Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: [An overview of the current status of 802.11af]
Date Submitted: [May 10, 2012]
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Re: [An Overview of 802.11af]

Abstract: [This document presents an overview of the current draft of 802.11af]
Purpose: [This document provides a list of the editing staff that will be working on 802.15.4g.]

Summary

- This document provides an overview of the activities of 802.11af task group

Scope, Purpose, Principle of the 802.11af

- **PAR Scope**: An amendment that defines modifications to both the 802.11 physical layers (PHY) and the 802.11 Medium Access Control Layer (MAC), to meet the legal requirements for channel access and coexistence in the TV White Space

- **Purpose**: the Task Group should create an amendment whose implementation in solutions is likely to receive Regulatory approval for operation in the TV White Spaces under the applicable regulatory rules in the different regulatory domains.

- **Principles**:
  - The amendment should not duplicate functionality that is being standardized in other Task Groups.
  - There is no need for backwards compatibility with 2.45 GHz ISM operation.
  - The starting point was to use the High Throughput PHY with scaling and modifications for the TV bands.

- **Vision/Outcome**: Use 802.11 PHYs to specify the basis for a system that the regulators can approve for operation in the TVWS bands.

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TG af timeline and current status

- Initial Working Group Letter Ballot: January 2011

- Second Working Group Letter Ballot: July 2012

- Recirculation Letter Ballot: November 2012

- Form Sponsor Ballot Pool: February 2013

- Initial Sponsor Ballot: March 2013

- Recirculate Sponsor Ballot: July 2013

- Final WG/EC Approval: March 2014

- RevCom/Standards Board Approval: March 2014

Task group now is working on the comment resolution of the first working group letter ballot

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Operating Scenarios of 802.11af

Scenario 1

White space database

Access point

Station
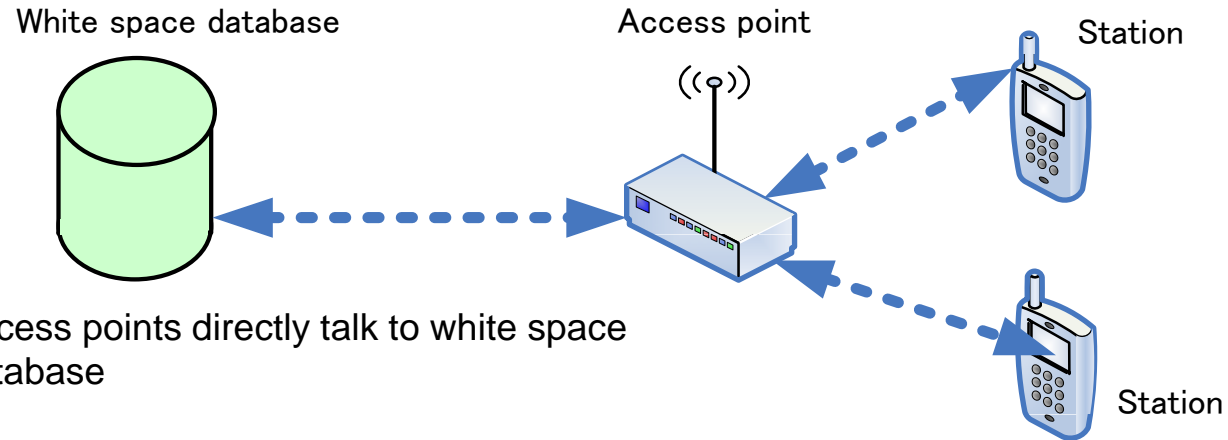
Access points directly talk to white space database

Station

Scenario 2

White space database

RLSS

Access point

Station
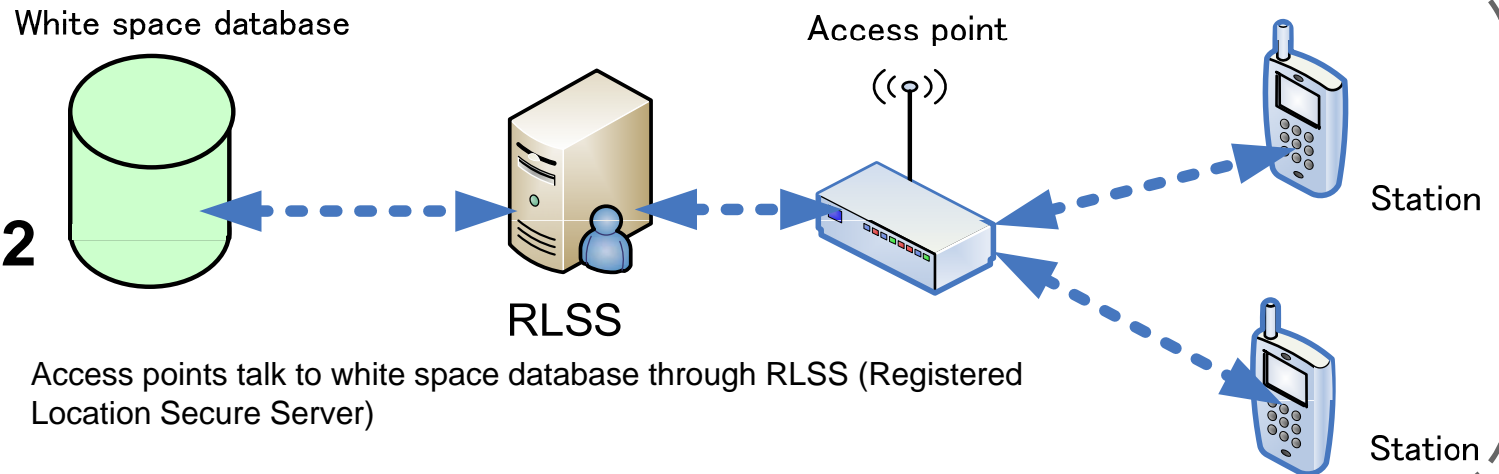
Access points talk to white space database through RLSS (Registered Location Secure Server)

Station

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Construction of 802.11af Standard

Technologies

DSSS

OFDM

Primary service protection

MIMO

TVWS Data base access

Standards

802.11b

802.11a/g

802.11n

802.11y

802.11u/z

802.11-2007

802.11ac

802.11af

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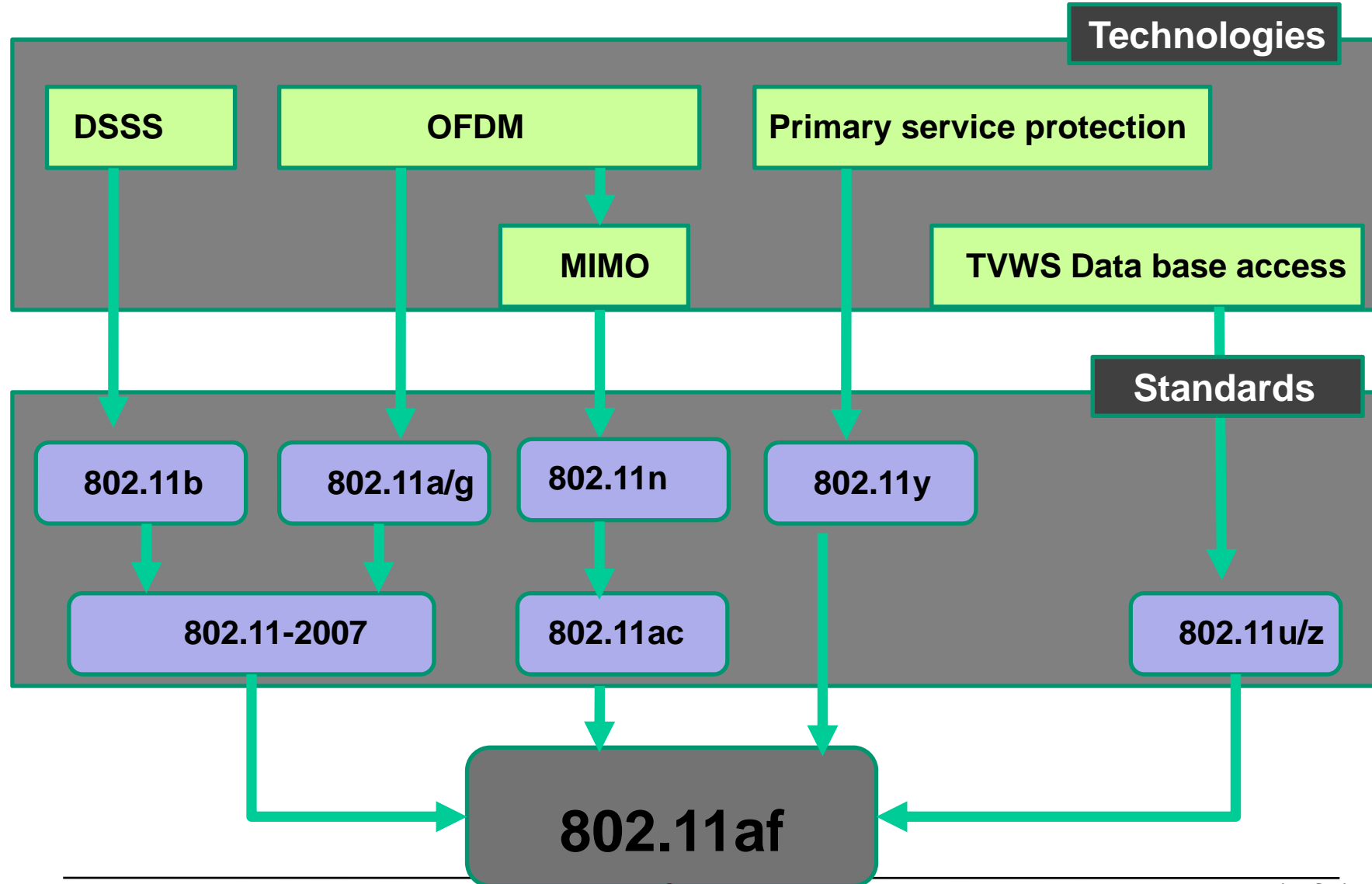
Basic Signaling Sequence of Operation

TVWS database

Master WiFi device

Client WiFi device

Geo-location information

Available channel list in that location

Enabling signal

60 seconds

- **Contact verification signal needs to be received every 60 seconds to keep transmission alive**

Channel availability Query

Channel schedule management

Channel power management

Network channel control

Contact verification signal

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Channel Availability Query

Element ID	Length	Device Location-Information body fields
1	1	16

Octets:

Device Location Information element format

B0 B5	B6 B30	B31 B39
Latitude Uncertainty	Latitude Fraction	Latitude Integer
6	25	9

Bits:

B40 B45	B46 B70	B71 B79
Longitude Uncertainty	Longitude Fraction	Longitude Integer
6	25	9

Bits:

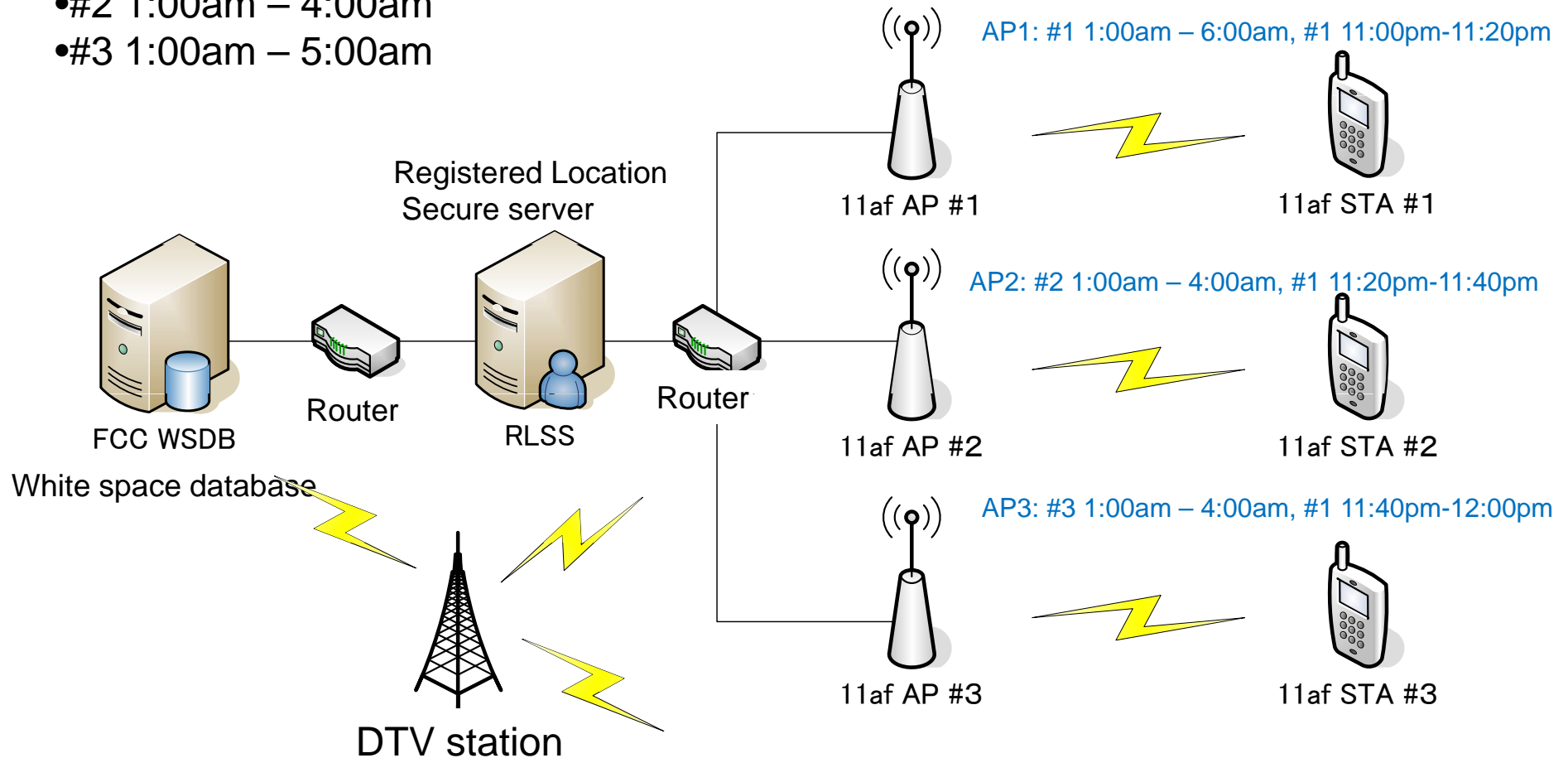| B80 B83	B84 B89	B90 B97	B98 B119	B120 124	B125 B127
Altitude Type	Altitude Uncertainty	Altitude Fraction	Altitude Integer	Reserved	Datum
4	6	8	22	5	3

Bits:
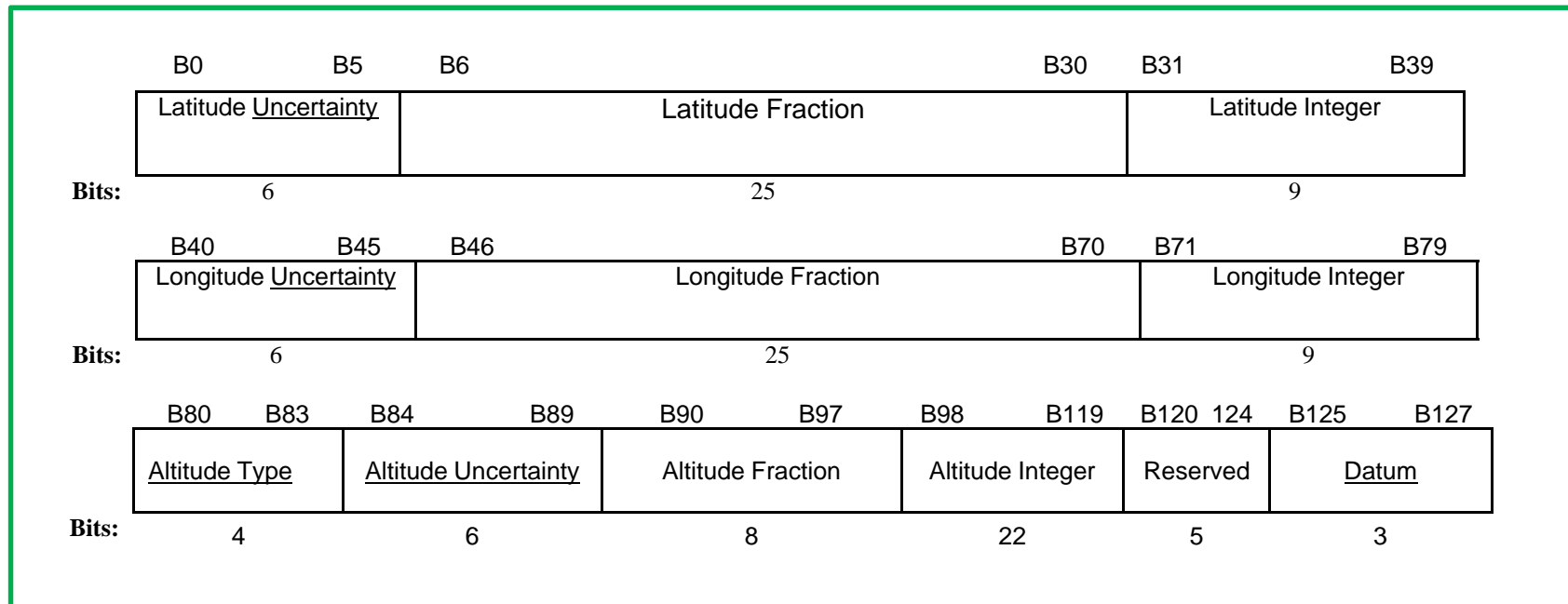
Device Location Information element body fields format

Channel Schedule Management

Channel availability
- #1 1:00am – 6:00am, 11:00pm-12:00pm
- #2 1:00am – 4:00am
- #3 1:00am – 5:00am

AP1: #1 1:00am – 6:00am, #1 11:00pm-11:20pm

11af AP #1

11af STA #1

Registered Location
Secure server

AP2: #2 1:00am – 4:00am, #1 11:20pm-11:40pm

11af AP #2

11af STA #2

Router

RLSS

Router

FCC WSDB

White space database

AP3: #3 1:00am – 4:00am, #1 11:40pm-12:00pm
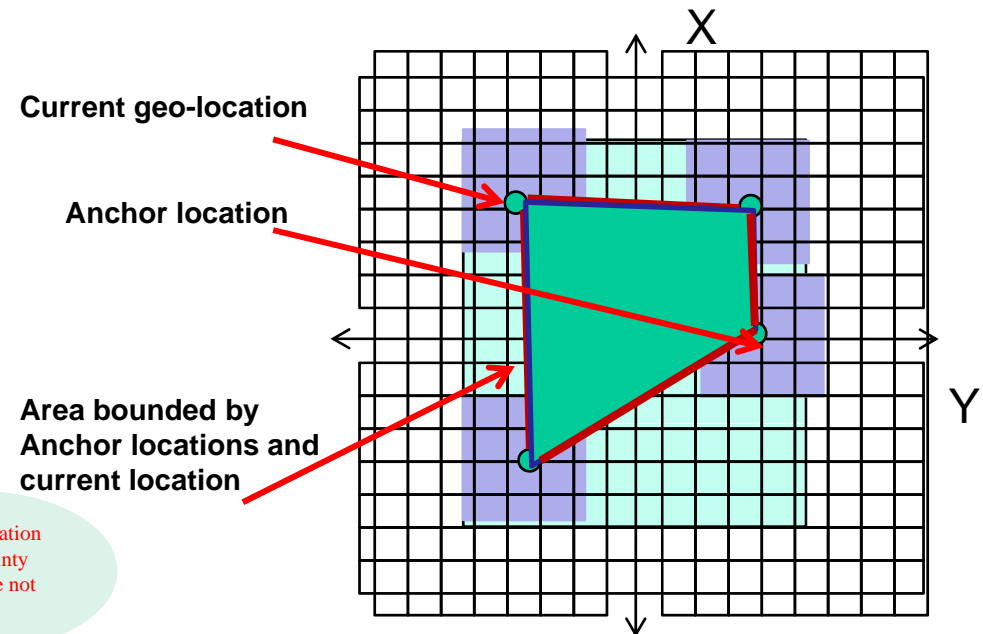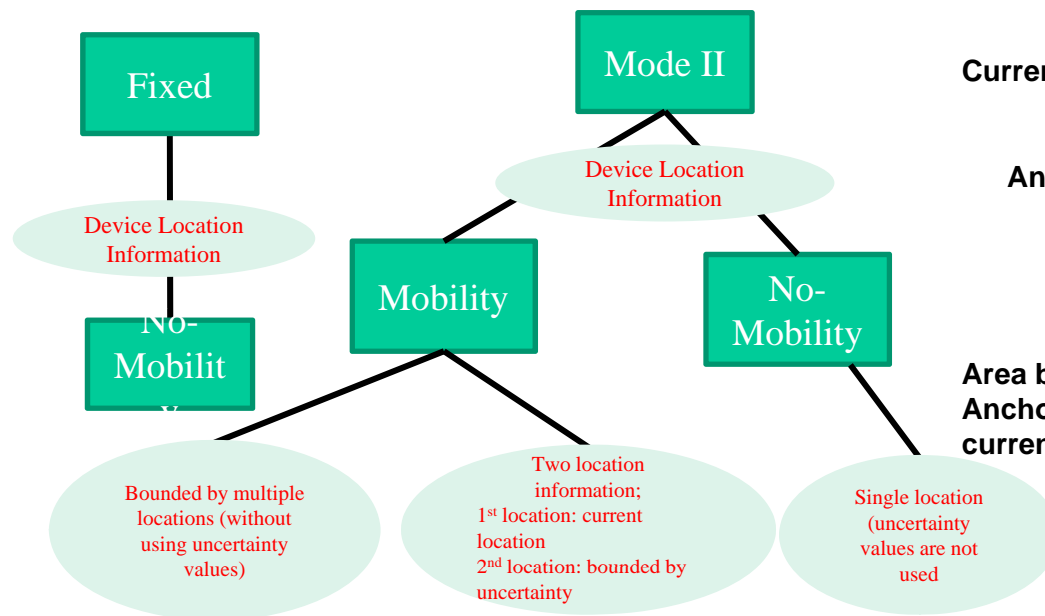
11af AP #3

11af STA #3

DTV station

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Network Channel Control

- The Network Channel Control in the current 802.11af draft requires that a mode I device first sends its intention to use TV channels and Spectrum Mask before starting WLAN operating in the TV channels to mode II device.

- The mode II device will decide whether this request is acceptable.

- If yes, the mode II device will subsequently send permission on the WLAN network channel usage to the mode I devices including allowable Maximum Transmit Power and Spectrum Mask.

- This allows for a strict control of the WLAN channel operation in TV band. From the perspective of TV operators, this gives a reasonable protection to their primary services.

Internet

RLSS

Internet connection

TV tower 1

Interference

Protected contour

AP1

Slide 10

TV tower 2

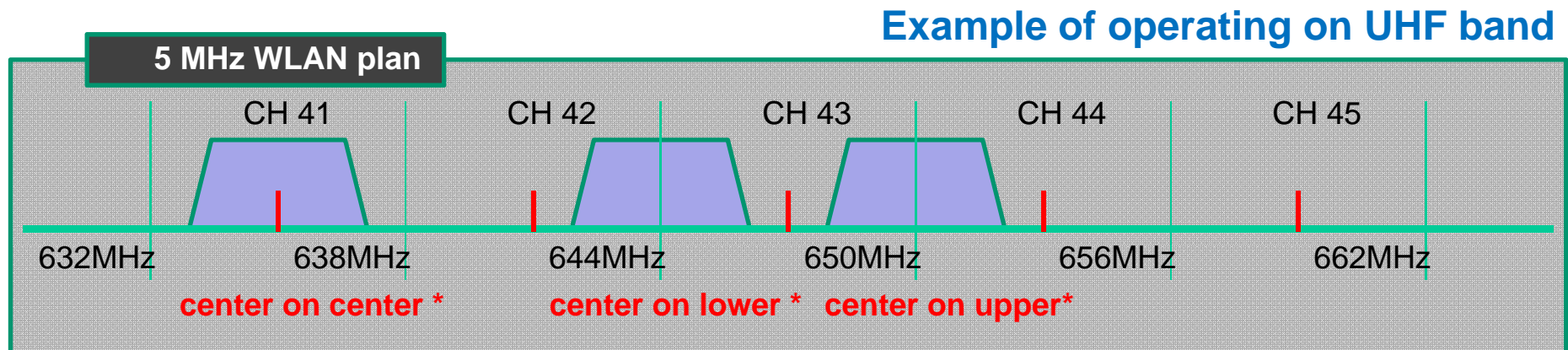Protected contour

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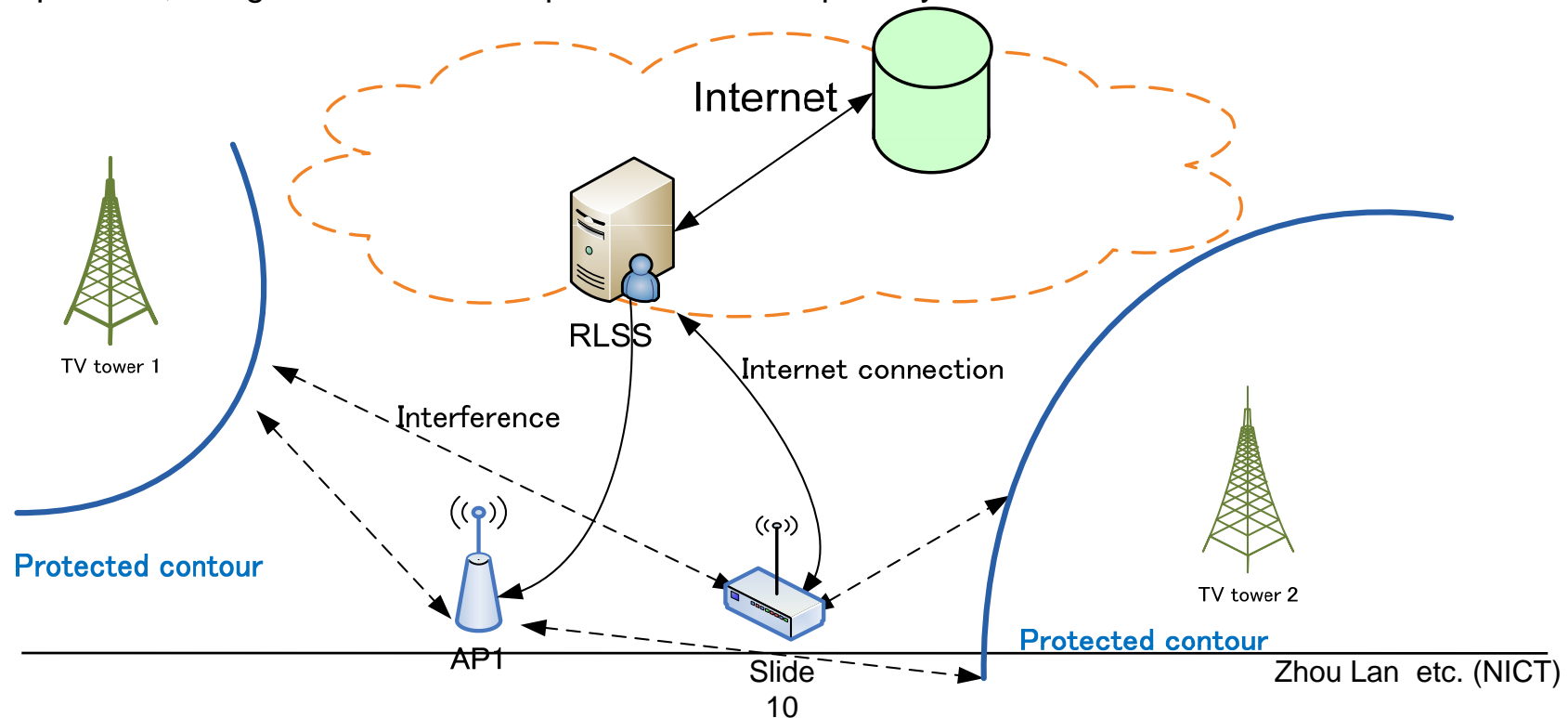
Mobility Support

- In order to support mobility, device needs to report their geo-location of multiple points, database calculate the common channel available in the constrained area defined by the multiple points
- There are two ways to convey multi-location information
    - One current point and one anchor point defined
    - Multiple anchor points
    - Demonstration system supports both method

Fixed

Mode II

Device Location Information

Device Location Information

Mobility

No-Mobility

No-Mobility

Bounded by multiple locations (without using uncertainty values)

Two location information;
1st location: current location
2nd location: bounded by uncertainty

Single location (uncertainty values are not used)

X

Current geo-location

Anchor location

Area bounded by Anchor locations and current location
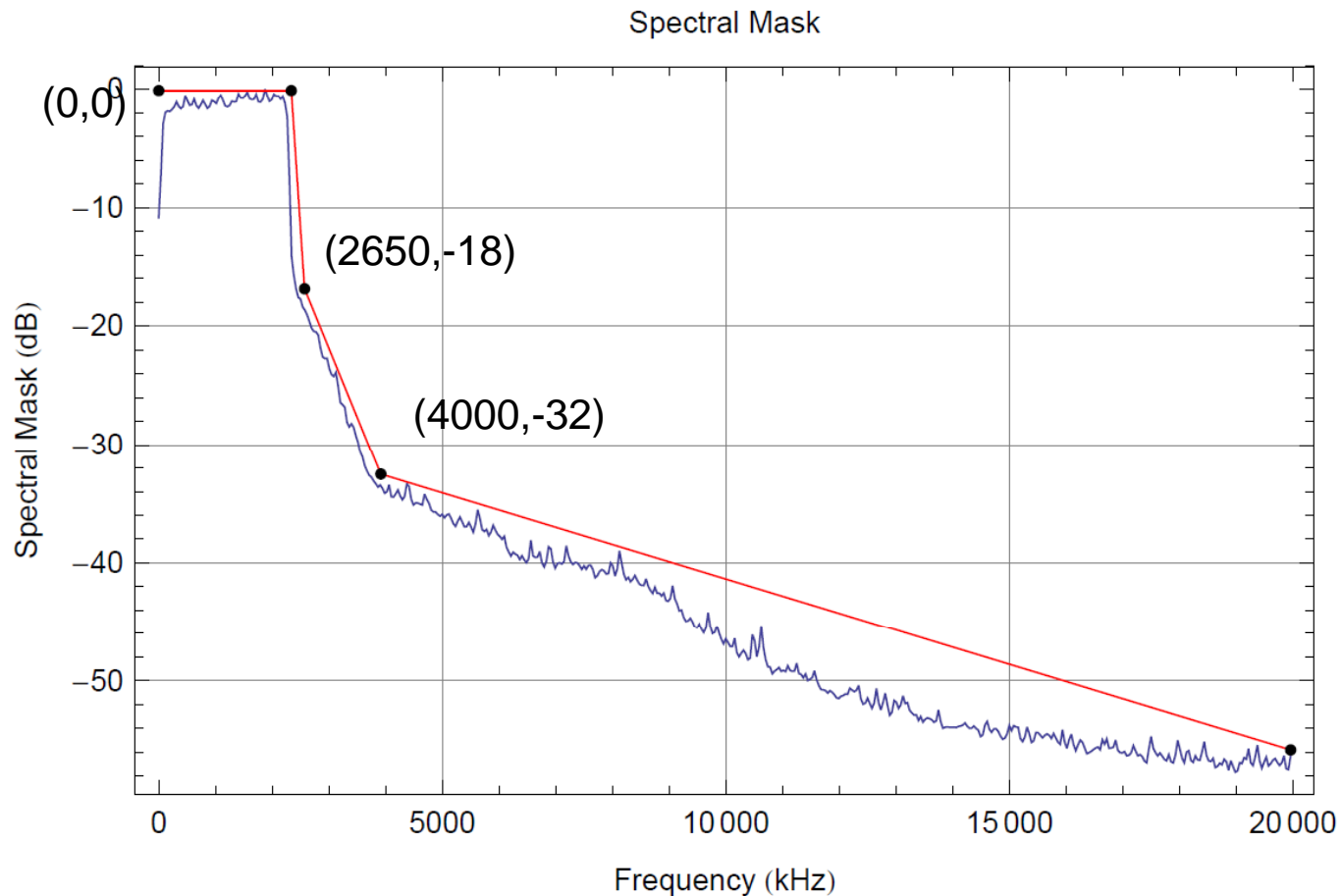
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Old channelization plan

- The TV white space in the States covers the VHF and UHF bands (54MHz to 698MHz)

- In order to operate 802.11af in the TV white space, the center frequency needs to be reallocated to the center/lower edge/upper edge frequency of TV channel in UHF and VHF band

- In addition, out-of-band emission needs to be suppressed to reduce the interference to the adjacent channel

Example of operating on UHF band

5 MHz WLAN plan

| CH 41 | CH 42 | CH 43 | CH 44 | CH 45 |

632MHz 638MHz 644MHz 650MHz 656MHz 662MHz

center on center *   center on lower * center on upper*

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Spectral Mask Descriptor for Ofcom

0	0	2500	0	2650	-20	20000	-55

Spectral Mask

(0,0)

(2650,-18)

(4000,-32)

Spectral Mask (dB)

Frequency (kHz)

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Relationship between 802.11ac and 11af

- Expect 11af to take 11ac PHY with necessary modifications by July, 2012 and WFA to certify devices starting Spring, 2013

- Expect TV frequencies to affect spatial streams more than any other WLAN PHY technologies

  - No backward compatibility needed therefore preamble needs improvement for efficiency

  - Long wavelengths 5.2m-1.4m (VHF) and 63 cm-43 cm (UHF) mean for the same size devices MIMO is less effective than at shorter wavelengths

  - TV channel bandwidths of 6 MHz, 7 MHz and 8 MHz have to be supported by world c

- Directions[1]

  - FFT: 128 instead of 64 to relax the filter design for out-of-band emission requirements

  - Preamble: keeping legacy part and merge some fields to improve the efficiency

  - Multi-channel support: multiple IFFT block for multi-channels

[1] IEEE 802.11-12/0616r0, TGaf PHY proposal

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