Simulation on Aggregate Interference from Wireless Access Systems including RLANs into Earth Exploration-Satellite Service in the 5250-5350 MHz Band

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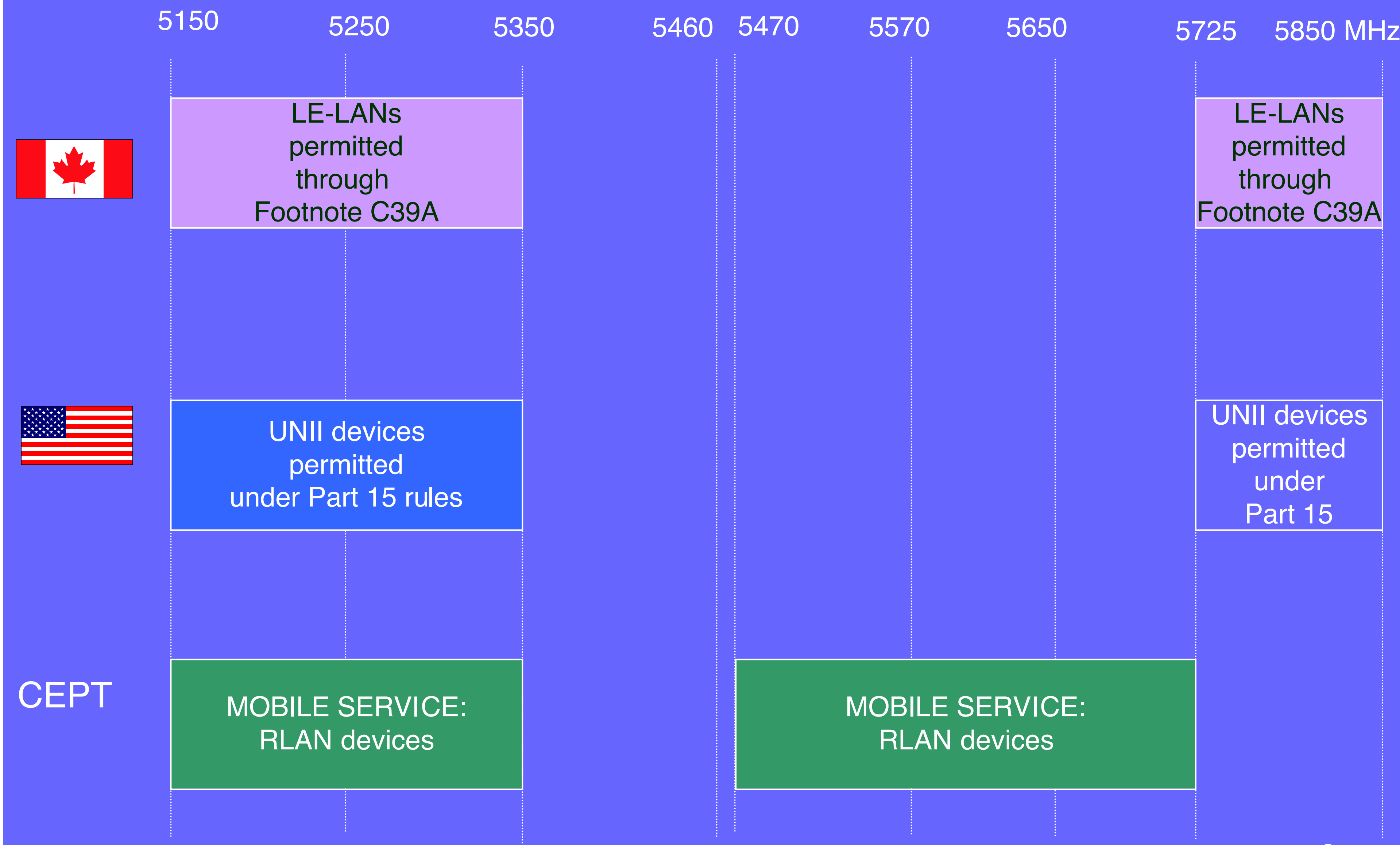
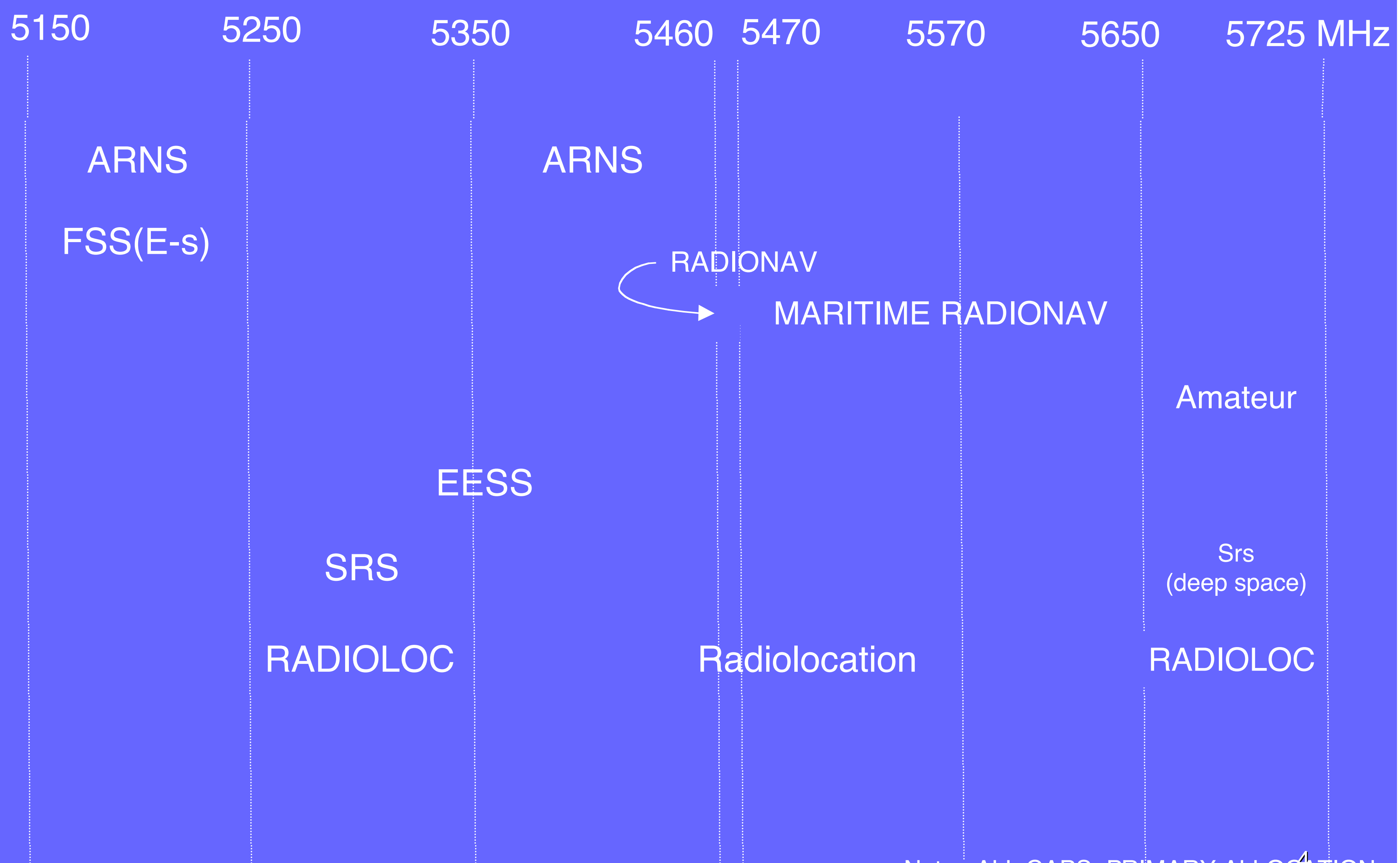
BACKGROUND

Current Canada/United States/CEPT provisions for RLAN applications

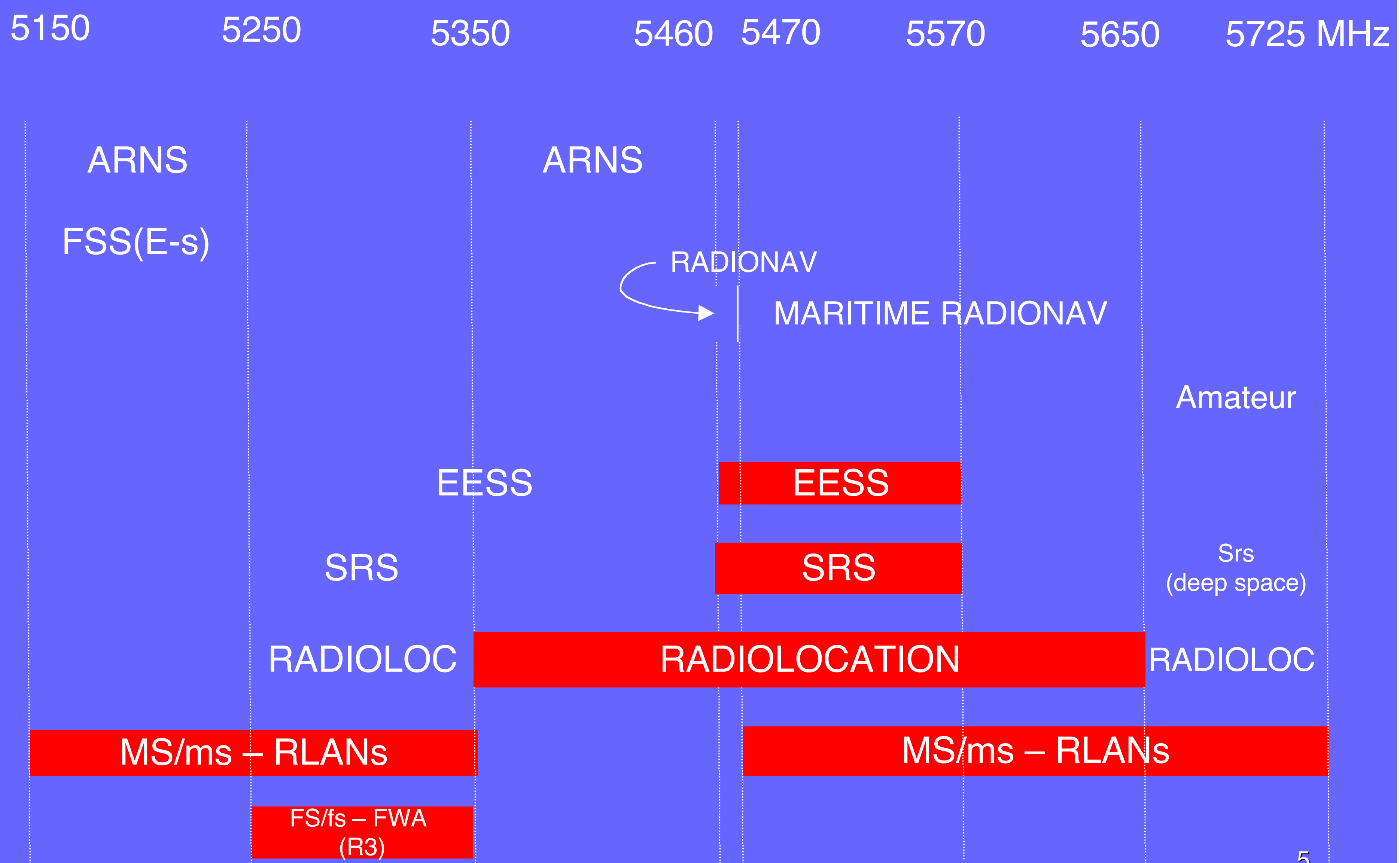


Current ITU Allocation

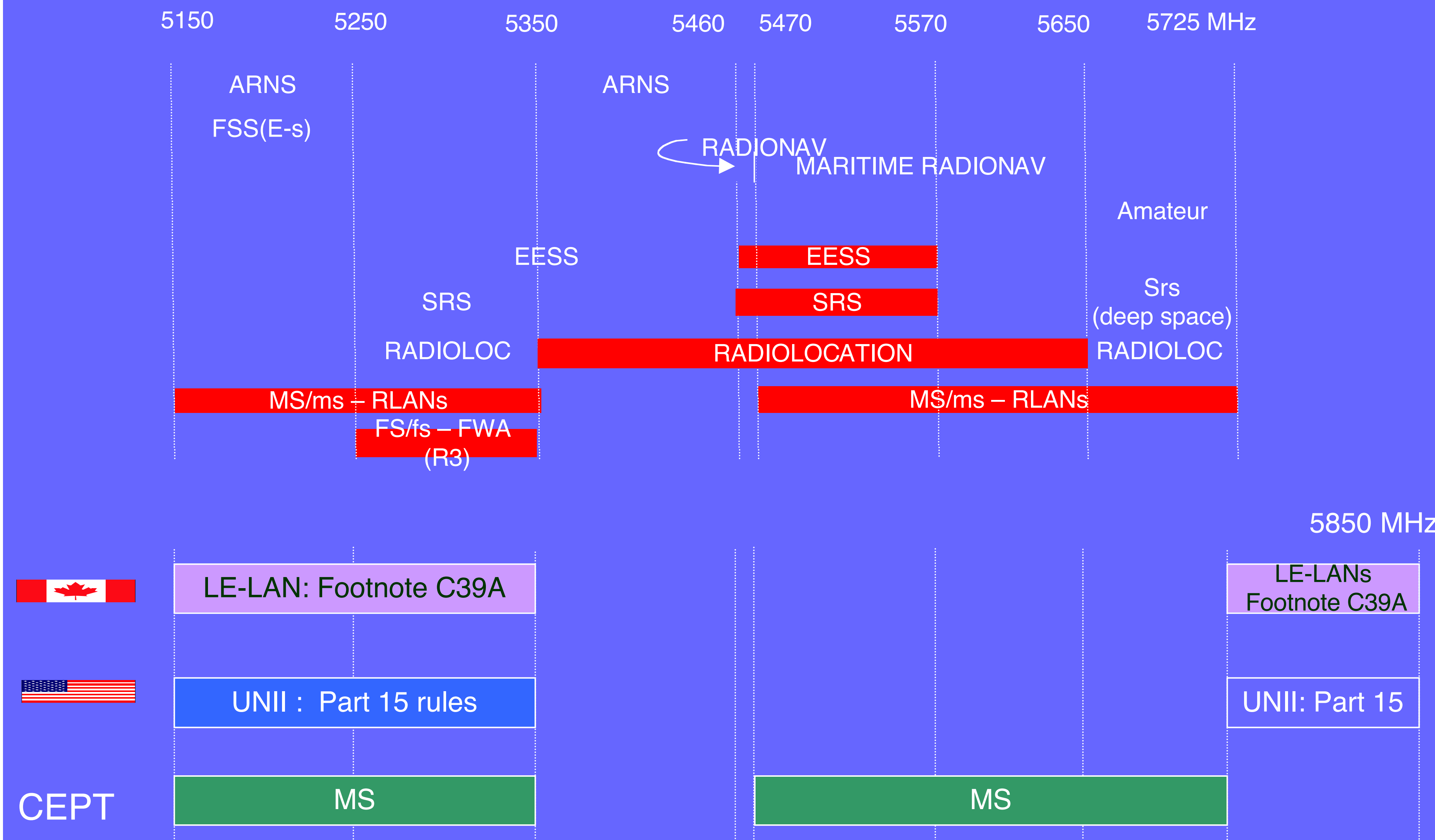


Note: ALL CAPS=PRIMARY ALLOCATION

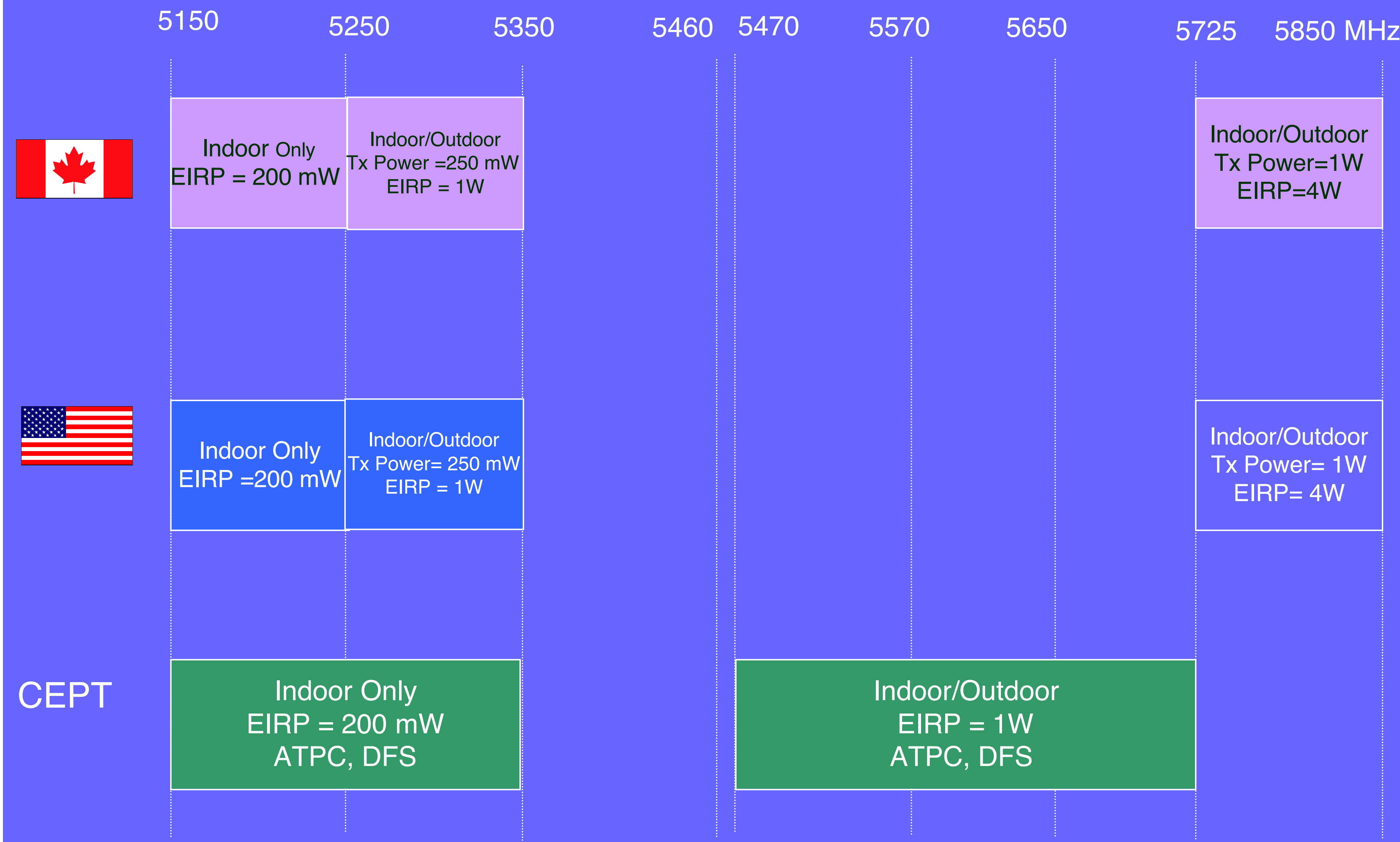
WRC-03 consideration



Overall Comparison of Allocations and provisions for RLANs and other services in the 5GHz range

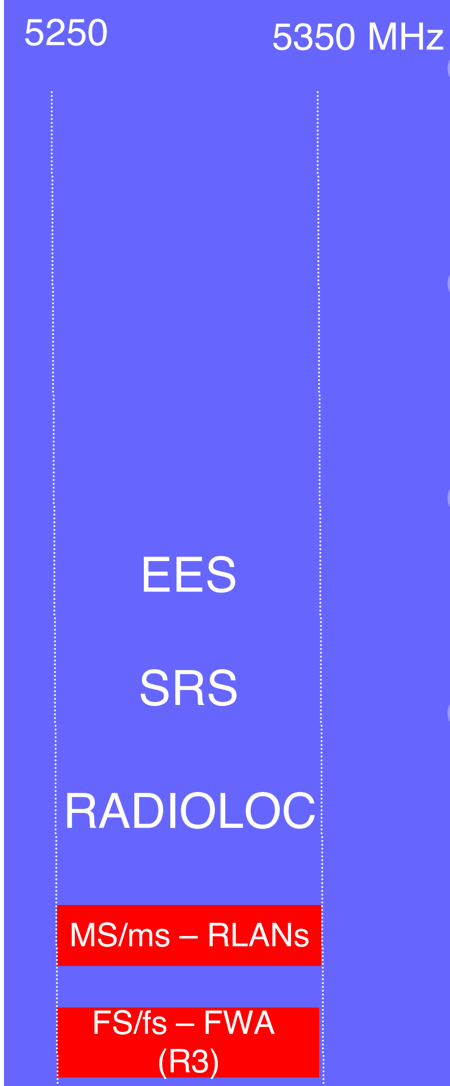


Current Canada/United States/CEPT technical rules for RLAN applications



Characteristics of EESS

Characteristics of EESS in the 5GHz range



- Radar scatterometers
  - useful for determining the roughness of large objects such as ocean waves
- Radio altimeters
  - used to determine the height of the Earth's land and ocean surfaces
- Imaging radars (synthetic aperture radars)
  - used to produce high resolution images of land and ocean surfaces.
- In this analysis only one of the imaging radars (SAR 4-most sensitive) and altimeters were examined

Characteristics of SARs in the 5 GHz range

Parameter	SAR 2	SAR 3	SAR 4
Orbital Altitude	600 km (circular)	400 km (circular)	400 km (circular)
Orbital inclination	57 degrees	57 degrees	57 degrees
Frequency	5405 MHz	5405 MHz	5300 MHz
Peak Radiated Power	4800 W	1700 W	1700 W
Pulse Bandwidth	310 MHz	310 MHz	40 MHz
Antenna Orientation	20-38 deg from nadir	20-55 deg from nadir	20-55 deg from nadir
Receiver Noise Figure	4.62 dB	4.62 dB	4.62 dB
Footprint	164.3 km^2	225.3 km^2	76.5 km^2
Receiver Bandwidth	356.5 MHz	356.5 MHz	46 MHz
Noise Power	-113.84 dBW	-113.84 dBW	-122.73 dBW
Interference Threshold	-119.84 dBW	-119.84 dBW	-128.73 dBW

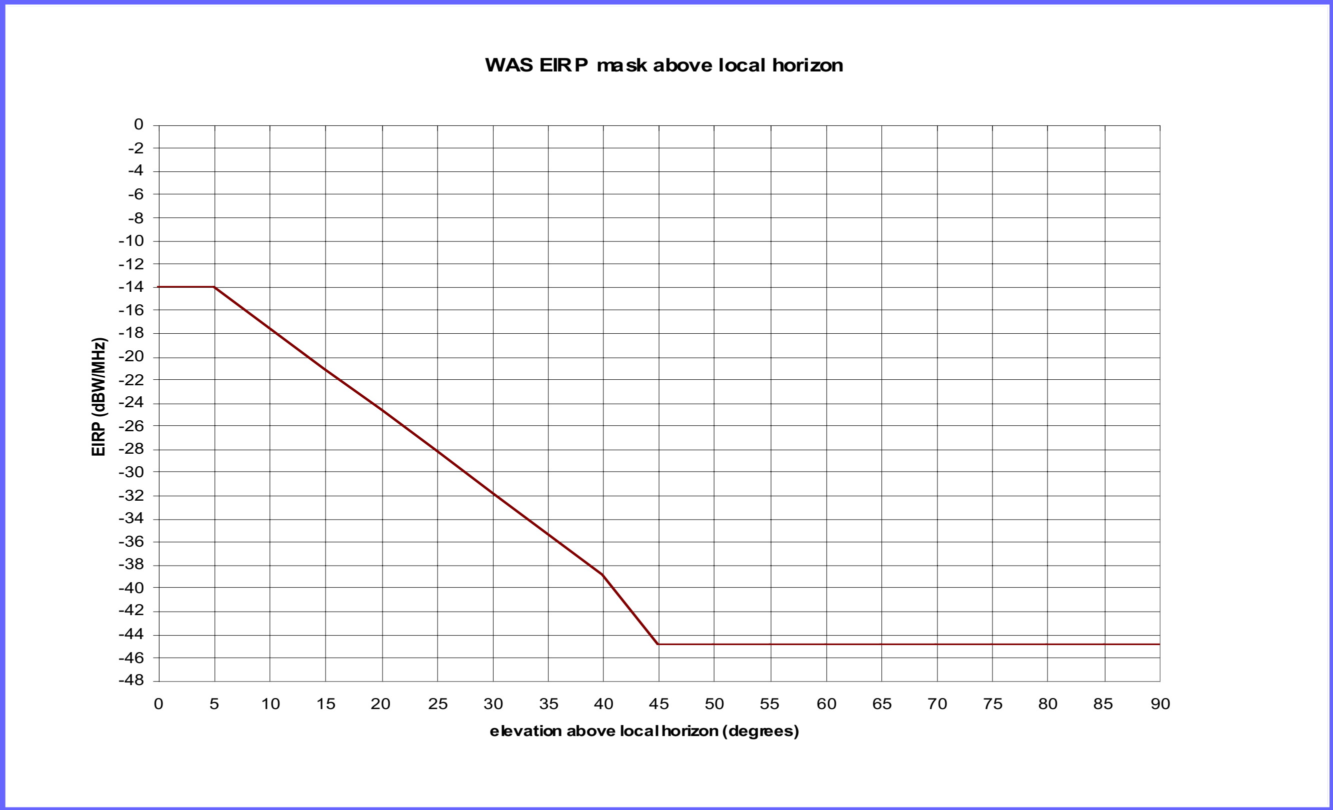
Source: ITU-R Doc 8A-9B/98

Characteristics of outdoor WAS/RLANs

Outdoor WAS in the 5250-5350 MHz Range

Parameter	Value
Frequency	5.3 GHz
Bandwidth	20 MHz
Antenna Gain Pattern —azimuth plane	Omnidirectional (for simulation purposes)
Antenna Gain pattern — elevation plane	Implicit within proposed EIRP mask to be shown later
Antenna tilt	0 degrees
Cell radius	1.5 km
Transmitter Power	250 mW
Scattering Coefficient	17 dB
Active Ratio	100%

EIRP mask used in simulation



-14 dBW/MHz	for $0° \le \theta < 5°$
-14 -0.711 (θ -5) dBW/MHz	for $5° \le \theta < 40°$
-38.9 -1.222(θ-40) dBW/MHz	for $40° \le \theta < 45°$
-45 dBW/MHz	for $\theta > 45°$

θ=elevation angle above the local horizon

For θ <0, EIRP= -13 dBW/MHz

Characteristics of indoor WAS/RLANs

Characteristics of Indoor WAS systems

	Indoor Type 1	Indoor Type 2
Parameter	**Value**	**Value**
Frequency	5.3 GHz	5.3 GHz
Bandwidth	20 MHz	20 MHz
Antenna	Isotropic (for simulation purposes)	Isotropic (for simulation purposes)
Antenna gain	0 dBi	0 dBi
Transmitter power	250 mW	200 mW
Building loss	18 dB	18 dB
Active Ratio	100%	100%

Distribution of WAS/RLANs

Distribution of WAS/RLANs

- Based on population data from the UN, cell radius of WAS/RLANs and perceived deployment rate. Deployment factor of 30% was used. See ITU-R Doc. 8A-9B/83
- City A (extremely large city)
  - Population = 17.6 million
  - Include effects of stations operating in sub-urban areas surrounding the city as well as to simulate effects of aggregate interference from stations operating in near-by cities, the radius was extended from 54 km to approximately 81 km.
- City B (medium size city)
  - Population = 3.7 million
  - Radius of this city = approximately 12 km. An actual radius of 18 km was used to account for effects from stations operating in sub-urban areas as well as effects from near-by cities.

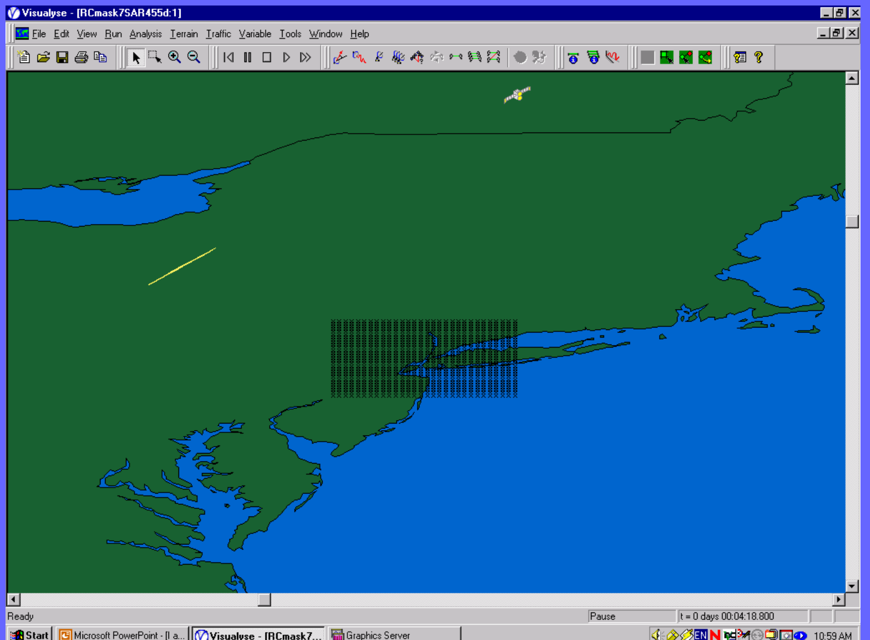
Distribution of WAS/RLANs

	Case 1	**Case 2**	**Case 3**
Indoor	Indoor Type 1	Indoor Type 2	Indoor Type 1
Number of active systems	440	440	440
Deployment Area (km^2)	76.5	76.5	76.5
Density (number of active systems/km^2)	5.75	5.75	5.75
Outdoor	Large city City A	Large city City A	Medium city City B
Number of active systems	870	870	43
Deployment Area (km^2)	13122	13122	648
Density (number of active systems/km^2)	0.066	0.066	0.066

Methodology

- Within each cell:
  - one station transmitting at all times
- One-third of all transmitters has an additional scattering coefficient of 17 dB
- 3dB polarization loss for outdoor systems
- 0dB polarization loss for indoor systems
- no atmospheric attenuation is assumed
- The satellite was simulated to run for a period of 30 days, the period of time in which the EESS would receive maximum interference was then revisited with time steps of 200 milliseconds. The results shown here represent a period of time in which the EESS would be visible by the WAS systems in a single orbit in which EESS would experience the maximum possible interference from the aggregate interference of WAS.
- Free space propagation
- Building loss = 18 dB

Simulation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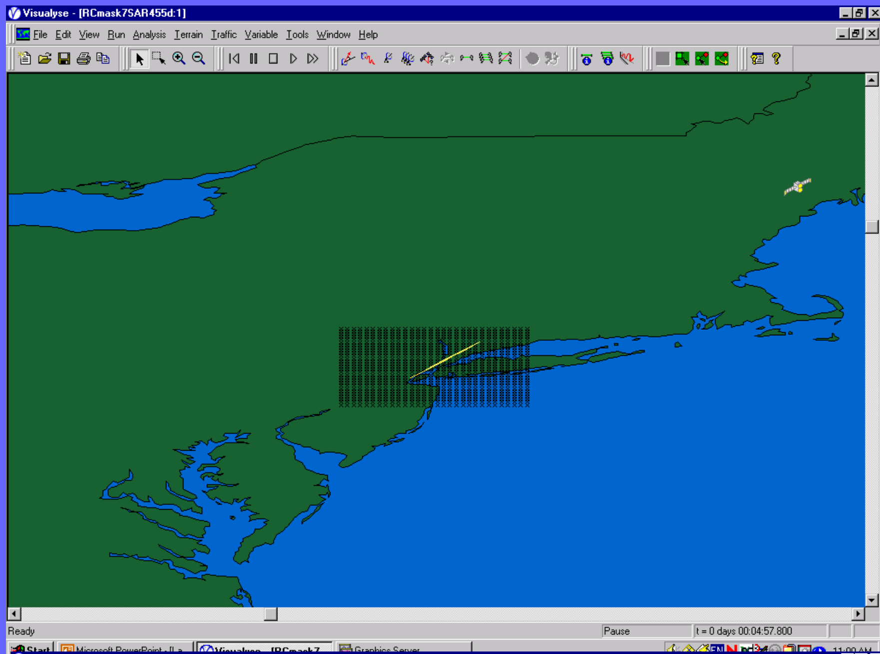
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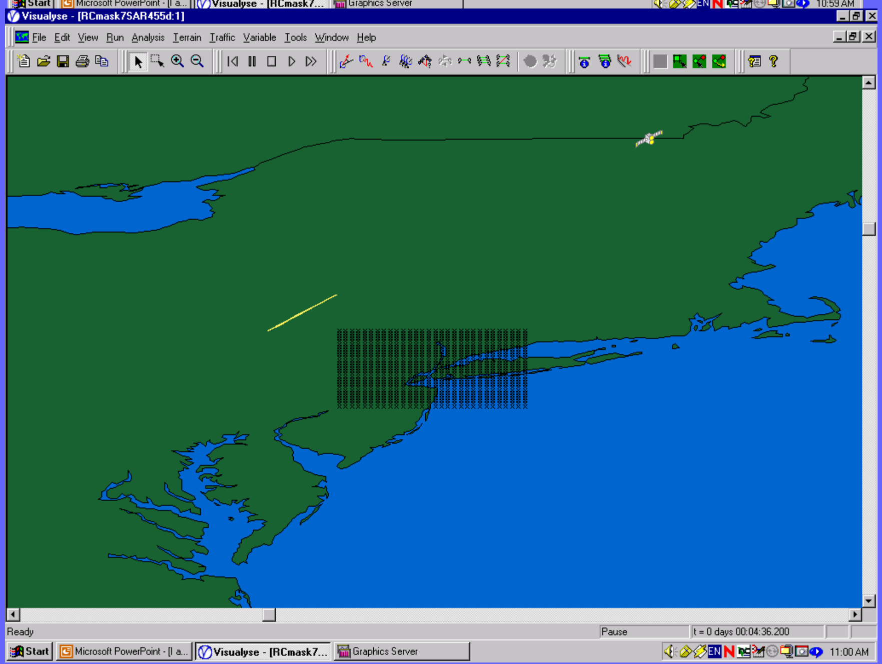
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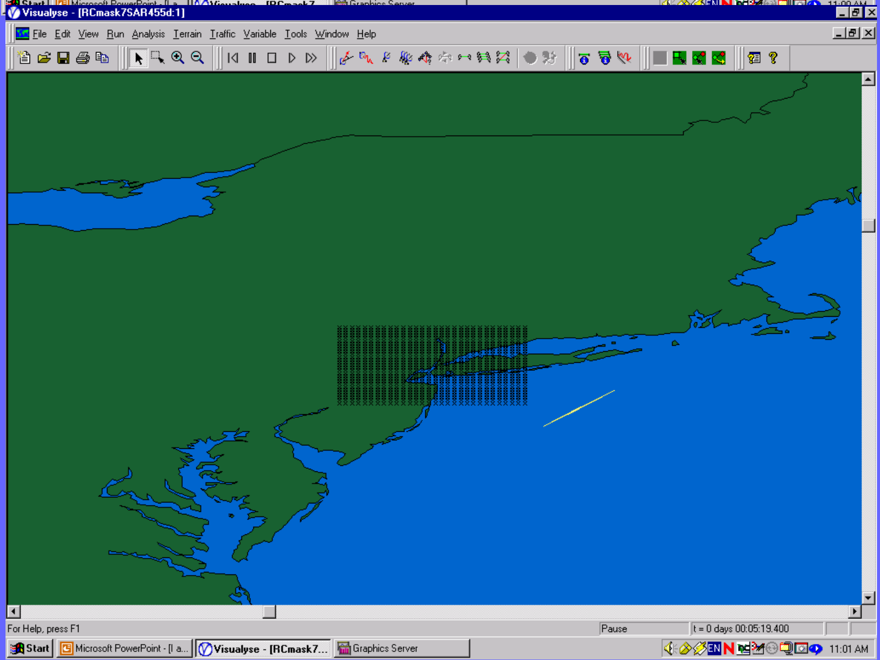
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For Help, press F1
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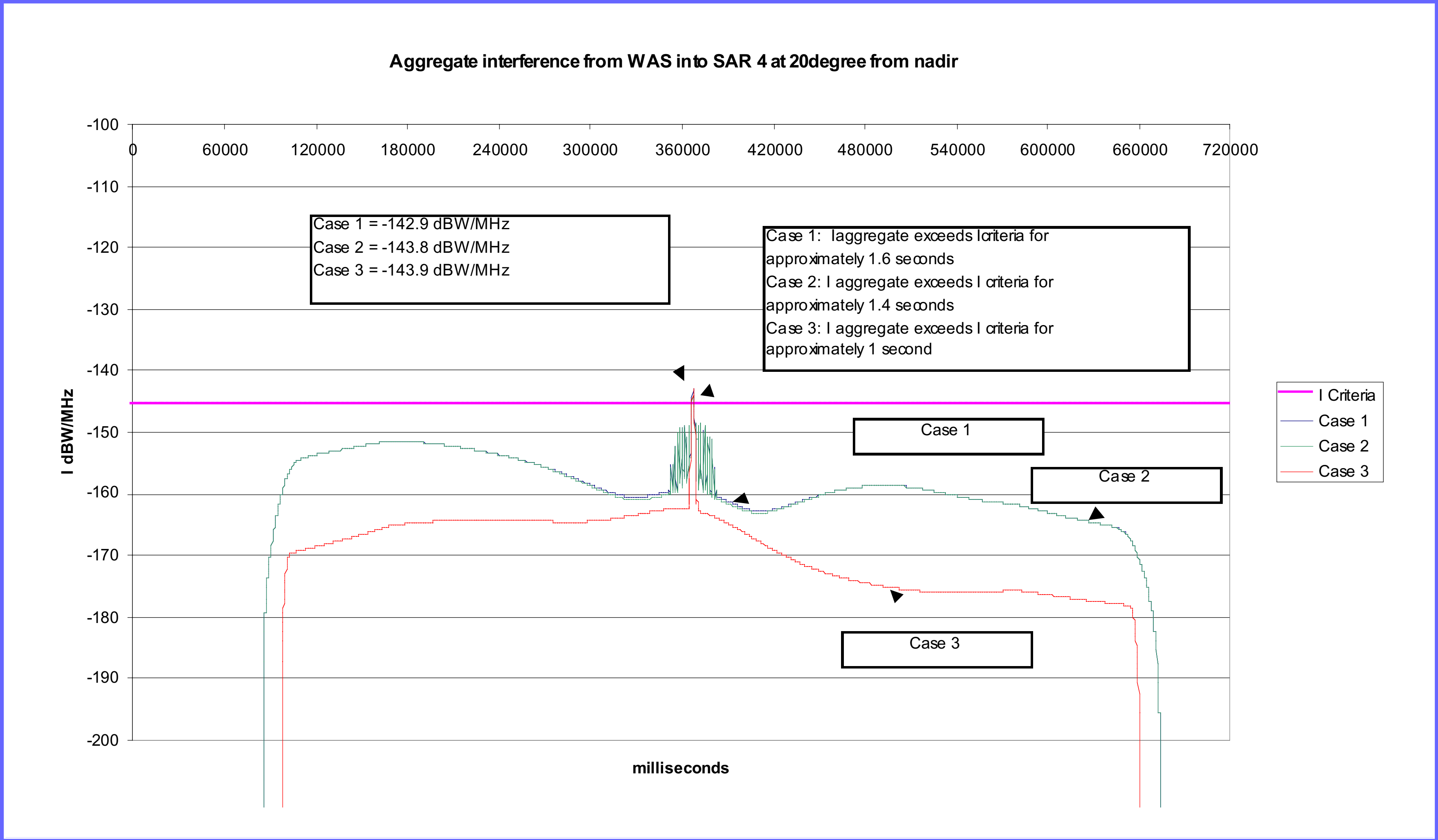
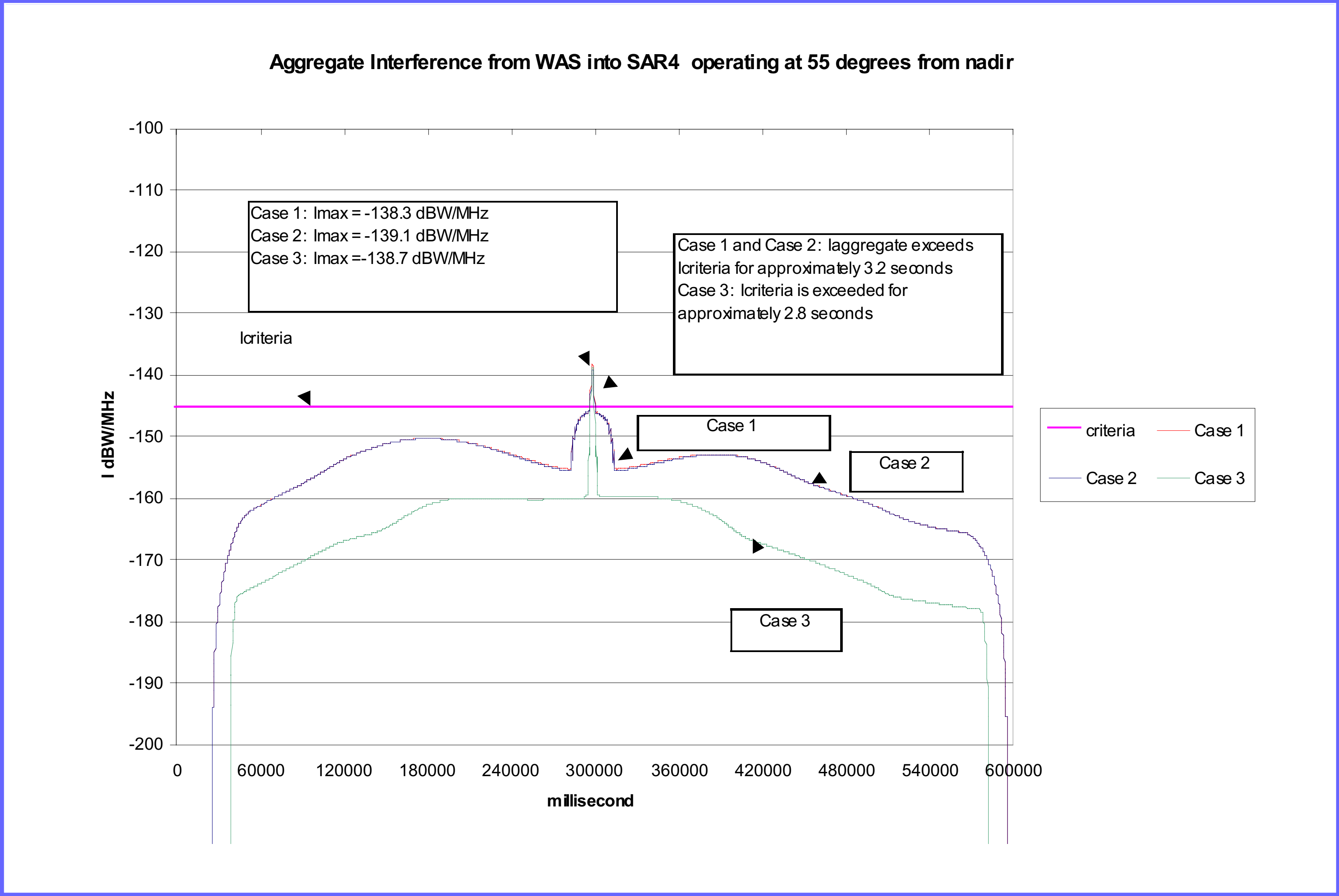
Results of simulation

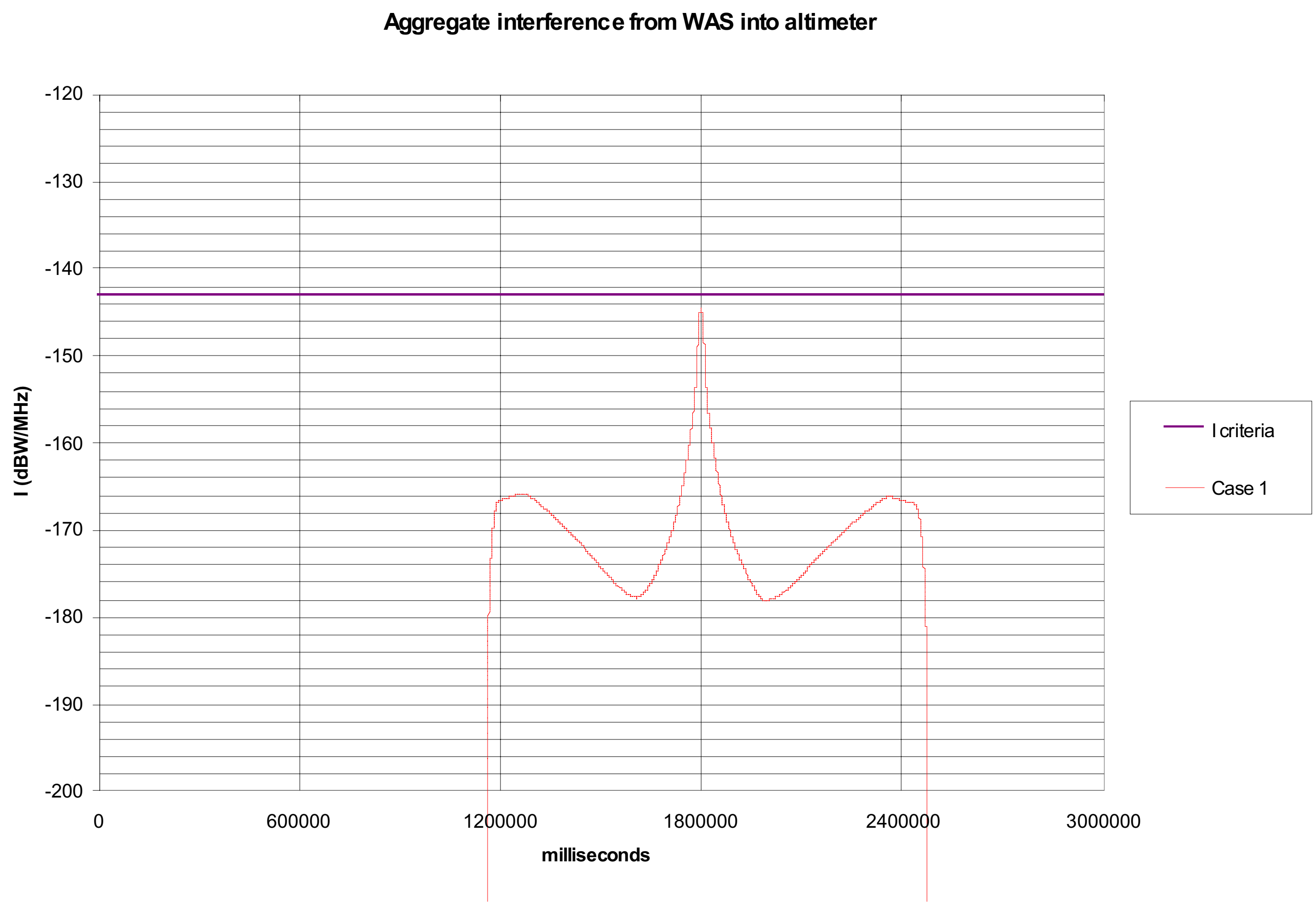
Aggregate interference from indoor and outdoor WAS into SAR 4 at 20 degrees from nadir



Aggregate interference from indoor and outdoor WAS into SAR 4 at 55 degrees from nadir



Aggregate interference from indoor and outdoor WAS into an altimeter



Summary of Result

EESS	SAR 4 @ 20deg from nadir			SAR 4 @ 55deg from nadir			Altimeter
WAS (see Table 7)	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3	Case 1
Interference criterion (dBW/MHz) (100% of the time)	-145.36	-145.36	-145.36	-145.36	-145.36	-145.36	-143.05
Maximum interference (dBW/MHz)	-142.9	-143.8	-143.9	-138.3	-139.1	-138.7	--
Duration of time in which Interference > Interference criterion	1.6 sec	1.4 sec	1 sec	3.2 sec	3.2 sec	2.8 sec	0

Observations

- Actual deployment of WAS indoor and outdoor is expected to be less than what is assumed in this analysis.
- The result represents worst case interference for the EESS
  - interference is expected to be less at any other time.

EIRP mask

- Based on comparison of results between City A and City B, the EIRP mask for outdoor WAS can be increased by at least 3 dB and the interference criterion for the SAR should still be met for the vast majority of cities in the world. Hence, the EIRP mask can be modified as follows:

-11 dBW/MHz	$0° \le \theta < 5°$
$-11 - 0.711(\theta - 5)$ dBW/MHz	$5° \le \theta < 40°$
$-35.9 - 1.222(\theta - 40)$ dBW/MHz	$40° \le \theta < 45°$
-42 dBW/MHz	$\theta \ge 45°$

where θ is the elevation angle above local horizon in degrees.

- However, since a maximum EIRP of 1W (-13 dBW/MHz) is allowed, the proposed EIRP mask then becomes…

Proposed EIRP mask for outdoor WAS/RLANs

-13 dBW/MHz	$0^\circ \le \theta < 5^\circ$
$-13 - 0.711(\theta - 5)$ dBW/MHz	$5^\circ \le \theta < 40^\circ$
$-35.9 - 1.222(\theta - 40)$ dBW/MHz	$40^\circ \le \theta < 45^\circ$
-42 dBW/MHz	$\theta \ge 45^\circ$

where θ is the elevation angle above local horizon in degrees.

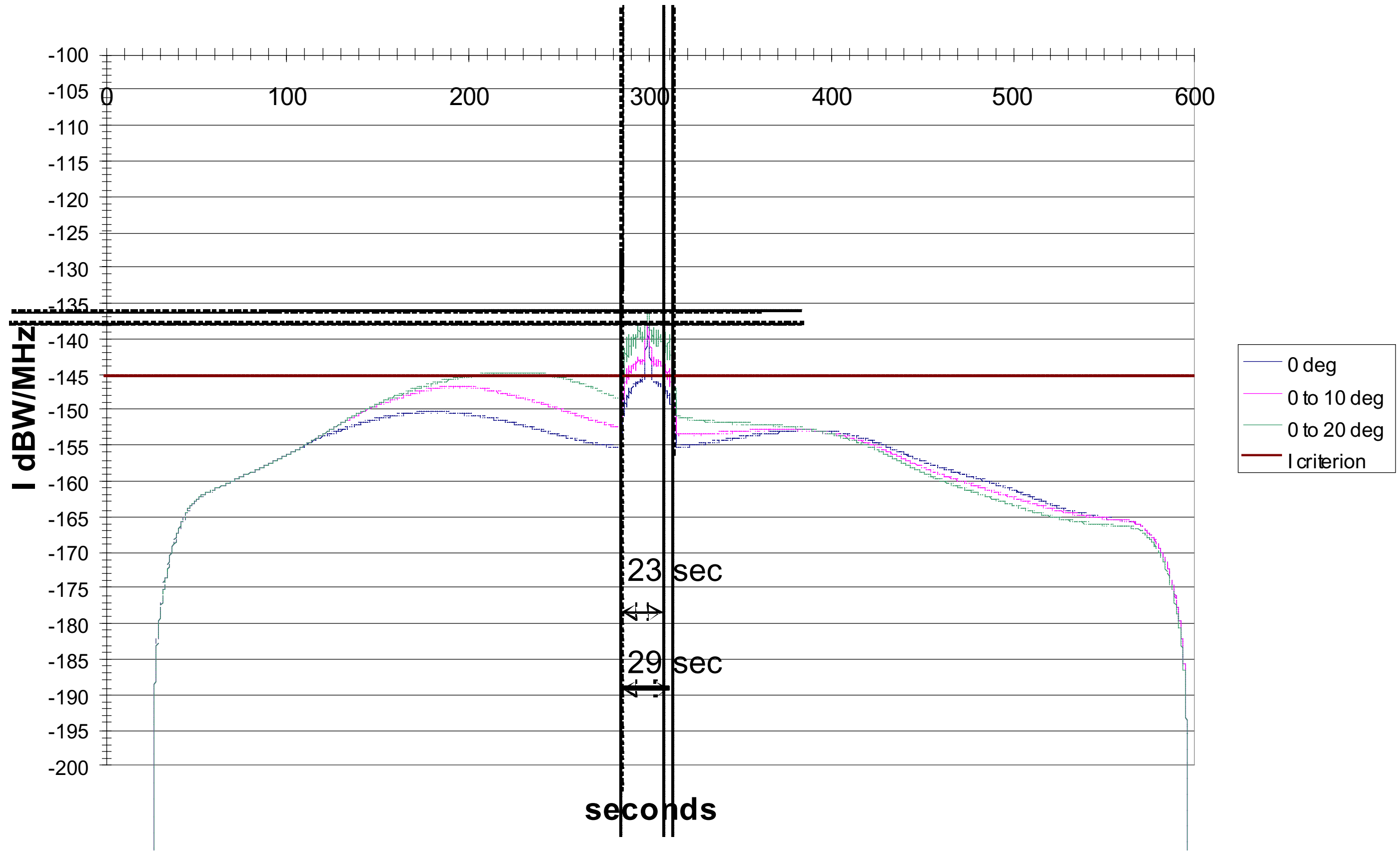
Further Simulation

Further simulation

- Regulatory concerns on how to enforce the proposed outdoor EIRP mask
- Simulation performed for SAR 4 operating at 55 degrees from nadir
- Assumed ALL of the WAS/RLANs were pointing upward, although still using the EIRP mask as proposed.
- Pointing angles assumed: 0 to 10 and 0 to 20 degrees

Further simulation

Figure 2: Interference from indoor & outdoor WAS (including the effect of scattering) into SAR 4 (55 deg from nadir)



Conclusion

Conclusion

- With respect to sharing between EESS and WAS/RLANs in the 5250-5350 MHz
  - Sharing appears to be feasible given that indoor systems have a maximum EIRP of 250 mW and that outdoor systems employ certain technical constraints such as the EIRP mask as proposed
- With respect to sharing between EESS and WAS/RLANs in the 5470-5570 MHz range
  - Further studies are required to examine the impact on wideband SARs (SAR 2 and SAR 3)
- Not covered in this presentation – sharing between WAS/RLANs and Radiolocation in the 5GHz range