Aeronautical Surveillance Spectrum Management

Federal Aviation Administration

International Compatibility Panel:

Sharing Radar Bands

Presented to: International Symposium on Advance Radio Technologies

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Date: July 27-29, 2011

Outline

FAA Approach to Aeronautical Spectrum Management

Shared Radar Bands and Products that Benefit the Safe Operation of Aircraft

Spectrum Sharing RFI Issue

Case Example: TDWR

Aeronautical Surveillance and Air Traffic Management

Our Mission

Our continuing mission is to provide the safest, most efficient aerospace system in the world.

Our Vision

We strive to reach the next level of safety, efficiency, environmental responsibility and global leadership. We are accountable to the American public and our stakeholders.

NextGen

The Next Generation Air Transportation system (NextGen) is the program that is transforming the National Airspace System (NAS) from ground-based Air Traffic Control to satellite-based Air Traffic Management and this depends on adequate aeronautical communications, navigation, and surveillance spectrum availability.

Aeronautical Surveillance Systems (including radar)

Are critical safety tools in the air traffic management process in the NAS and used globally.

FAA Approach to Aeronautical Spectrum Management

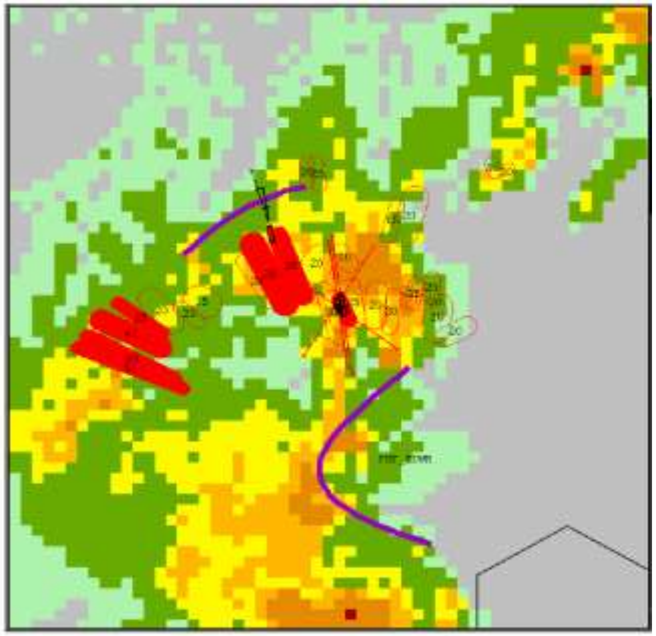
- **Policy**
  - We believe that regulations must be clear, enforceable, and always side in favor of protecting systems that protect lives
    - **FAA Orders (Safety Management System, Spectrum Planning, etc.)**
    - **Radio Regulations (NTIA rules, FCC rules, ITU-R, etc.)**
    - **International Civil Aviation Organization (ICAO) Standards And Recommended Practices (SARPs)**
    - **RTCA, Inc./Eurocae Minimum Operational Performance Standards (MOPS)**
- **Compatibility**
  - We believe that systems sharing aeronautical spectrum must ensure interference-free operation of all systems that benefit the safety operation of aircraft
    - **Conceptual design through stakeholder collaboration**
    - **Modeling and Simulation**
    - **Bench Testing**
    - **Field Testing**
    - **In-Service Performance Monitoring**
- **Capacity**
  - **We believe that capacity must be preserved for expansion of the safety services**
    - **For example, to match the quality of service with an expanding air traffic load**

Shared Radar Bands and Products that Benefit the Safe Operation of Aircraft

En-route ATC Surveillance	1240-1370 MHz
Airport ATC Surveillance	2700-2900 MHz
NEXRAD Weather Surveillance	2700-3100 MHz
Radio Altimeter	4200-4400 MHz
Microwave Landing System	5030-5150 MHz
Airborne Weather Radar	5350-5470 MHz
Terminal Doppler Weather Radar	5600-5650 MHz
Airborne Doppler Weather Radar	8750-8850 MHz
Airport Surface Detection Equipment	9000-9200 MHz
Airborne Doppler Weather Radar	13.25-13.40 MHz
Airport Surface Detection Equipment	15.7-16.2 GHz

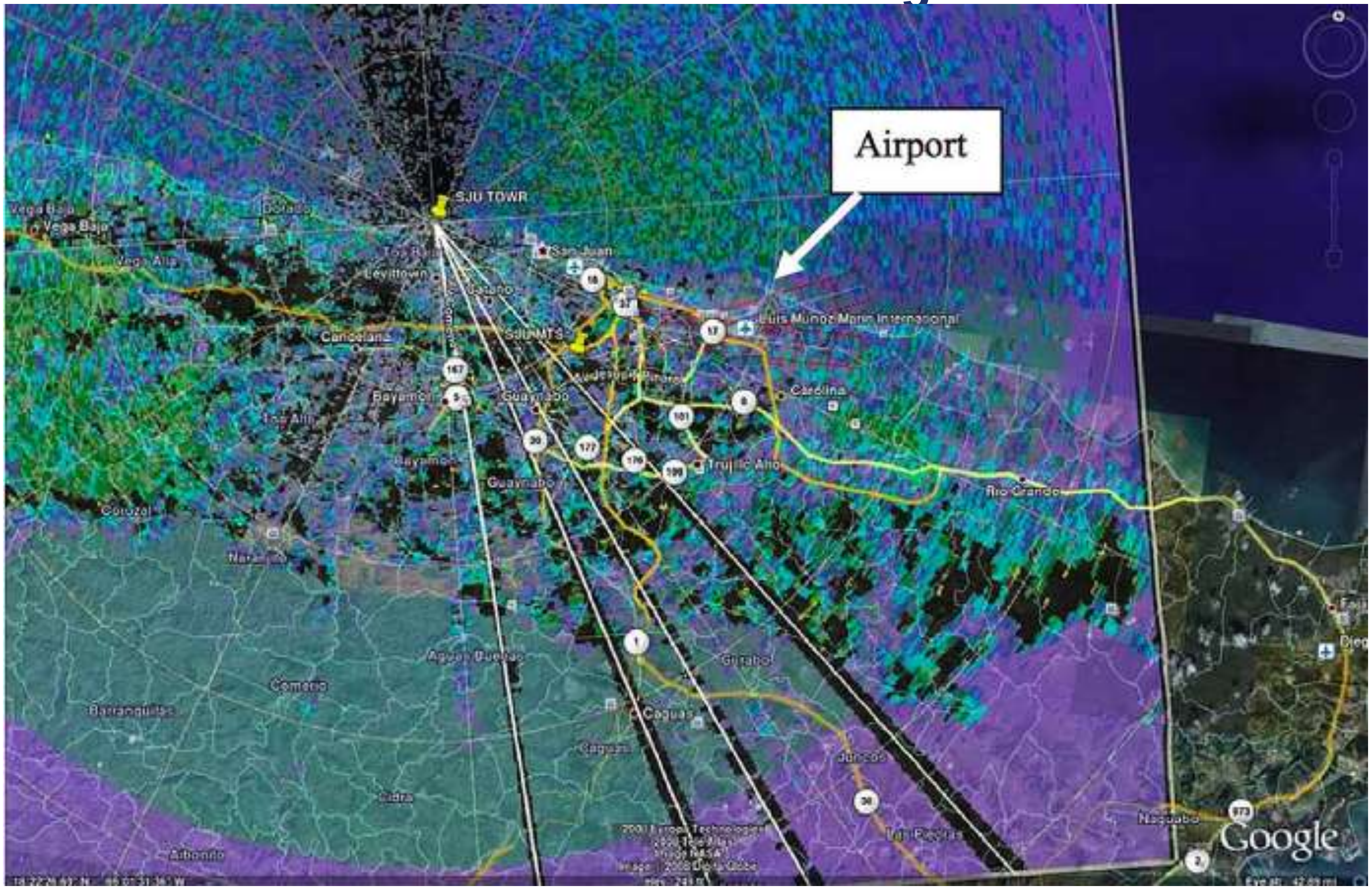
Case Study: TDWR Interference

- Wind shear detection system used to increase the safety of the National Airspace System
  - 45 commissioned at the largest airports vulnerable to wind shear
  - Uses a 360-degree scan strategy to build a series of circular scans at various elevations
  - Operates in one of two modes
    - Monitoring (used to search all directions for microburst activity)
    - Hazardous (1-minute near surface scan update to capture rapid evolution of wind shear)
- Displays precipitation reflectivity
- Capable of microburst detection up to 16nmi
  - Uses the doppler shift and other requirements to set an alarm for ATC
  - ATC then relays info to pilots
  - Pilots determine to proceed or not
- Capable of gust front detection up to 32.4 nmi
  - Used to alert ATC, then pilots
  - Used for AT planning, including runway configuration changes or AT spacing increase
- Specifications: 5600 – 5650 MHz tuning range, Resolution (0.55 degree angular, 150 meter range), Power 250 kW, Pulse Length 1.1 us, 460 km reflectivity range, 89 km doppler range



San Juan, PR RFI to TDWR

- **In the fall of 2007, ATC reported interference to the TDWR**
- **Local System Techs and the Terminal Weather Group concluded that external noise was interfering with the radar**



Interference appears as voids in weather data

The signatures of weather phenomena are relatively small, so easily masked by the RFI

The microburst that caused Delta Flight 191 to crash in 1985 was less than 2 nmi in diameter

SJU TDWR RFI

- **FAA investigation expanded in 2008 and confirmed the RFI was external to the radar and suspected DFS-capable 5-GHz U-NII devices**
  - **The 5 GHz Unlicensed National Information Infrastructure (U-NII) band began in the late 1990s with industry proposals towards the FCC authorizing devices to be used for unlicensed wireless data networks. The FCC began a rulemaking that eventually led to the dynamic frequency selection (DFS) requirement for detection and avoidance of incumbent radar signals by unlicensed wireless devices in U-NII bands. The 2003 ITU-R World Radio Conference (WRC-03) enabled the allocation on a worldwide basis.**
  - **The DFS U-NII devices entered the market in about 2006**
- **An in-depth study was conducted by NTIA, FAA and FCC at the San Juan, Puerto Rico TDWR site (one such site experiencing interference) to confirm the initial findings by the FAA.**
  - Study confirmed that 9/10 cases of interference were due to U-NII
  - Both co-channel and adjacent channel emitters caused interference
  - DFS U-NII devices from some vendors did not detect and avoid
  - FCC stopped all 5-GHz DFS U-NII device certification

SJU TDWR RFI

- **Further characterization of the impact of the 5-GHz DFS U-NII was performed on a test TDWR at the Mike Monroney Aeronautical Center in Oklahoma City, OK**
  - Cooperative effort between the FAA, NTIA, and industry
  - Several actual U-NII device emissions were digitized using a VSA and produced with a VSG
  - The levels of interference that cause corruption of data were characterized
  - The Radar detection performance and off-tuning requirements of different U-NII devices were tested in close proximity to the TDWR
- **EMC testing concluded that:**
  - TDWR interference artifacts begin to become visible at I/N levels of -8 dB, so the FAA wants the protection criteria to be -10 dB, as with NEXRAD
  - 30 MHz of off-tuning is required to ensure elimination of visible interference
  - One device can couple into the TDWR side lobe and cause more than one interference wedge in different azimuths
  - Five out of Seven devices detected and avoided the TDWR
  - Two did not detect and avoid despite passing FCC certification testing

5 GHz DFS UN-II Device RFI to TDWR Mitigations

- New simulated radar waveforms that more accurately replicate the TDWR have been created by NTIA for the FCC for use in their certification process; NTIA has tested DFS U-NII devices against these waveforms in a laboratory setting.
- Interim: the 5600-5650 MHz TDWR band is not available for use by DFS U-NII devices.
- Manufacturers whose U-NII devices did not detect TDWR signals have altered their detection algorithms and are now able to detect TDWR signals; this functionality can be retroactively deployed to existing legacy devices via firmware updates.
- A voluntary database has been established for coordination between wireless internet service providers (the primary users of DFS U-NII devices) and TDWR sites.
- Some wireless internet service providers have been fined by the FCC for repeated violations.
- The FCC has been working with wireless internet service providers to cooperatively re-tune their U-NII frequencies away from TDWR operating frequencies.

FAA Perspective

- **FAA has a long history of sharing spectrum with the public and other US agencies**
  - Cooperation and collaboration help prevent introducing safety risks to the NAS
  - Reliance on regulation alone is not sufficient
  - Compatibility must be demonstrated (slide 4)
  - Capacity must be preserved (slide 4)
- **Under no circumstances can unmitigated risks that may impact the safety of the NAS be allowed to operate**
- **The FAA prefers to share spectrum through coordinated licensed spectrum vs. unlicensed spectrum**
  - It’s very difficult to find users of unlicensed devices
- **Generally, FAA discourages sharing aeronautical and non-aeronautical spectrum**
  - The FAA can’t wait for interference to be discovered and then mitigated