XtremeSpectrum

Analysis of XtremeSpectrum Proposal of November 2001 and Federal Systems Including GPS

All Federal Criteria Are Satisfied

Updated 2/4/2002 To Include Federal Radar System Siting Policies

This Presentation Will Show

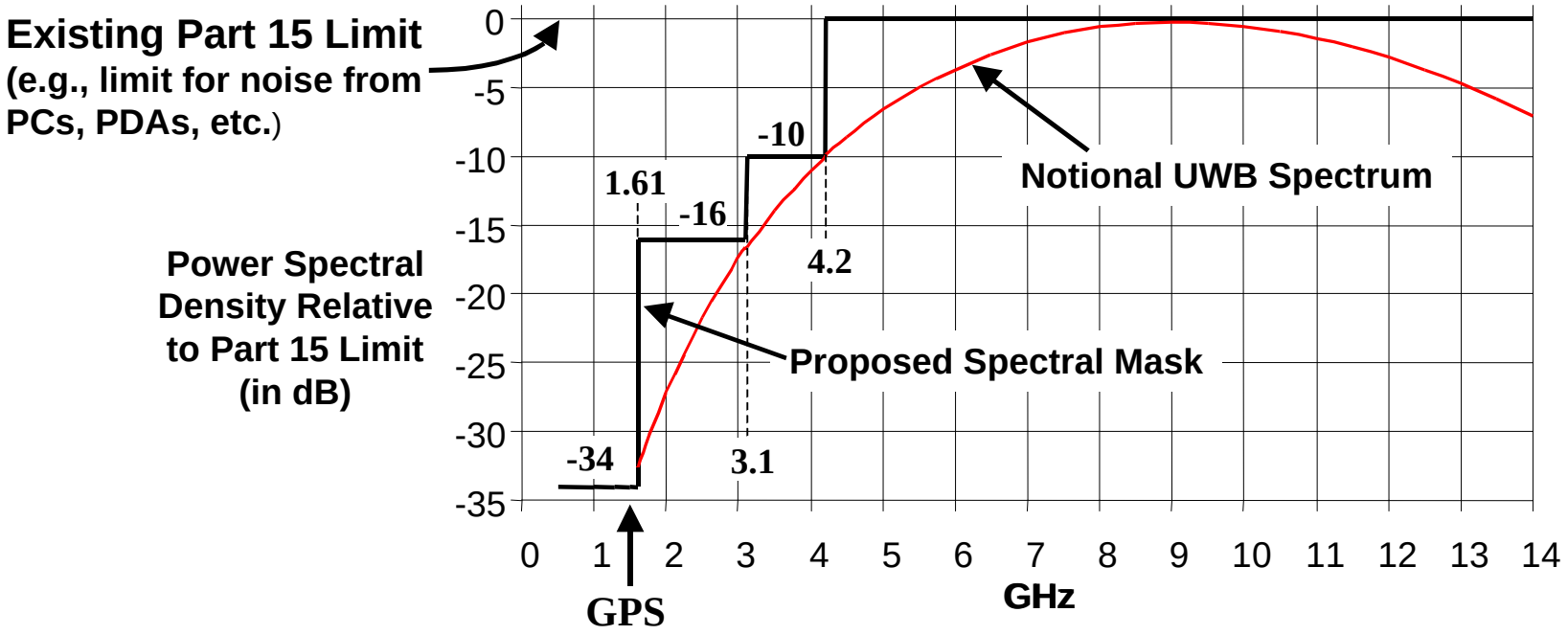
XtremeSpectrum

- **Protection criteria for NTIA 01-43 systems met**
  - By XtremeSpectrum proposal for Peer-to-Peer operation
  - These limits are more conservative than needed
- **GPSIC recommendation for GPS protection met**
  - These levels are lower than any other FCC proceeding
  - UWB can guarantee level of safety for GPS—other spectrum users do not
- **No new technical information or techniques are contained or used in this analysis**
  - Updated To Include Federal Radar System Siting Policies

Key Usage Constraints From the XtremeSpectrum Proposal

- **No mast or pole mounted UWB devices**
  - Devices are indoors, on a patio or rooftop or on the ground
    - UWB will go where computers go—and must be safe!
- **No automatic peer-to-peer**
  - Must be affirmatively initiated by the user
- **Building attenuation not needed to meet NTIA protection criteria**
  - Even though devices are mostly indoors
- ***Note these constraints, they impact the analysis***

UWB Levels From the XtremeSpectrum Proposal



- **Levels are far below those proposed in the NPRM**
- **Levels in the GPS bands meet GPSIC proposal, they exceed RTCA and all other GPS advocates in ALL other FCC proceedings**

The record does not justify limits tighter than Sec. 15.209(a) values in the 3100-4200 MHz band. XtremeSpectrum will accept this limit if necessary to resolve a ban on peer-to-peer

Assessment Criteria

XtremeSpectrum

- **Only NTIA SP 01-43 criteria used**
- **All NTIA supplied data accepted**
- **NTIA used I/N criteria from ITU-R**
  - Widely accepted ITU-R Recommendation
  - I/N criteria for radionav has been vetted in ITU-R SG 8 and accepted by FAA
- ***XS applied US Government established mandates & guidelines to scenario geometries***

Formatting of this Presentation

XtremeSpectrum

- **Systems are generally covered as**
  - What they are
  - Issue identification
  - Issue resolution summary
  - Issue resolution detail (as needed)
- **Summary tables supplied with most systems**
  - Summary table entries follow NTIA SP 01-43 Table 1
  - Supply dB below Class B to meet protection criteria
  - Supply separation range to meet protection criteria

Reference Information on RF Safety—Not Used to Meet Criteria

- **Radars are not directed (sited) to pose an RF hazard to the public**
  - This is an ethical consideration related to real world scenario geometries
- **Key test standards for RF radiation safety (e.g. around big radars)**
  - General Electronics Devices, 3V/m (Computers, calculators, GPS …)
    - IEC 61000-4-3 general EMC test
  - Critical Medical Electronic Devices, **10 V/m** (pacemakers, insulin pumps …)
    - IEC 60601-1-2 (**FDA recommendation – 10V/m)**
  - Automobiles, **50 V/m** (automatic braking systems, electronic ignition, etc.)
    - SAE J1113 – part 8 - also 20 V/m part 9
  - Aircraft, **100 V/m**
    - FAA Notice N8110.71 – for fixed wing aircraft
  - Fuels, **3.1 kV/m**
    - DNA 4284-F-SAS-1
- **Part 15 UWB levels are never larger than 500 uV/m at 3 m**

Margins Between NTIA 01-43 and XtremeSpectrum Proposal

System		NTIA Acceptable* dBm/MHz		XSI Mask dBm/MHz	dB Below Class B	Ave Bldg Loss (dB)	dB Margin of XS Proposal relative to NTIA Protection Criteria	
	GHz	2m	30m				2m Case In/Out	30m Case In/Out
DME, Interrogator	0.960-1.215	-46	NA	-75	34	9	38/29	-
DME, Transponder	1.025-1.150	-63	-56	-75	34	9	21/12	28/19
ATCRBS, Transponder	1.030	-44	NA	-75	34	9	40/31	-
ATCRBS, Interrogator	1.090	-31	-45	-75	34	9	53/44	39/30
ARSR-4	1.240-1.370	-60	-80	-75	34	9	24/15	0/-5
SARSAT	1.544-1.545	-68	-65	-75	34	9	16/17	19/10
ASR-9	2.7-2.9	-44	-65	-57	16	9	22/13	1/-8
NEXRAD	2.7-2.9	-39	-73	-57	16	9	27/18	-7/-26
Marine Radar	2.9-3.1	-56	-57	-57	16	12	13/1	12/0
CW Altimeters	4.2-4.4	14	NA	-41.3	0	12	67/55	-
Pulsed Altimeter	4.2-4.4	14	NA	-41.3	0	12	67/55	-
MLS	5.030-5.091	-45	NA	-41.3	0	12	8/-4	-
TDWR	5.60-5.65	-35	-63	-41.3	0	12	18/6	-10/-22

* Using Dithered with PRF > 1 MHz

Non-GPS Radar & Navigation Systems From NTIA Reports

XtremeSpectrum

- **Air Surveillance Radar**
  - ARSR-4, ASR-9
- **Weather Radar**
  - NEXRAD, TDWR
- **Radio Navigation Systems**
  - DME, ATCRBS, Altimeters, MLS
- **Maritime Radar**
- **Search and Rescue Satellites**
  - SARSAT

Air Route Surveillance Radar (ARSR)—What It Is

XtremeSpectrum

- **Measures enroute aircraft range and azimuth**
  - 200 nm (370 km) for a 2.2 m^2 (3.4 dBm^2) RCS airplane in clear air
- **Specifications**
  - ** Doppler processing gain of 9dB **
  - Antenna
    - Maximum gain 41.8dBi
  - Nine vertically stacked beams with different gains
  - Beam-One 3 dB Beamwidth Vertical 2.0, Horizontal 1.4 Degrees
  - Peak EIRP 1.4 GW

ARSR-4
Issue Identification

XtremeSpectrum

- **No issue for 2m UWB at XS proposal of Class B –34dB**
  - NTIA SP 01-43 Figure 4-8
  - No building loss applied—Protection criteria satisfied in & out door
- **No issue for 30m indoor UWB at XS proposal of Class B –34dB**
  - NTIA SP 01-43 Figure 4-8
- **Potential issue for 30m UWB at Class B –34dB on rooftop or patio**
  - NTIA SP 01-43 Figure 4-8 indicates 5 dB additional isolation needed

	NTIA 01-43 Margin from Class B UWB (separation)	XS Proposed –34 dB UWB [outdoor] (separation)	–34 dB UWB and 9 dB isolation [indoor] Or 9 dB Doppler Proc. Gain (separation)
ARSR-4 (2 m UWB)	-19dB (6.1 km)	+15 dB (0 m)	+24 dB (0 m)
ARSR-4 (30 m UWB)	-39 dB (>15 km)	-5 dB (~400 m)	+4 dB (0 m)

ARSR-4 Issues
Multiple Resolutions—Summary

XtremeSpectrum

- **FAA Order 6340.15 mandates separation of 615m (details follow)**
  - The scenario at 200m identified as a potential issue in NTIA SP 01-43 is excluded
  - Worst case FAA compliant scenario has +4dB margin. No additional isolation needed
- **Other solutions available to NTIA & FCC include …**
- **Include the 9 dB Doppler processing gain of the radar in the analysis**
  - Doppler processing improves the I/N by 9 dB, providing the margin
- **The low beam of the low bank of the ARSR-4 is blocked by the building**
  - With low beam blocked the UWB is not a factor to it
  - Other beams of the ARSR-4 do not see the building so the UWB is no factor
- **Allowing 5dB losses for indoor propagation meets the protection criteria**
  - Reasonable since this radar should not be pointed at nearby patios and rooftops
- **Reduce the UWB level—XS will support this if needed to resolve this issue**
- **FYI, ARSR-4 is typically located in remote border areas of the US**
  - At 200m a 30m building would be subject to unsafe RF fields in excess of 2000 V/m
    - Exceeds safety standards for airplanes, automobiles, electronic & medical device

ARSR-4 Detail on FAA Setback Requirement

XtremeSpectrum

- **Reference FAA Order 6340.15, Ch 3, Paragraph 34a**
  - States that a minimum separation of 2000 ft (615m) from any above ground objects is required
- **The worst case FAA compliant scenario is UWB at 30m high on a rooftop or patio 615m away from ARSR-4**
  - The XS proposal in the ARSR-4 band is Class B –34 dB
  - At 615m away and 30m high the margin is a positive +4.2 dB
  - No further isolation is needed
  - FYI, at 615m the building is still in dangerous RF fields of +650V/m
    - Exceeds safety test standards of autos, planes, and electronics

Airport Surveillance Radar (ASR-9)—What It Is

XtremeSpectrum

- **Monitor aircraft in the airspace "in and around" airports**
- **Radar Parameters**
  - ***** Doppler processing gain of 9dB *****
  - 2.7-2.9 GHz,
  - Dual 1.3 Megawatt Transmitters
  - 33.5 dBi Gain Antenna
  - Max Range 110 km.
  - 4 dB NF+2 dB losses,
  - 4 MHz bandwidth (–104 dBm Receiver Noise Floor)
  - Pulse Width 1.08 µs & PRF dithered from 928 up to 1321 pulses/sec

ASR-9
Issue Identification

XtremeSpectrum

- **No issues for 2m UWB at XS proposed Class B –16dB**
  - NTIA SP 01-43 Fig 4-11
  - No building loss applied—Protection criteria satisfied in & out door
- **No issues for 30m indoor UWB at XS proposed Class B –16 dB**
  - NTIA SP 01-43 Figure 4-12
- **Potential issue: worst case scenario is UWB 30m high on a rooftop or patio 200m away from ASR-9**
  - NTIA SP 01-43 Figure 4-12 indicates 8 dB isolation required beyond the 16dB below Class B in the XtremeSpectrum proposal

	NTIA 01-43 Margin from Class B UWB (separation)	XS Proposed –16 dB UWB [outdoor] (separation)	–16 dB UWB and 9 dB isolation [indoor] Or 9 dB Doppler proc gain (separation)
ASR-9 (2 m UWB)	-3 dB (0.8 km)	+13 dB (0 m)	+22 dB (0 m)
ASR-9 (30 m UWB)	-24dB (1.3 km)	-8 dB (~350 m)	+1 dB (0 m)

ASR-9—Issues
Multiple Resolutions—Summary

XtremeSpectrum

- **FAA Order 6310.6 mandates separation of 462m (preferably 1610m)**
  - The 200m scenario in SP 01-43 is excluded
  - Worst case scenario of 30m building at 462m has positive margin of +4.4dB
- **Other solutions available to NTIA & FCC include …**
- **Include the 9 dB Doppler processing gain of the radar in the analysis**
  - Doppler processing improves interference to noise ratio by 9 dB, provides the margin
- **The ASR-9 is blocked by the building and illuminates it**
  - At 200m the building is subject to unsafe RF fields in excess of 1500 V/m
    - Risk to airplanes, automobiles, electronic & medical devices
  - Keep buildings and UWB 330m (computed value), or more, away from ASR-9
- **Allowing 9dB losses for indoor propagation meets the protection criteria**
  - Reasonable since this radar should not be pointed at nearby rooftops & patios
- **Reduce the UWB level—XS will support this if needed**

ASR-9 Detail on FAA Setback Requirement

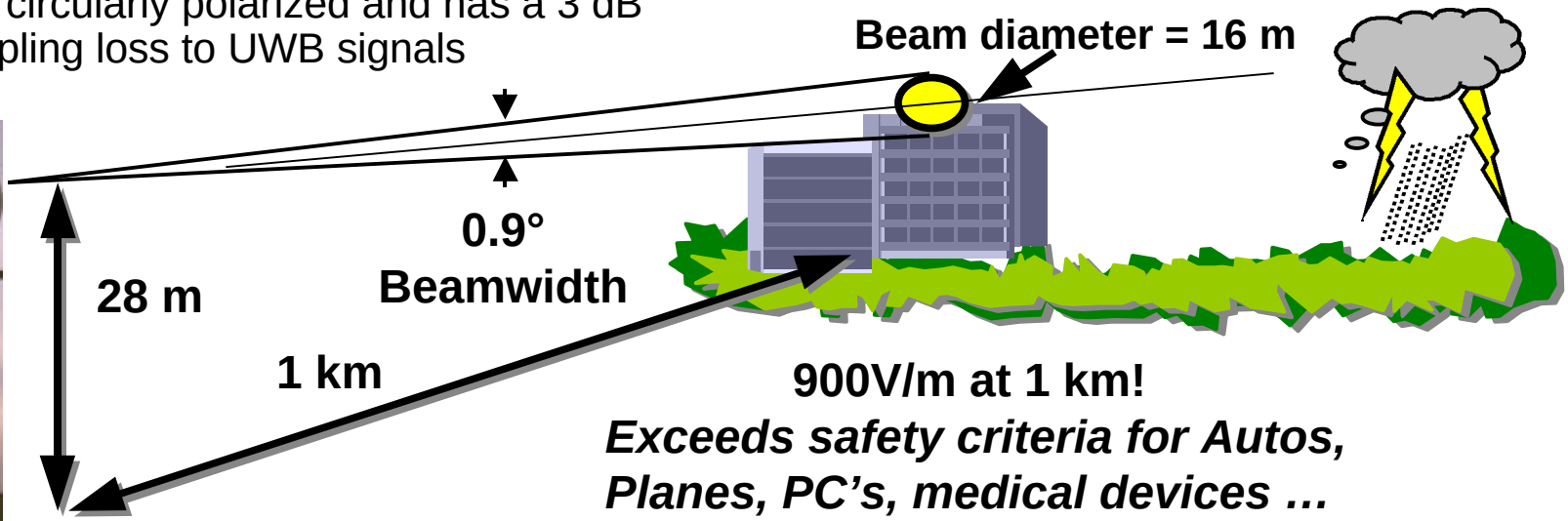
XtremeSpectrum

- **Reference FAA Order 6310.6, Ch 2, Paragraph 17a**
  - States that a minimum separation of 1500 ft (462m) from any above ground structure is required
- **The worst case FAA compliant scenario is UWB at 30m high on a rooftop or patio 462m away from ASR-9**
  - The XS proposal in the ASR-9 band is Class B –16 dB
  - At 462m away and 30m high the margin is a positive +4.4dB
    - Even without factoring in the 9 dB Doppler processing gain
  - ASR-9 protection criteria is met. No further isolation is needed
  - FYI, at 462m the building is still in dangerous RF fields over 400V/m
    - Exceeds safety test standards of autos, planes, and electronics

Next Generation Weather Radar (NEXRAD)—What It Is

XtremeSpectrum

- **Detect hazardous & routine weather**
- **Specifications**
  - 2.7-3.0 GHz
  - 750 KW peak, 300-1300 W Average
  - 45.5 dB gain Antenna (.925° spot beam)
  - -113 dBm/500KHz noise floor
  - It is circularly polarized and has a 3 dB coupling loss to UWB signals
- **Weather radars see volumes (voxels)**
  - Voxels grow with range since the flashlight beam radiated spreads with distance.
  - Because of this weather radars see farther & with better SNR than other radars



900V/m at 1 km!

Exceeds safety criteria for Autos, Planes, PC's, medical devices …

NEXRAD
Issue Identification

XtremeSpectrum

- **No issues for 2m UWB at XS proposal of Class B –16dB**
  - NTIA SP 01-43 Figure 4-3
  - No building loss applied—Protection Criteria satisfied in & out door
- **Potential issue: worst case scenario is UWB 30m high on rooftop or patio 200m from NEXRAD**
  - NTIA SP 01-43 Figure 4-4 indicates 32dB below Class B needed
  - Solutions next slide

	NTIA 01-43 Margin from Class B UWB (separation)	XS Proposed –16 dB UWB [outdoor] (separation)
NEXRAD (2 m UWB)	+2dB (0m)	+18 dB (0 m)
NEXRAD (30 m UWB)	-32 dB (>5.8 km)	-16 dB (~1.2 km)

NEXRAD Issues
Multiple Resolutions—Summary

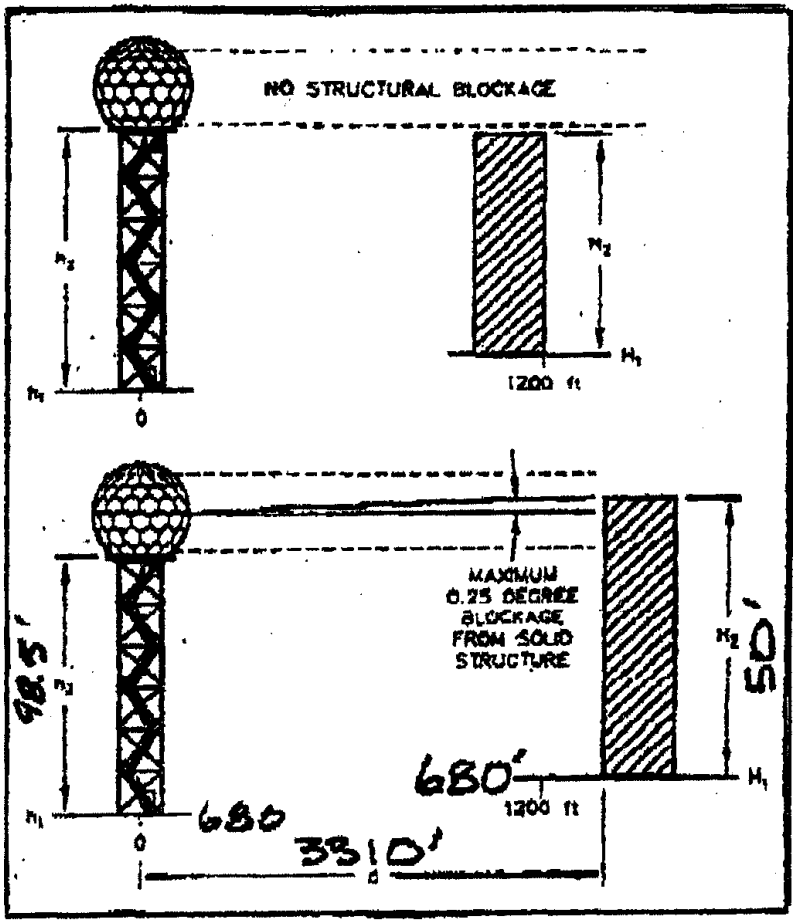
XtremeSpectrum

- **NOAA NEXRAD Guidelines exclude the scenario (details follow)**
  - All NOAA compliant sitings and NTIA spreadsheets show XS meets criteria
  - Worst case NOAA complaint scenario has +4dB positive margin
- **NEXRAD engineers indicate building backscatter damages radar**
  - Damage to radar limits performance—not UWB (details follow)
- **Building blockage limits radar performance—not the UWB device**
  - UWB 30m high must be on patio or roof since no mast or pole mounts allowed
  - NEXRAD is a spot beam and is blocked by the building—UWB not a factor
- **Must blank or elevate the radar to operate (UWB not a factor)**
  - Clearing a 30m building at 200m requires .91º degrees elevation for 16 dB
- **FYI, if NEXRAD not blanked building is subject to excessive RF**
  - Fields over 800V/m. Unsafe for auto, planes, medical devices, electronics

NEXRAD—Detail on NOAA Setback Guidelines

XtremeSpectrum

- **Reference WSR-88 Weather Surveillance Radar Guidelines**
- **States no structure within 370m should block the radar beam**
  - Maximum elevation of the structure must be less than the sum of the ground elevation and tower height of the radar
- **Worst case NOAA scenario is 30m structure 370m out from the NEXRAD**
  - NEXRAD tower is 30m high by guideline
  - NTIA NEXRAD spreadsheet parameters
    - H_R=34.27 (tower height + phase center)
    - H_{TX}=30 (UWB height)
    - EIRP=-57.3 (UWB level in XS proposal)
      - **NO BUILDING ATTENUATION APPLIED**
- ***NOAA scenarios & NTIA spreadsheets Protection Criteria Satisfied (+4dB)***



Guidelines for Allowable Structural Blockage

NEXRAD—Details on Building Backscatter

XtremeSpectrum

- **Summary of XtremeSpectrum discussions with NEXRAD engineers**
- **Informed us that backscatter from buildings close to NEXRAD will burn out the radar's front end**
  - Reasonable considering the power of the radar and the near in geometry
- **Told us that NEXRAD is sited to avoid buildings (see guidelines)**
- **If a building goes up in NEXRAD's beam they blank the beam**
  - Gave example in Hawaii of NEXRAD on US Air Force Base and nearby hotel outside the base's perimeter

Terminal Doppler Weather Radar (TDWR)—What It Is

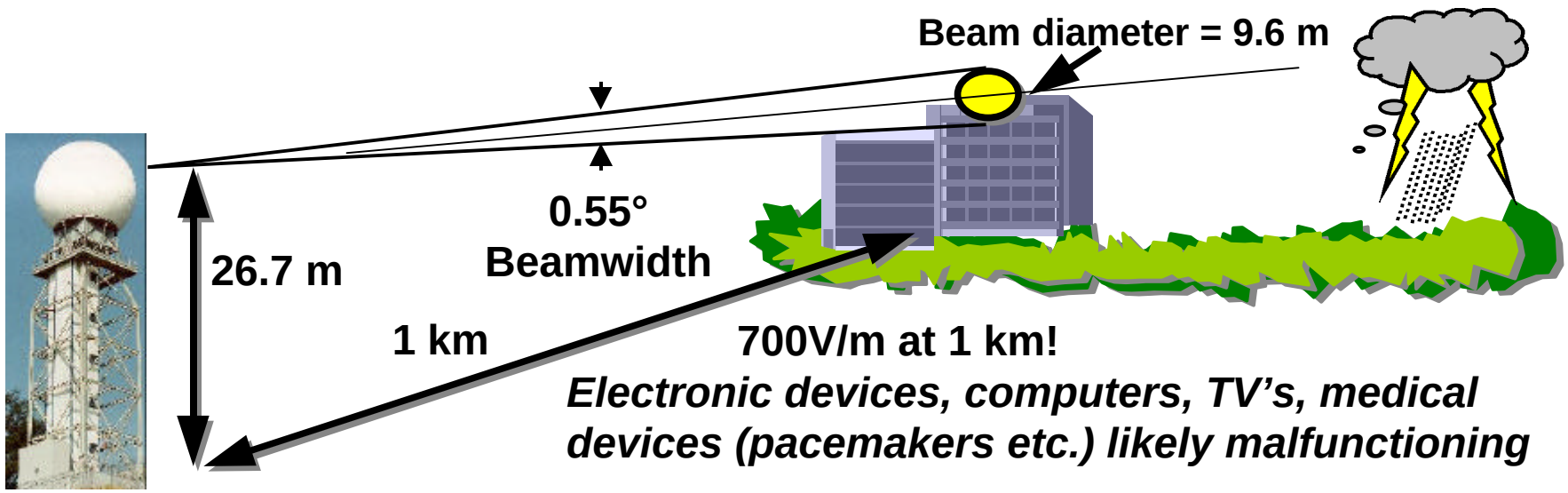
XtremeSpectrum

- **Detect wind shear & other weather hazards at airports**
- **TDWR is powerful—radiating 15 Billion Watts EIRP!**
- **Specifications are**
  - 5.6 GHz
  - 150 kW peak
  - 50 dB gain Antenna (0.55° spot beam)
  - Noise floor -110 dBm / 910 kHz bandwidth
  - It is circularly polarized -- 3 dB coupling loss to UWB signals
- **Siting is critical**
  - Buildings and terrain must not block coverage over the runways
  - Must be 8-10 km from runway to meet aircraft RF safety limits
  - Safety requires it to be far from people or blanked if too close

TDWR
Issue Identification

XtremeSpectrum

- **No issues for 2m high UWB at XS proposal of Class B**
  - NTIA SP 01-43 Figure 4-23
  - No building loss applied—Protection criteria satisfied in & out door
- **Potential issue for 30m high UWB at XS proposal of Class B**
  - Scenario geometry below (solution next page)



TDWR
Issue Resolution

XtremeSpectrum

- **Worst case scenario is outdoor 30m UWB 400m from the TDWR**
  - NTIA SP 01-43 Figure 4-24 indicates 22dB additional isolation required
- **Building blockage limits radar performance—not the UWB device**
  - UWB 30m high is on patio/rooftop since no mast or pole mounts are allowed
  - TDWR is a spot beam radar and is therefore blocked by the building
  - Issue is resolved for UWB. No further margin needed
- **Must blank or elevate the radar to operate (UWB not a factor)**
  - Clearing 30m building at 400m needs 1.25º degrees elevation (9m) for 22dB
- **FYI, if the TDWR is not blanked or elevated the building is subject to excessive RF fields**
  - Fields would exceed 800V/m
  - Exceeds safety standards for automobiles, airplanes, electronic devices, medical devices etc.

Distance Measuring Equipment (DME) NTIA Criteria Satisfied

XtremeSpectrum

- **Distance Measuring Equipment (DME)**
  - Measures range from aircraft's interrogator to ground transponder
  - Operates at 960-1215MHz
- **No issues with XS proposal of –34dB below Class B**
  - DME protection criteria from NTIA SP 01-43 Table 4-25, 4-26
- **DME NTIA protection criteria is satisfied**
  - Even with main beam to main beam coupling. Margin for indoor not needed

	NTIA 01-43 Margin from Class B UWB (separation)	XS Proposed –34 dB UWB (separation)	–34 dB UWB and 9 dB building isolation (separation)
DME Interrogator	-5.0 dB (80 m)	+29 dB (0 m)	+38 dB (0 m)
DME Transponder (UWB 2 m high)	-22 dB (260 m)	+12 dB (0 m)	+21 dB (0 m)
DME Transponder (UWB 30 m high)	-15.0 dB (260 m)	+19 dB (0 m)	+28 dB (0 m)

Air Traffic Control Radio Beacon System (ATCRBS)—Criteria Satisfied

XtremeSpectrum

- **Air Traffic Control Radio Beacon (ATCRBS)**
  - Aircraft transmits an identifier in response to interrogation
  - Operates at 1030 & 1090 MHz
- **No issues with XS proposal of –34dB below Class B**
  - ATCRBS protection criteria from NTIA SP 01-43 Table 4-17 and 4-18
- **ATCRBS NTIA protection criteria is satisfied**
  - Even with main beam to main beam coupling. Margin for indoor not needed

	NTIA 01-43 Margin from Class B UWB (separation)	XS Proposed –34 dB UWB (separation)	–34 dB UWB and 9 dB building isolation (separation)
ATCRBS Transponder	-3.1 dB (20 m)	+30.7 dB (0 m)	+39.7dB (0 m)
Interrogator (2 m)	+10.8 dB (0 m)	+44.8 dB (0 m)	+53.8 dB (0 m)
Interrogator (30 m)	-5.6 dB (270 m)	+28.4 dB (0 m)	+37.4 dB (0 m)

Pulsed and CW Radio Altimeters NTIA Criteria Satisfied

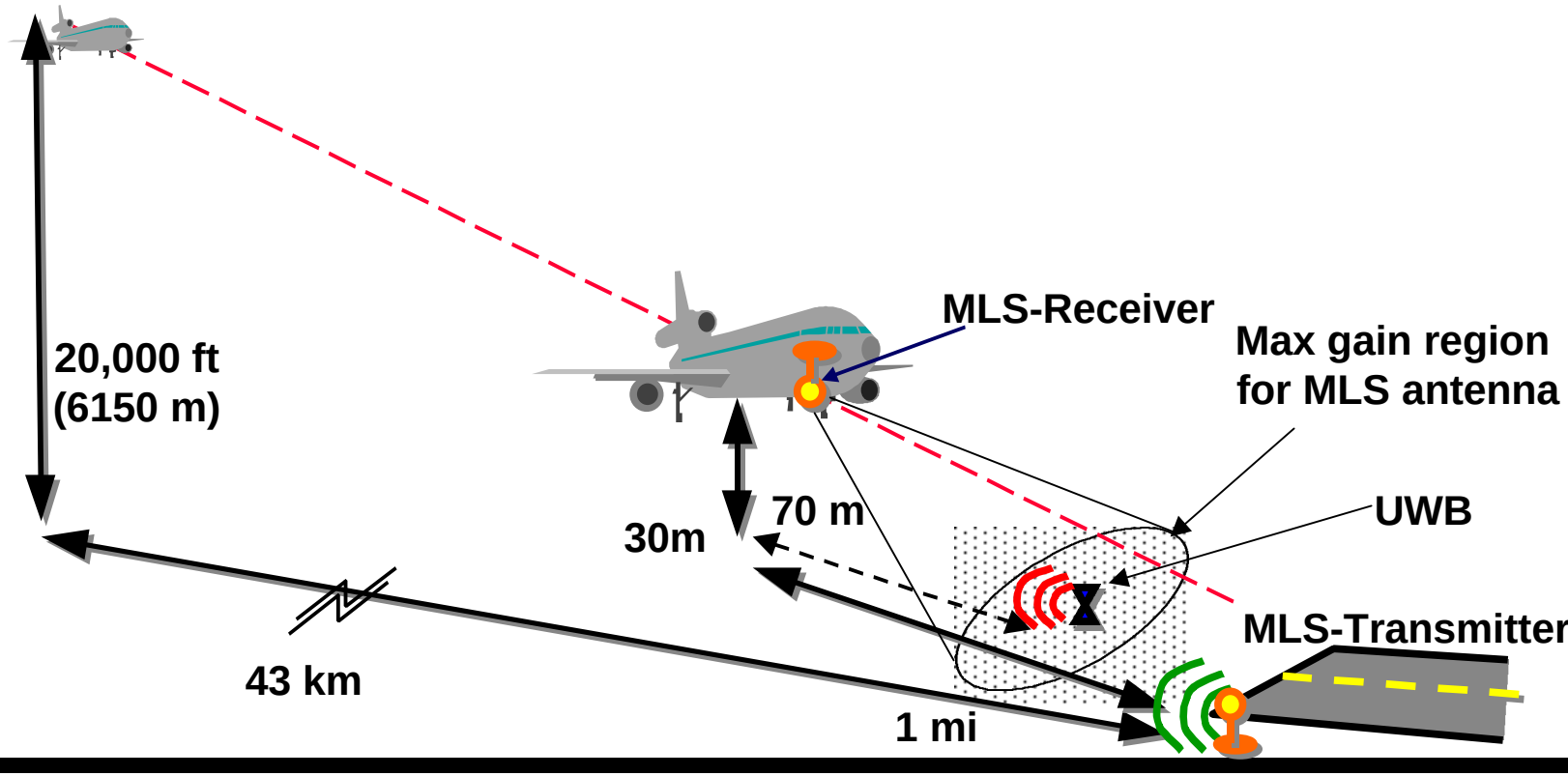
XtremeSpectrum

- **Radar altimeters provide aircraft with altitude above ground level**
  - Operate at 4.2-4.4 GHz
- **No issues with XS proposal of Class B at any height**
  - Protection criteria from NTIA SP 01-43 Table 4-16, Table A-4
  - SP 01-43 shows 55-66 dB of margin from ground based UWB
  - Assumes free-space propagation & main beam to main beam coupling
  - No building loss applied—Protection criteria satisfied in & out door

Microwave Landing System (MLS)—What It Is

XtremeSpectrum

- **MLS is a radio-navigation system for precision approach & landing**
  - MLS operates at 5.030-5.091 GHz
- **The MLS transmitters are at the corners of the runway**



MLS Issues & Resolution

XtremeSpectrum

- The I/N threshold calculation in SP 01-43 is exceeded for a short interval (~1 sec) about 70m from the runway
- However, since the MLS antenna pattern only illuminates a small region during approach and landing it is reasonable to allocate the interference budget to it. This would satisfy the I/N criteria
- FYI, because the separation between MLS transmit and receive is so small, no position errors are possible from these UWB levels in this scenario

Maritime Radar
What It Is

XtremeSpectrum

- **Prevent ships from hitting shorelines or each other**
- **Typical System (Furuno S-band Marine Radar)**
  - 60 kW peak power into antenna
  - 27dBi Gain Antenna

  } **30 MW EIRP**

    - Narrow beam width (1.9°)
    - Azimuth sidelobes are at least 30 dB down (1000 times smaller than main lobe) beyond 10 degrees off the main lobe.
  - 3.05 GHz
  - 20m Height
  - 4 dB NF+2dB losses,
  - 4 MHz bandwidth (–104 dBm Receiver Noise Floor)
  - Pulse Width
    - 1.2μs for > 5km
    - 0.4μs for < 5km
- **A Robust Radar**
  - Spec'd to 160 km even though the radar horizon is less than 50 km

Maritime Radar
NTIA Criteria Satisfied

XtremeSpectrum

- **NTIA SP 01-43 no issues for 2m UWB at Class B –16 dB**
  - The XS proposal evaluated at NTIA SP 01-43 (pg 4-63, Table 4-53)
    - No margin for building losses applied
- **NTIA SP 01-43 no issues for 30m UWB at Class B –16 dB**
  - The XS proposal evaluated at NTIA SP 01-43 (pg 4-64, Table 4-55)
    - No margin for building losses applied
- **No issues with UWB devices on the decks of cruise ships**
  - The deck is below the radar and in its nearfield
    - The beam has not formed

Search and Rescue Satellite (SARSAT)—NTIA Criteria Satisfied

XtremeSpectrum

- **XS proposal is Class B –34dB in SARSAT**
  - No building losses applied in this analysis
- **NTIA SP 01-43 indicates no issues for 2m high UWB**
  - NTIA SP 01-43 (pg 4-31, Table 4-38a) adjusted to XS UWB levels
- **NTIA SP 01-43 indicates no issues for 30m high UWB**
  - NTIA SP 01-43 (pg 4-33, Table 4-40a) adjusted to XS UWB levels

	NTIA 01-43 Margin from Class B UWB (separation)	XS Proposed –34 dB UWB (separation)	–34 dB UWB and 9 dB building isolation (separation)
SARSAT (2 m UWB)	-27dB (2.9 km)	+7 dB (0 m)	+16 dB (0 m)
SARSAT (30 m UWB)	-24 dB (5.5 km)	+10 dB (0 m)	+18.3 dB (0 m)

XtremeSpectrum

GPS, Assisted GPS and Aggregation

GPS—All Proposed Federal and Industry Protection Criteria Met

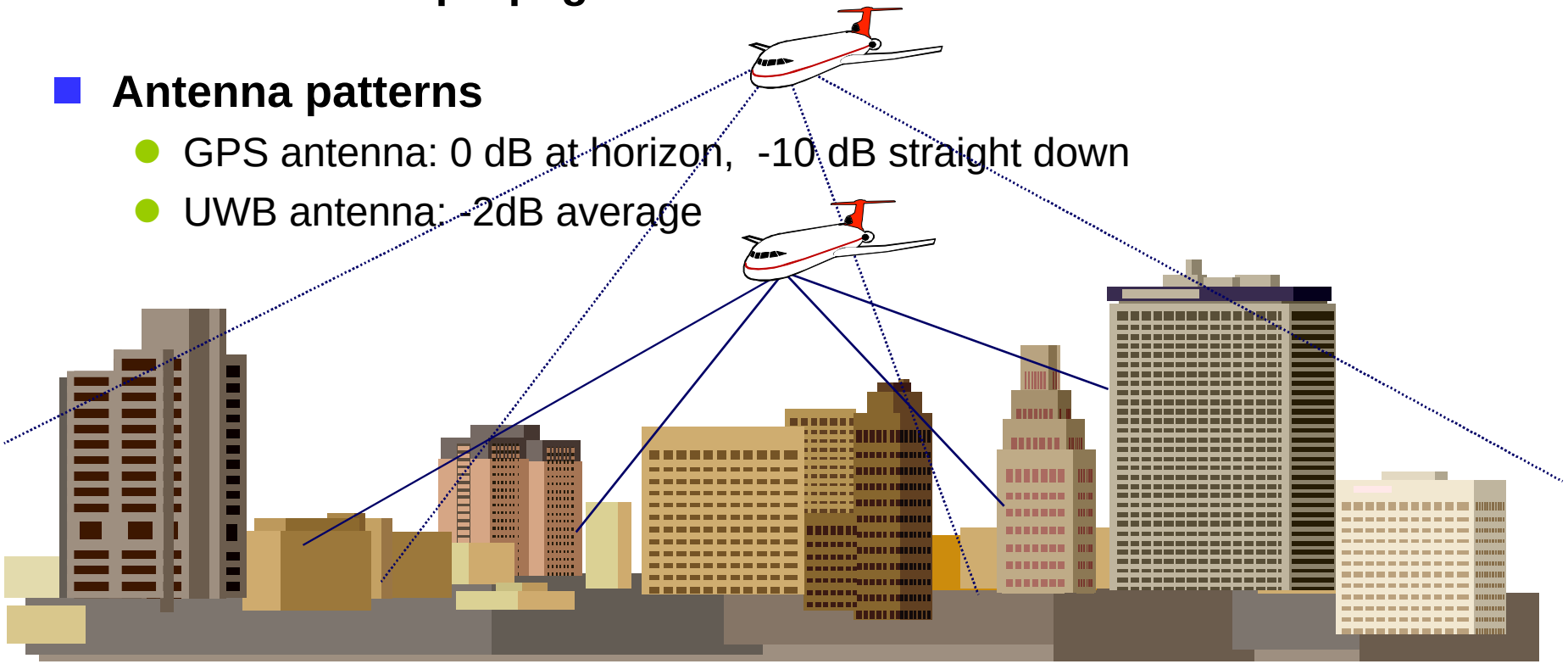
XtremeSpectrum

- **Analyzed with XS proposal of 34dB below Class B for GPS**
  - Limits UWB in GPS bands to levels requested by GPSIC. Exceeds RTCA and all other GPS advocates in all other FCC proceedings
- **Low flight over heavy concentration of UWB transmitters**
- **Precision approach near hi-rise with UWB transmitters**
- **High flight over heavy concentration of UWB transmitters**
- **Assisted GPS**
- **Aggregation effects are insignificant**
  - No impact on safety criteria
  - Yes, signal power adds but signal strength falls much faster

City Over-Flight Scenarios

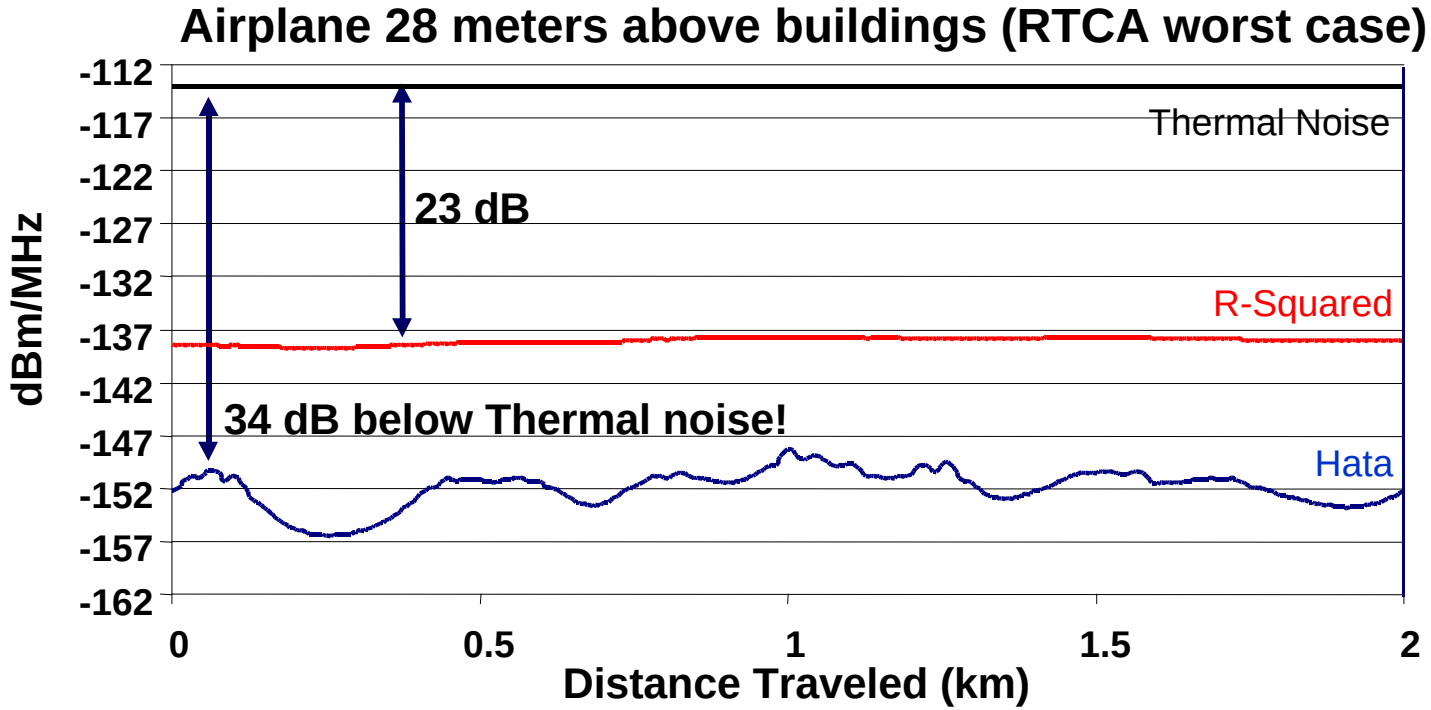
XtremeSpectrum

- **As height goes down**
  - Blockage by buildings tends to reduce the signal, but
  - The shorter path tends to increase the signal
- **Okumura-Hata propagation model**
- **Antenna patterns**
  - GPS antenna: 0 dB at horizon, -10 dB straight down
  - UWB antenna: -2dB average



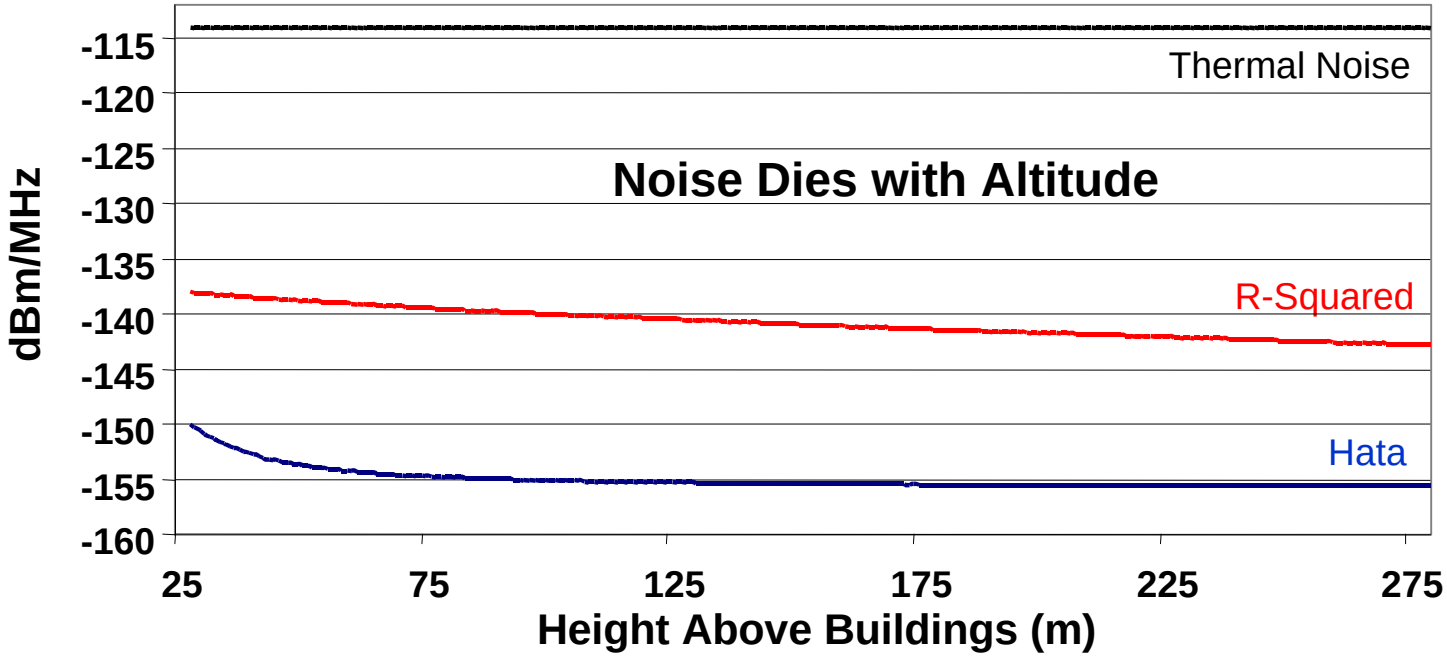
Low Altitude Airborne GPS Safety Criteria Satisfied

XtremeSpectrum



- **City with 200 UWB devices per sq. km—aggregation is insignificant**
  - Emitter density from NTIA report
  - All devices transmitting simultaneously
  - All devices outside, no building attenuation
  - Plane passes over highest elevation UWB
- **Margin greater than 30dB**

High Altitude Airborne GPS Safety Criteria Satisfied

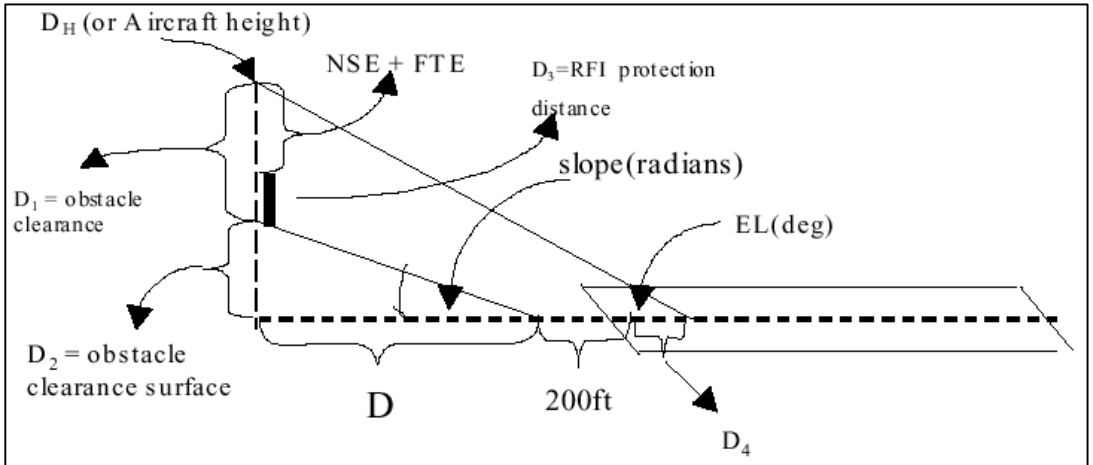


- **City with 200 UWB devices per sq. km —aggregation is insignificant**
  - Emitter density from NTIA report
  - All devices transmitting simultaneously
  - All devices outside, no building attenuation
  - Plane directly over highest elevation UWB
- **Margin greater than 30 dB and increases with altitude**

Precision Approach GPS Safety Criteria Satisfied

XtremeSpectrum

RTCA analysis of category II precision approach



Aircraft antenna height above control point = 7ft

EL = 3 deg

D_H = 100 ft CAT II

D_4 = 50/tan(EL) ft

D = D_H/tan(EL) - D_4 - 200 = 754.1 ft for CAT II

slope = 1/50 for CAT II/III

D_2 = D*slope = 15.1 ft

Obstacle Clearance = D_1 = D_H - D_2 = 84.9 ft

aircraft antenna-to-obstacle surface = 84.9 + 7 = 91.9 ft

- **RTCA study**
  - Outdoor Study
  - Worst case UWB position near runway
  - Had multiple UWBs
    - 10 equidistant emitters
  - Had Spectral Lines
  - Ultra Conservative
    - Extra 10 dB margin
- **Answer was**
  – 18.7 dB from Part 15
  – 28.7 dB for lines
- **Proposal is for – 34 dB**

Assisted GPS

XtremeSpectrum

- **Assisted-GPS units obtain 20 to 30 dB of additional processing gain over and above a standard GPS C/A code receiver.**
- **Key point is that the additional processing (i.e. longer integration times) is equivalent to a narrower filter bandwidth**
  - It passes the GPS signals and rejects noise (or anything that does not look like the desired GPS signal)
- **The UWB signal is suppressed along with everything else**
- **An assisted-GPS unit is no more sensitive to UWB interference than a normal GPS unit.**
  - i.e. The noise floor of the A-GPS unit may drop from –130 dBm to –150 dBm, but the effective bandwidth is 100 times smaller so 20 dB less UWB noise can get in.
  - A UWB transmitter does not need to drop its power by 20 dB

In-building Aggregation Is Insignificant

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WPAN #	Range to Victim Receiver m	Power received by Victim Receiver picowatt/MHz	% of total energy received by victim receiver	Accumulated Power Received By Victim Receiver	Location of WPANs
1	3	0.029506	90.957	0.029506	Net in same room
2-18	7	0.001880	5.796	0.031386	17 Nets, 8 in adjacent rooms (left, right, above, below, left-above, right-above, left-below, right-below) PLUS 9 across the hall
19-50	11	0.000580	1.789	0.031966	32 Nets 16 in 2nd adjacent Rooms + 16 across hall
51-98	15	0.000252	0.776	0.032218	48 Nets, 24 in 3rd adjacet rooms + 24 across hall
99-162	19	0.000130	0.402	0.032348	64 Nets 32 in 4th adjacent rooms + 32 across hall
163-242	22	0.000091	0.280	0.032439	80 Nets 40 in 5th adjacent rooms + 40 across hall
Total Interference = .032439 picowatts/MHz = -104.9 dBm/MHz =1.099 times the power from the closest emitter					

- **By 4th ring, there are 64 simultaneous transmitters added at equal distance, yet together they produce less the 1/2 percent of the total interference power**
- **The tiny received noise does not increase without bound**
- **The more distant WPANs become insignificant**
- **<u>i.e. In-building aggregation is insignificant</u>**

Plot of Previous Slide

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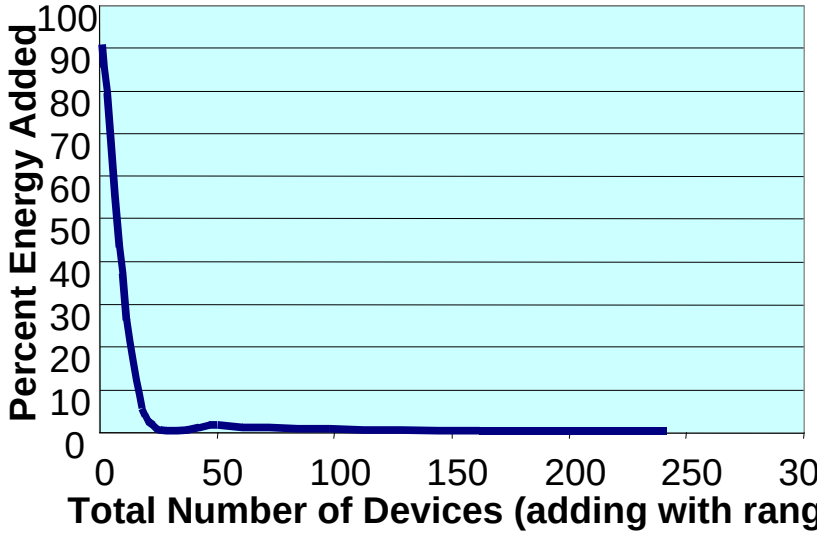
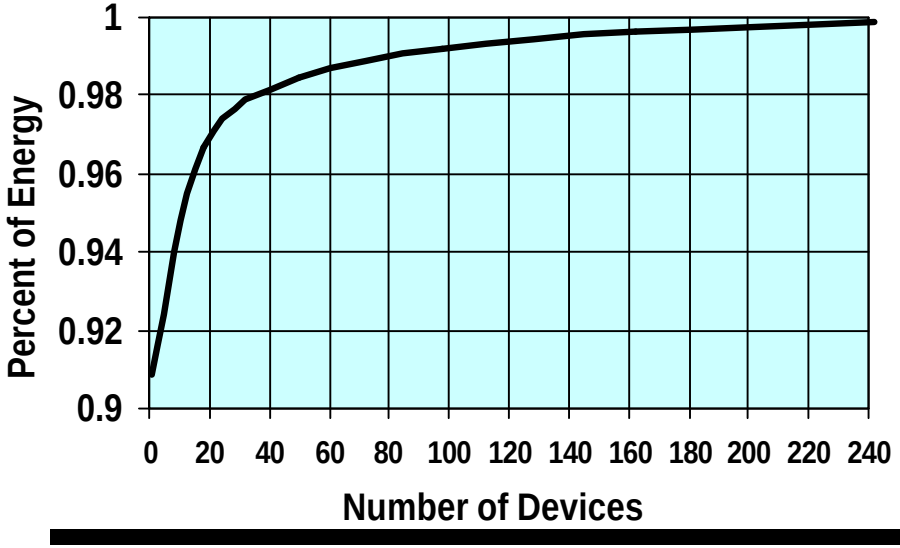
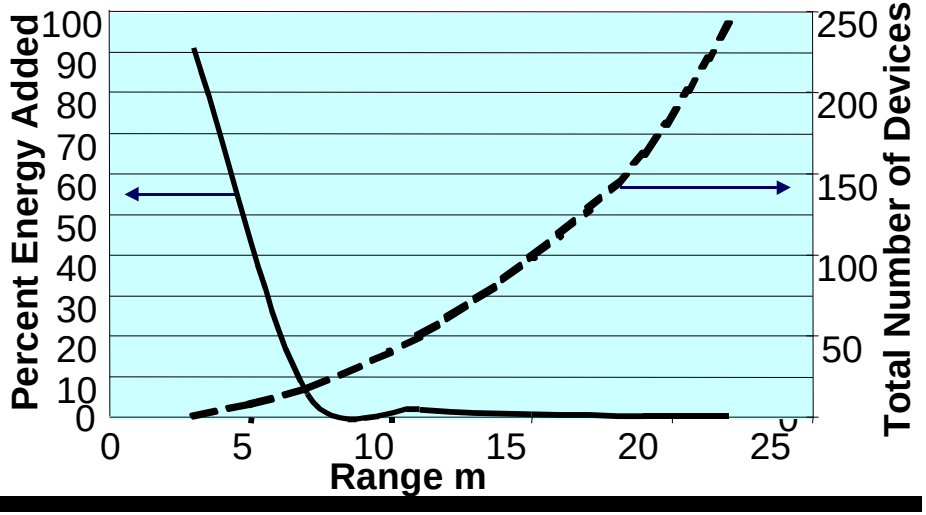
- Yes, Power adds Linearly
- But…
  as the number of devices grows, ***the energy added becomes insignificant***
- i.e. Aggregation effect is immaterial







XtremeSpectrum

UWB in Airliner First Class Cabin

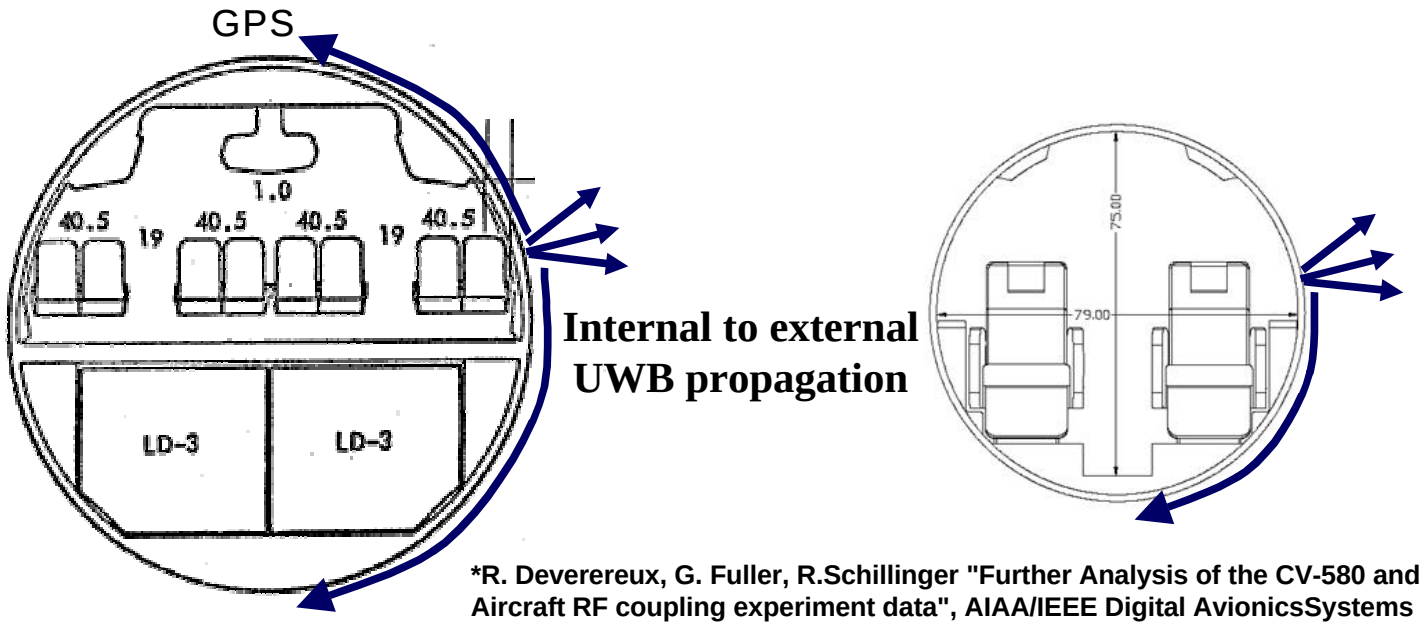
Special Case Analysis For Accidental Peer-to-Peer UWB In the First Class Cabin of an Airliner

Accidental First Class Cabin Use Under XtremeSpectrum's Proposal

- **Consistent with existing policy electronic devices should be switched off during taxi, takeoff, approach & landing**
  - Usage should be accidental
- **XtremeSpectrum proposed rules eliminate accidental use**
  - Peer-to-Peer handheld operation requires affirmative initiation
    - Turning on the device is not enough, user must initiate communication
- **Nevertheless, analysis assumes UWB device transmits 100% of the time**

First Class Cabin Analysis Methodology

- **Assumed free space propagation**
  - Very conservative because more than 40dB isolation
    - Measured isolation of 51 dB at GPS, 40-45 dB typical from 109 MHz to GPS*
    - Coupling to outside of fuselage is through windows and around metal exterior
- **Evaluated XtremeSpectrum proposal by NTIA SP 01-43 and SP 01-45**



*R. Devereux, G. Fuller, R.Schillinger "Further Analysis of the CV-580 and B-727 Aircraft RF coupling experiment data", AIAA/IEEE Digital AvionicsSystems Conference 1997 pp. 4.1-1-8

All Safety Criteria Satisfied for Accidental UWB in Airplanes

XtremeSpectrum

- No interference for airborne UWB into aviation receivers based on extension of NTIA results for UWB on ground

	NTIA 01-43/01-45 Margin from Class B UWB	XS Proposed Mask	Separation range for UWB in freespace
DME Interrogator NTIA 01-43 Table 1	-5.7 dB margin or Class B at 90 m	34 dB	1.8 m
ATCRBS Transponder NTIA 01-43 Table 1	-3 dB margin or Class B at 20 m	34 dB	0.4 m
GPS NTIA 01-45 Table 4	-27.3 dB for noise -like UWB at 2 m	34 dB	0.9 m
CW Altimeter NTIA 01-43 Table 4-16	66.5 dB for UWB at 760 m range	0 dB	0.36 m
Pulsed Altimeter NTIA 01-43 Table 4-16	56.2 dB for UWB At 1522 m range	0 dB	2.3 m

Proceeding Should Address Footnote US 246

XtremeSpectrum

- **US246 - …, no stations shall be authorized to transmit in the following bands:**
  - 608 - 614 MHz*
  - 1400 - 1427 MHz*
  - 1660.5 - 1668.4 MHz*
  - 2690 - 2700 MHz*
  - 4990 - 5000 MHz ##
  - 10.68 - 10.70 GHz ##
  - 15.35 - 15.4 GHz ##
  - 23.6 – 24.0 GHz*
- **Rules should allow UWB in bands marked ##**
- **Bands marked * are considered out-of-band**