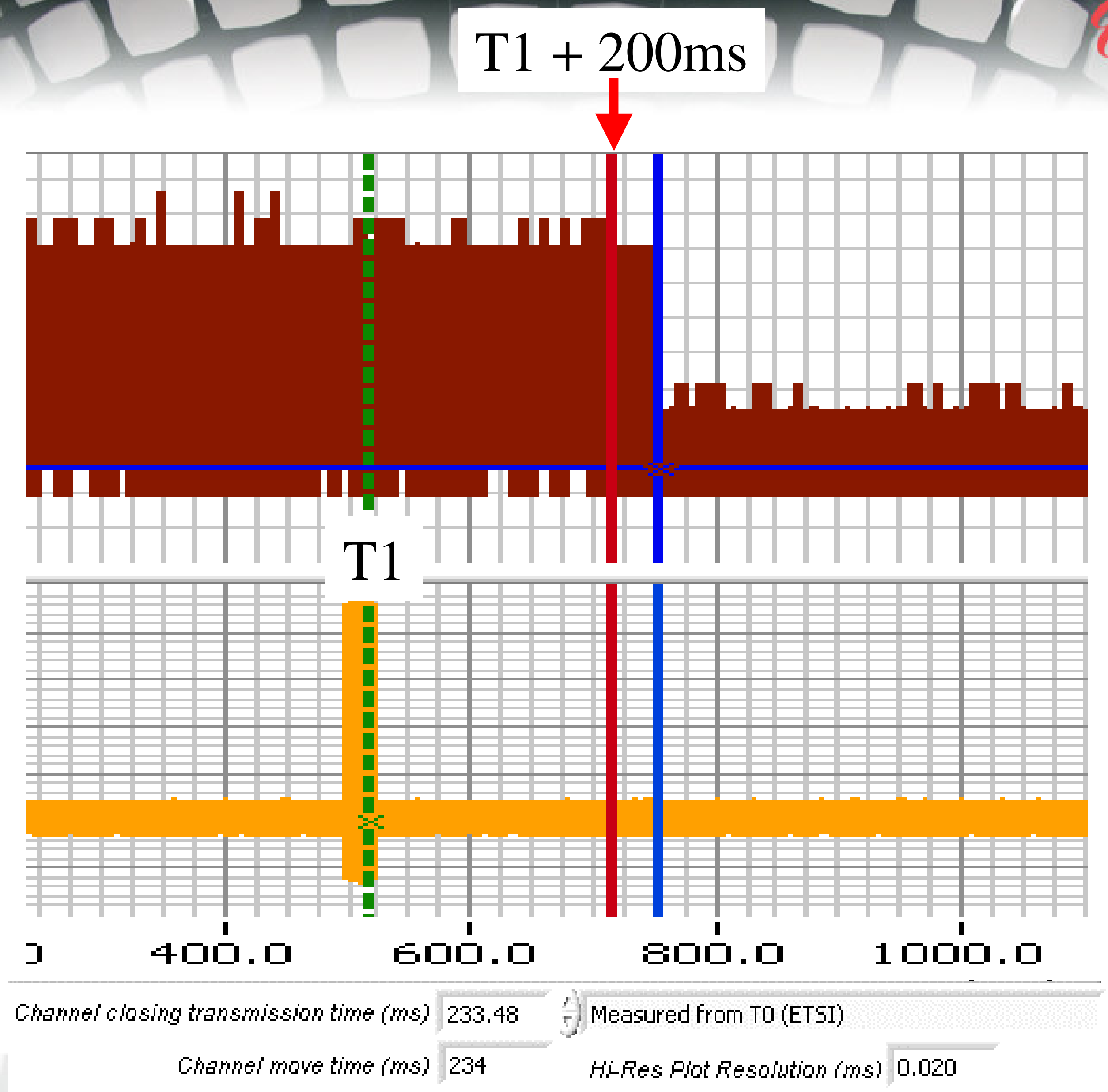
- Channel move time / channel closing transmission time
  - Channel move time is measured from the end of the radar signal (noted as T_1) to the end of transmissions on the channel
    - Should be less than 10 seconds

In-Service Monitoring Tests

- Channel move time / channel closing transmission time
  - Channel closing transmission time - FCC:
    - Total transmission time from T_1 + 200ms to the end of the channel move time
    - Should be less than 60ms
  - Channel closing transmission time - EN:
    - Total transmission time from T_1 to the end of the channel move time
    - Should be less than 260ms

Timing Plots - Channel Closing





T1 + 200ms
T1
400.0
600.0
800.0
1000.0
Channel closing transmission time (ms)
233.48
Measured from T0 (ETSI)
Channel move time (ms)
234
Hi-Res Plot Resolution (ms)
0.020

EUT Test Modes

- Master device features for rapid testing:
  - Ability to report start of CAC
  - Test mode for the probability of detection test and detection bandwidth tests
    - Inhibits channel move when radar is detected
    - Channel move replaced by reporting radar detected via serial/ethernet interface
    - Mode cannot be available to end-users
    - For FCC alone there are 180 trials for in-service monitoring and ~ 160 for detection bandwidth

Working with Test Labs and TCBs

- Test Labs and TCBs can assist with:
  - Testing to evaluate algorithms for DFS compliance
  - DFS Testing and Report Development
  - Submittals to FCC
  - Approvals (for client devices)
  - Permissive Changes
- Elliott Laboratories offers all of the services offered above!

Elliott Labs DFS Services

- If you are interested in working with Elliott Laboratories for DFS compliance you should:
  1) Contact your assigned Sales Rep
     – If you don't have one contact info@elliottlabs.com for more info
  2) Explain your specific DFS objectives
     – Be prepared to specify your device type(s) and the markets that you would like to certify your device(s) for (i.e. US, EU, or both)
  3) Request a project proposal and be prepared to provide samples of your equipment to Elliott Labs asap
     – FYI: Our DFS lead times are currently running approx 3-4 weeks
  4) Given the likelihood that your product will fail to meet the DFS requirements on the first pass, please have your firmware engineers prepared to participate in the debugging process if necessary

What information should I provide prior to testing ?

Questions your lab may ask:

- Is the EUT a master device, client device or both ?
- Will you bring your own master / client to support the testing ?
- What are the operating frequencies for the device ?
- What is the lowest antenna gain for your master device ?
- What are the operating modes your device supports (e.g. 802.11a, 802.11n, 20 MHz and 40 MHz channels) ?
- Do you need EN 301 893 V1.2.3 or EN 301 893 V1.3.1 ?

What do I need to bring to the test?

- Ideally bring both master and client devices
  - SSIDs, IP settings, mpeg file and media player pre-configured
    - If using test lab master device, ask for these settings/software so you can configure the client
    - If using test lab client device, provide settings ahead of time
    - Significant time can be spent just getting master and client to associate

What do I need to bring to the test?

- Test modes installed
  - If master does not have sufficient memory for both test mode and normal mode bring two samples
- Coaxial adapters to facilitate connection of a standard N- or SMA- coaxial connector to your master device antenna port
- Lowest gain antenna you anticipate using with the master device

The FCC Submittal Process

- Devices with radar detection DFS capabilities (master /ad-hoc) ***have*** to be submitted to the FCC
  - Approval time >> 6 weeks ….
  - Pre-certification sample request and test by FCC will be performed for the foreseeable future
  - Provide detailed operating instructions for the FCC test engineers so they understand how to run the system

The FCC Submittal Process

- Devices without radar detection DFS capabilities (client) can be submitted to a TCB
  - Approval time 1 - 2 weeks if approved master device supported the DFS tests
  - If FCC-approved master device was not used, approval will be held up until the master device is approved

FCC Submittal Documents

- List of all antennas and their gains, with data to support the high and low gain specifications.
  - Gains should account for any feed-cable loss.
- Statement that the test modes used during testing are not available to the general public

FCC Submittal Documents

- Statement that the system employs uniform loading techniques (master device)
  - the method should be described in the operational description
- Statement that the system employs transmit power control
  - the method should be described in the operational description

FCC Submittal Documents
Client Device

- FCC ID or proposed FCC ID for the Master Device
- Statement declaring that the device is not capable of operating in an ad-hoc mode, or any mode that would allow it to initiate communication in the 5GHz band.

Q&A Session

Thanks you to all participants for their attendance. The pace was fast and I hope you all managed to keep up. Judging by the questions, I think you did! I have done my best to answer all of the questions raised. A couple of questions I have grouped together because the answers overlapped to some degree.

Q: Is the 5470 or 5725 band open now in US for certification testing.

A: Yes, the band can be used for unlicensed devices. This was done on release, by the FCC, in early 2006 of test methods and acceptance criteria for the DFS-related requirements for this band.

Q: Do we need to recertify existing products if all DFS bands are disabled and not used?

A: If the existing products, certified without DFS capability, were never authorized to operate in the DFS bands (5250 – 5350 MHz and/or 5470 – 5725 MHz) then no further action is required.

If, however, the existing product, certified without DFS capability, was authorized to operate in the 5250 – 5350 MHz band then either a permissive change to add the DFS capability or a new certification to remove the 5250 – 5350 MHz band would be required prior to the June 2007 cut-off date.

Q&A Session

Q: If you meet the DFS ETSI V1.3.1 do you automatically meet V1.2.3 since people refer to both versions? And what is the major difference from DFS point of view?

A: *The differences between the two are:*

- *Radar parameters are*
- *The channel utilization during the DFS evaluation is different between the two versions (10% in V1.2.3 and 30% in V1.3.1)*
- *V1.2.3 did not specify a detection probability so interpretation of pass/fail was vague. V1.3.1 specifies a minimum detection probability based on a minimum number of trials*
- *V1.3.1 allows a channel availability check to be valid for 24 hours while V1.2.3 requires the channel availability check to be performed immediately before the channel is used.*

From a radar detection and response point of view a product complying with V1.3.1 would very likely also comply with V1.2.3.

If a product meets V1.3.1 then it does not need to meet V1.2.3 by virtue of V1.3.1 being a harmonized standard.

Q: Is it a requirement to jump to other open channels?

A: *No, the requirement is that you stop transmitting on the channel if radar is detected and remain off that channel (as in not using that channel) for the non-occupancy period. At the end of the non-occupancy period the channel could be used again following a successful channel availability check.*

Q&A Session

Q: Is Uniform Loading a portion of the testing? or is this by manufacturer declaration?

A: For the FCC rules there is no test associated with Uniform Loading and compliance is determined based on the manufacturer's attestation and associated description of how they implement this requirement in their system.

The EN standards do require that the loading be within 10% of theoretical loading, where the theoretical loading would have any one channel selected (100/n) % of the time, for a system using n channels. From a practical perspective, with 19 different channels available the number of reboots of a system that truly uses a random channel selection to get a result within 10% of 1/n across all channels would take several thousand trials. My recommendation would be to verify that, with the system operating from its normal software (i.e. not a test mode), the same channel is not selected every time and use this to support a manufacturer's attestation.

Uniform loading is not required for systems that employ spectrum management software, such as those installed at large campuses and having multiple different "cells" since these systems by their very nature assign frequencies across the band to individual cells to avoid interference issues.

Q&A Session

Q: What is the difference between active scanning and passive scanning? How do you verify Active scanning vs Passive Scanning during DFS testing ?

A: Active scanning is where a client transmits a "find me" signal to increase the speed at which it is discovered by a master device. In Passive scanning the client device is listening for a "join me" signal from a master device before joining a network.

When performing a DFS test it becomes apparent that a client device is employing active scanning by observing transmissions from the client before the master is powered on. Transmissions may also be observed at the end of the channel move time or during a CAC period by a client using active scanning

Q: Is there a max and min of the pulse width?

A: Yes, the maximum and minimum pulse widths are shown in the parameter sections for each radar type.

Q&A Session

Q: For the frequency hopping radar, what is the dwell time on each frequency ?
Q: Can you expand on the frequency hoping radar signal ?

***A**: The FCC hopping radar hops at a rate of 333Hz (i.e. it changes frequency every3ms). On each frequency the radar sends a burst of 9 pulses. Each pulse is 1us wide and the interval between each pulse is 333us.*

The hopping sequence lasts for 300ms, which means it hops on 100 different frequencies .

The hopping radar uses a total of 475 frequencies between 5250 and 5724 MHz. in a single 475 channel sequence, no channel is used more than once. To simulate the radar you generate a random, 475 channel sequence and then pick a 100-channel subset of that sequence as the test sequence. The test sequence needs to contain at least one frequency that falls within the radar detection bandwidth of the device under test.

Q&A Session

Q: Is that s/w available for public usage?

Q: Are there any manufacturers making test equipment for these tests?

***A**: There is no commercial software available that does the complete test.*

Agilent and other equipment manufacturers have generators capable of recreating the radar signals and some include GUIs to facilitate programming the generators. If you are lucky you can write programs to interface with the GUIs to automate some or all of the tests.

Q: Does Elliot have a conducted test setup or is it up to the client to supply all the couplers & attenuators?

***A**: Elliott would only require that the device be modified, if necessary, to have standard N- or SMA- style coaxial connectors for the antenna ports to facilitate connecting into their couplers/combiners etc.*

Q&A Session

Q: How much bandwidth usage do you need when testing dfs?

***A**: If the question is asking what I think it is asking, the channel utilization during the DFS In-service monitoring test needs to be at least 30% for the EN and ~40% for the FCC testing. What utilization is meant to imply is that there are transmissions between master and slave for at least 30 or 40% of the time. The period over which this is evaluated is not explicitly stated, but for successful testing the transmissions should be as evenly distributed as possible.*

The FCC set-up for 802.11/Windows systems with the Mpeg file has the majority of transmissions being done by the radar detection device (typically the master device).

Note that for frame-based systems the talk:listen ratio for FCC tests needs to be set at 45:55.

Q&A Session

Q: The 30 minute limit for staying off the channel needs to persist through a reboot, correct?

A: Great question ! This is not explicitly stated. My guess is that this is because it is assumed that a system would typically be powered on more or less continuously and not be switched on/off regularly. There is no test specified to verify the non-occupancy lasts through a reboot – in fact the fact that the non-occupancy does not last through a reboot is often used during DFS testing to try and repeat tests on a channel when a device does not have test modes.

Hopefully the FCC are not reading this and make it a requirement and add another test ☺.

Q: Legacy devices that were certified prior to July 20, 2006 which are not DFS-compliant, are they allowed to operate beyond July 20, 2007 without Permissive change?

A: Devices already sold may continue to be operated without any further action. Devices certified prior to July 20 2006 that do not have DFS would need to be re-certified through the permissive change procedure if they are to be sold after July 20, 2007.

Q&A Session

Q: For an omni-directional antenna, is it acceptable to provide average antenna gain.

A: The gain to be used to determine the amplitude of the radar signal during testing or to determine which antenna should be used is the maximum gain of the antenna. For an omni-antenna the highest gain needs to be used, not the average. Hopefully the difference between the two is small!

Q: What is the typical power difference between radar signal and signals from master/client

A: The radar signal at the master device rf input should be around -62dBm + G, where G is the gain of the lowest gain antenna. So, for a device with a low gain antenna, the level would be -62dBm.

The level of the client device transmissions will vary with the set-up. While it is hard to give a firm value, I would expect it to be at least -20dBm.

For the FCC tests it is the master that is transmitting most of the time and so radar signals tend to be missed because the detection device is transmitting (i.e. not receiving and unable to "hear" the radar") rather than because they are masked by the client device transmissions.

Q&A Session

Q: Does in service monitoring mean that client/master are talking to each other or talking to each other at a specific signal strength?

A: *They are talking to each other, the signal strength is not specified.*

Q: I heard that the 1.3.1 ver for EU was required by June 07 but might be delayed any change?

A: *The latest Official Journal listing has v1.3.1 superseding v1.2.3 on March 31, 2008*

Q: If we meet the FCC DFS requirements, does that mean we can use that same data to satisfy the EN301893 requirements?

A: *Unfortunately no. Although the FCC method represents a worst-case with respect to channel utilization during the evaluation and for the channel closing transmission time measurement, the radar parameters are different enough that separate tests would need to be performed for in-service monitoring. The radar signal used for the CAC is also different for the two standards.*

I guess that a manufacturer might choose to use the FCC test results for in-service monitoring to support their declaration of conformity.

Q&A Session

Q: If the manufacturer has a product using a pre-approved WLAN module. Do you still need to perform DFS testing? and if not, can a TCB submit the application for the manufacturer's product?

A: *If the module is being used within the limitations of the grant then I understand that no further action would be required and you would have the FCC ID of the module on your product. If you wanted your own FCC ID then it would likely need to go through the FCC.*

One caution would be that, from a DFS perspective, the antenna gain of the end device needs to be at least equal to, if not higher than, the antenna used during the DFS evaluation of the module. I would strongly recommend some level of confidence checking on the product with integrated module to be sure the detection threshold is still valid. You should anticipate the FCC and other interested parties performing sample audits (i.e. tests) on commercial products. I think you would agree that it would be better for you to find you have an issue rather than letting the FCC find it !

Q&A Session

Q: Do you have some more detailed info about Japan DFS requirements?

A: Yes, but not enough time to review some of those requirements in the time frame of the presentation.

Q: The majority of this testing is designed around consumer devices using 802.11a technology; have you seen any manufacturers using proprietary technologies in this band?

A: When the U-NII band first opened I saw mostly proprietary technologies. This changed over the last 4-5 years and I have not seen anything but 802.11a.

Please contact **info@elliottlabs.com** for more information about ways that Elliott Laboratories can assist you with your DFS requirements or visit:

http://www.elliottlabs.com/wireless/dfs_testing_and_certification_services.htm