DFS and US Activities
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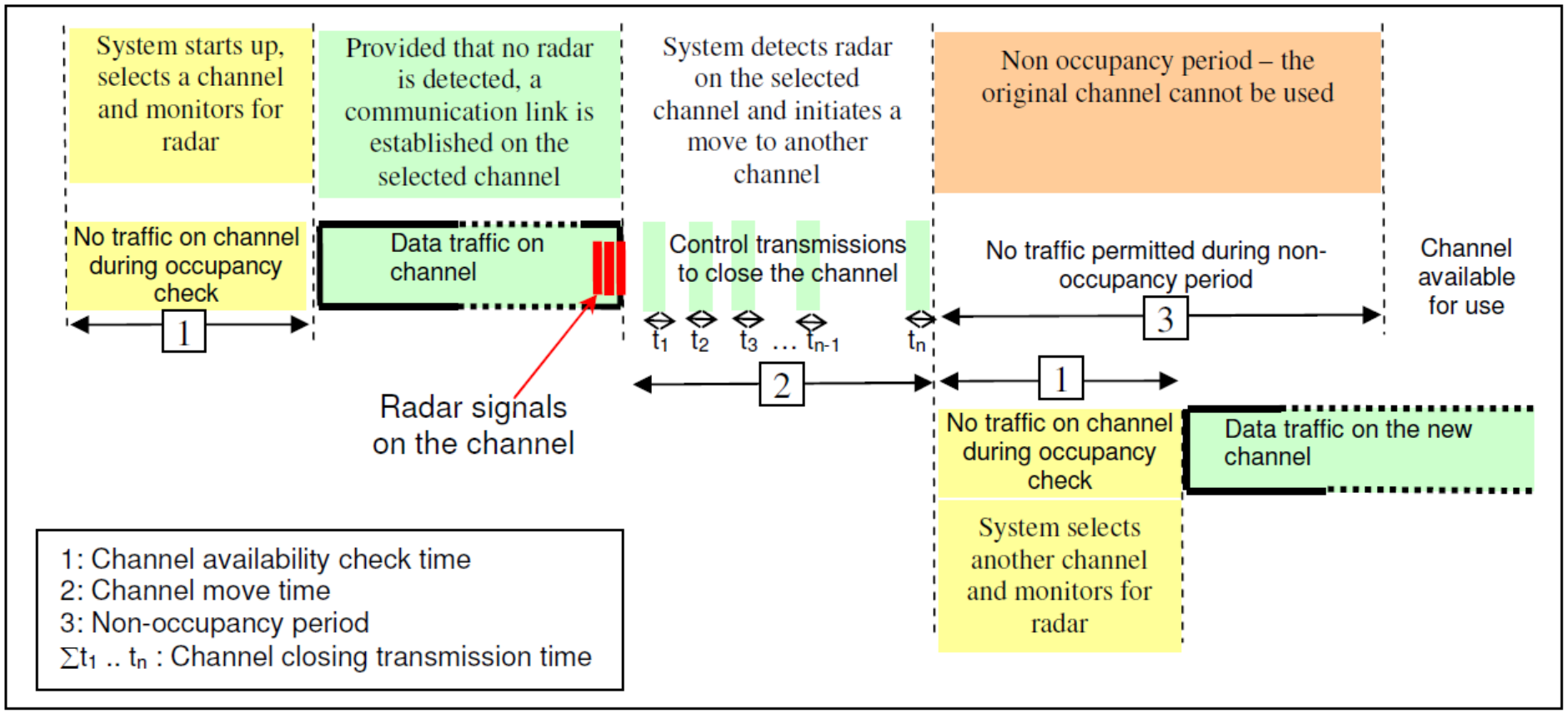
Background to DFS

- The 5250 – 5350 MHz and 5470 – 5725 MHz bands were being used by radar systems well before 802.11a was thought of
  - To allow 802.11 and similar devices access to these bands there needed to be a mechanism for these new devices to detect and avoid radar systems
    - Not quite spectrum sharing, radar devices have priority.
  - Dynamic Frequency Selection (DFS) was the mechanism
    - Device checks to see if radar is on a channel before using it "**Channel Availability Check**"
      - If radar is detected the device must select a different channel
    - Once on a channel continuously checks to see if radar is present "**In Service Monitoring**"
      - If radar is detected the device must clear the current channel and select a different channel
      - Clearing the channel
        - master device must inform all associated clients to change channel
        - Client device must clear the channel in response to the clear channel command

Background to DFS



Background to DFS requirements in the USA

- The FCC opened up 5150 – 5250 MHz and 5250 - 5350 MHz bands when it originally adopted the UNII rules into Part 15 Subpart E.
  - No DFS requirements
- Wireless Industry wanted alignment with the Rest of the World to include 5470 – 5725 MHz band
  - Already assigned for Federal use – radars
- Task group of with the wireless industry, Department of Defense (through the Department of Commerce), National Telecommunications and Information Administration (NTIA) resulted in 2003 release of the Report and Order FCC 03-287.
- To allow unlicensed use of 5470 – 5725 MHz a requirement for DFS was proposed to cover both this new band and the existing 5250 – 5350 MHz band.
  - The timing and threshold requirements were almost identical to those in EN 301 893 v1.2.3, but the signal parameters were different and included a frequency hopping radar.

Background to DFS requirements in the USA

- It took almost three years for the parties involved to settle on an acceptable test procedure and radar parameters
- The DFS procedures were finally released January 2006
- FCC required that all master devices be approved directly by FCC
  - TCBs could not approve these device
  - FCC required a pre-grant evaluation of the DFS capabilities, performed by the FCC lab, prior to issuing grants
    - Testing was in addition to the testing performed at the lab.

Trouble?

- Interference problems between 5 GHz unlicensed devices and airport TDWR radar systems were reported
  - TDWR systems operate in the 5600-5650 MHz band
  - Critical for checking wind conditions affecting take-off and landing

- FCC placed a hold on the issue of grants for all master devices in mid 2009
- On October 8, 2009, the FCC introduced interim measures (KDB 443999 D01 v01) that restricted the approval of master devices in the 5470-5725 MHz band to those devices that were limited to operating indoors

Enforcement Actions

- The FCC enforcement actions related to weather radar are publically available here:

  http://www.fcc.gov/encyclopedia/weather-radar-interference-enforcement

- The five most recent reported issues are shown below:

Enforcement Actions

10-01-2014	CMARR, Inc., San Juan, PR	FORFEITURE ORDER
06-24-2014	CMARR, Inc., San Juan, PR	NAL
02-21-2014	Directlink, LLC, Parker, Colorado	FORFEITURE ORDER
02-07-2014	Skybeam Acquisition Corporation, Englewood, Colorado	FORFEITURE ORDER
02-07-2014	Rapidwave, LLC Saratoga Springs, Utah	FORFEITURE ORDER

- NAL - Notice of Apparent Liability
  - Describes issue and proposed fines and actions
- Forfeiture Order
  - Final action taken

Enforcement Actions

Reviewing CMARR NAL these were the FCC's main issues:

- 1. A penalty of $25,000 … for apparently willfully interfering with a Federal Aviation Administration (FAA) weather radar in San Juan, Puerto Rico, by **operating radio transmitters without a license**. Given … the fact that CMARR had already received a warning for similar violations, these actions warrant a significant penalty.
- 2. In this Notice of Apparent Liability for Forfeiture (NAL), we find that CMARR, operator of an Unlicensed National Information Infrastructure (U-NII) transmission system in San Juan, Puerto Rico, apparently willfully and repeatedly violated Sections 301 and 333 of the Communications Act of 1934, as amended (Act), by causing interference to the FAA by operating an **intentional radiator without a license** …

Without a license – the band in question is license exempt so what does this mean ???

Enforcement Actions

- 3. … The TDWR serving the San Juan International Airport operates on the center frequency of 5610 MHz.
- 4. On November 13, 2013, in response to an FAA complaint of interference, … monitored radio transmissions on the frequency 5610 MHz in the San Juan area, which were originating …[from] the same direction as the source of the interference reported by the FAA. ... conducted an inspection of the rooftop and found that the transmissions on 5610 MHz were not present. CMARR's owner confirmed … that the highest transmitter on a tower on the rooftop, an XXXX model XX, had been transmitting on 5610 MHz. He also stated that the transmitter had been retuned away from 5610 MHz minutes before the agent arrived …
- 5. The XXXX model XX is certified for use as a Part 15 intentional radiator only in the 5745-5825 MHz band and is not certified as a U-NII intentional radiator. **According to Commission records, CMARR does not hold a license to operate on 5610 MHz from this location in San Juan, Puerto Rico**.

Opening up 5470-5725 MHz

- The FCC continued to work with industry, the FAA and NTIA
  - October 2010 the FCC announced interim procedures to allow outdoor systems to use 5470-5725MHz.
    - Excluded channels which overlap 5600 – 5650 MHz (indoor and outdoor systems)
    - Outdoor devices must be professionally installed when operating in the 5470 – 5725 MHz band
      - installation within 35 km of a TDWR location requires separation by at least 30 MHz (center-to-center) from the TDWR operating frequency
      - register devices in an industry-sponsored database

Opening up 5470-5725 MHz

Further Rule changes were proposed in 2013 to:

- Open up the 5600-5650 TDWR band by addressing radar detection requirements to include TDWR types of radars
- Make manufacturers responsible for ensuring installers or end users:
  - Cannot configure the device to operate on non-approved operating frequencies
  - Cannot over-ride DFS features and functions
- Rules came into effect June 2, 2014, with a one year transition period for new devices
  - Devices already approved may continue to be sold until June 2016, after June 2016 all devices must meet new rules

Rule Changes

- New rules – DFS related changes:
  - Allow use of 5600-5650 MHz TDWR band
    - Modify radar waveforms to be tested
      - Replaced radar type 1 with a new type to match TDWR types of pulses
    - Require minimum detection bandwidth be at least over the entire 99% bandwidth of the signal
    - KDB 905462 D02 UNII DFS Compliance Procedures New Rules v01r01
  - Software security description to be submitted (KDB 594280 D02 U-NII Device Security
    - Applies to client and master devices

- FCC continues to perform pre-grant testing on master devices
  - TCBs can issue the grant but only after FCC have complete their validation of the DFS features - no indication of relaxing this requirement

Rule Changes

New Radar Waveforms

Table 5 – Short Pulse Radar Test Waveforms

Radar Type	Pulse Width (μsec)	PRI (μsec)	Number of Pulses	Minimum Percentage of Successful Detection	Minimum Number of Trials
0	1	1428	18	See Note 1	See Note 1
1	1	Test A: 15 unique PRI values randomly selected from the list of 23 PRI values in Table 5a	Roundup $\left\{\left(\frac{1}{360}\right)\cdot\left(\frac{19\cdot 10^6}{PRI_{\mu sec}}\right)\right\}$	60%	30
		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			
2	1-5	150-230	23-29	60%	30
3	6-10	200-500	16-18	60%	30
4	11-20	200-500	12-16	60%	30
Aggregate (Radar Types 1-4)				80%	120

Note 1: Short Pulse Radar Type 0 should be used for the detection bandwidth test, channel move time, and channel closing time tests.

Old type 1 now used for detection bandwidth and timing tests

New Waveform to better represent TDWR

Types 2, 3 4 remain the same

Rule Changes

New Radar Waveforms

Table 6 – Long Pulse Radar Test Waveform

Radar Type	Pulse Width (µsec)	Chirp Width (MHz)	PRI (µsec)	Number of Pulses per *Burst*	Number of *Bursts*	Minimum Percentage of Successful Detection	Minimum Number of Trials
5	50-100	5-20	1000-2000	1-3	8-20	80%	30

Type 5 remains the same

Table 7 – Frequency Hopping Radar Test Waveform

Radar Type	Pulse Width (µsec)	PRI (µsec)	Pulses per Hop	Hopping Rate (kHz)	Hopping Sequence Length (msec)	Minimum Percentage of Successful Detection	Minimum Number of Trials
6	1	333	9	0.333	300	70%	30

Type 6 remains the same

Rule Changes

- Require minimum detection bandwidth be at least over the entire 99% bandwidth of the signal (previously 80% of the bandwidth)
  - All operational bandwidths need to be tested
  - Modified to allow testing at 5MHz steps across the bandwidth (used to be 1MHz steps), with smaller steps close to signal edge
    - Allow faster testing, especially with wider signals (80MHz, 160MHz !!)
  - No traffic on channel for these measurements

- Traffic during probability tests
  - Previously required streaming of a specific video file from master to client
  - Modified to allow any data file of a type that is typical for the device, including software pings if it has random ping intervals
    - Unicast or Multicast protocols are preferable but other protocols may be used
    - Minimum channel loading of approximately 17% or greater

THANK YOU.