

Radio Frequency Interference

- **ICAO Regional Preparatory Workshop for WRC-23**
- **Bangkok, Thailand**
- **13-14 Feb 2023**

Scope

- Sources and types of Radio Frequency Interference (RFI)
- Broadband Noise Examples (e.g. LEDs)

What is Radio Frequency Interference (RFI)?

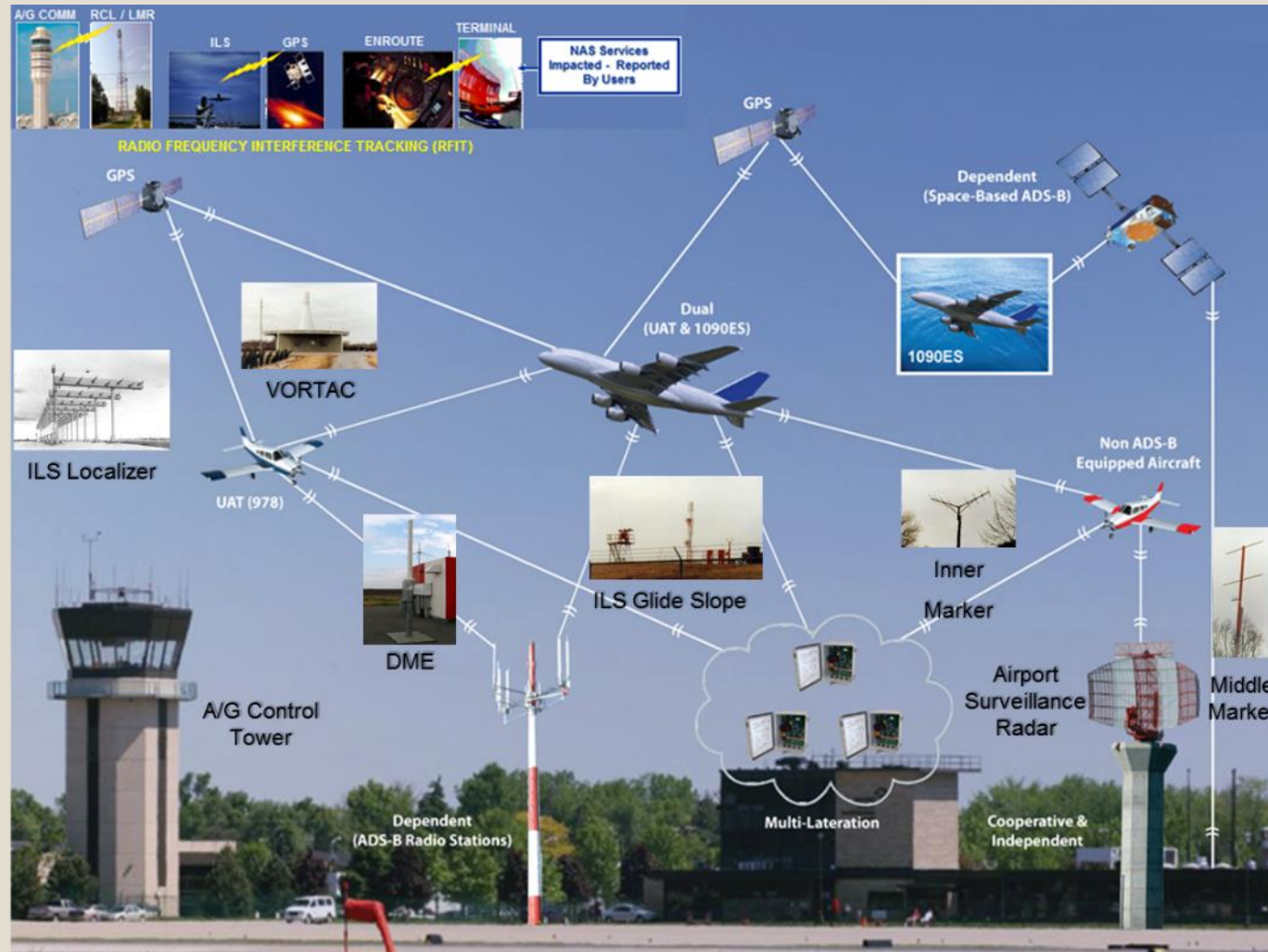
- ITU Definition

- *“The effect of unwanted energy due to one or a combination of emissions, radiations, or inductions upon reception in a radiocommunication system, manifested by any performance degradation, misinterpretation, or loss of information which could be extracted in the absence of such unwanted energy.”*

- Criteria to mitigate inter-system interference are established as an element of ICAO SARPs.

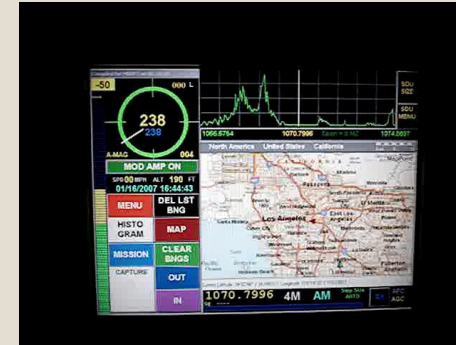
- E.g. 8 dB D/U for co-channel DME assignments
 - E.g. 20 dB D/U for VHF services (voice and data)

RF Dependent Aviation Systems



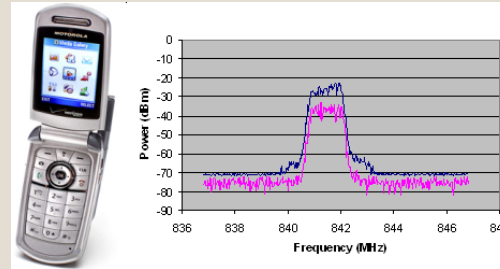
RFI Categories

- Authorized Transmissions
 - Properly Licensed (i.e. FM, AM, TV)
- Unauthorized Transmissions
 - Wireless Video Cameras
 - High Power Cordless Telephones
 - Unlicensed Pirate FM Stations Spurious
- Intentional
 - Unauthorized Jamming
- Unintentional
 - Spurious Transmissions
 - Intermodulation products



RFI Sources

- Citizens Band (CB) Radios (5th harmonic)
- Paging Systems
- Stuck Microphone Transmissions
- Cell phone Spurious Emissions
- Electronic Attack (EA) Missions
- Wireless wide area networks
- GPS/Cell phone jammers
- Amateur "HAM" Radio
- Land Mobile/Dispatch
- Leaking wired transmission (e.g. cable television)
- Broadband Noise (e.g. power transformers, LEDs)



US National Airspace System RFI



- Most Common Source of RFI:
 - The “unknown source”
 - Unauthorized Transmissions
 - Pirate FM Broadcast Spurious
- Most Common FAA Victim:
 - VHF/UHF Voice Communications
- Most Difficult RFI to Resolve:
 - High Altitude Pilot Only Reported RFI
 - Intermittent RFI (Airborne/Ground)
 - Broadband RFI across many frequencies

Broadband Noise Examples in US

*How many engineers does it take to change
a light bulb?*

Regulations for LEDs – US Example

- LEDs classified under US FCC Part 15 B – unintentional radiators
 - 150 $\mu\text{V}/\text{m}$ measurement at 3m (100 kHz ref bandwidth for VHF freqs)
 - European EN55015 is approx. equivalent (100 $\mu\text{V}/\text{m}$)
- Specific FCC requirements
 - Unintentional radiators are subject to operation on the condition that **no harmful interference is caused**
 - Use **good engineering designs** and construction techniques
 - Operation of lighting devices will be required to **cease operation** if harmful interference occurs
- Several Examples of interference in the US despite these

LAX Terminal 6 Example



LAX T6 Example

- Airline/CSP reported high noise floor at the end of Terminal 6 interfering aircraft at the gates suspect LED lighting in terminal
 - Survey showed high noise levels in that area -70/80 dBm
- Reported issue to airport authority
 - Followed up with local national regulator office
- Meeting with CSP and airport electricians
 - Were able to do some testing but further testing needed in off hours
 - CSP/airport tested again but could not find breakers to turn off rotunda lighting
- Additional site survey with senior engineer and specialist equipment discovered bar lighting was not the source
 - True interference from external lights

LAX T6 True Culprit



BNA Example

- Airline reported poor and “No Comm” at two gates (9 & 25)
- Actions performed
 - Verified ground station functionality
 - On-site inspection: All good, problem continues.
 - Replace GS transceiver. Issue still occurred.
 - Next step was field inspection of location: Full RF assessment of BNA
- Noise source was isolated to the under jetway lighting



ORD Example

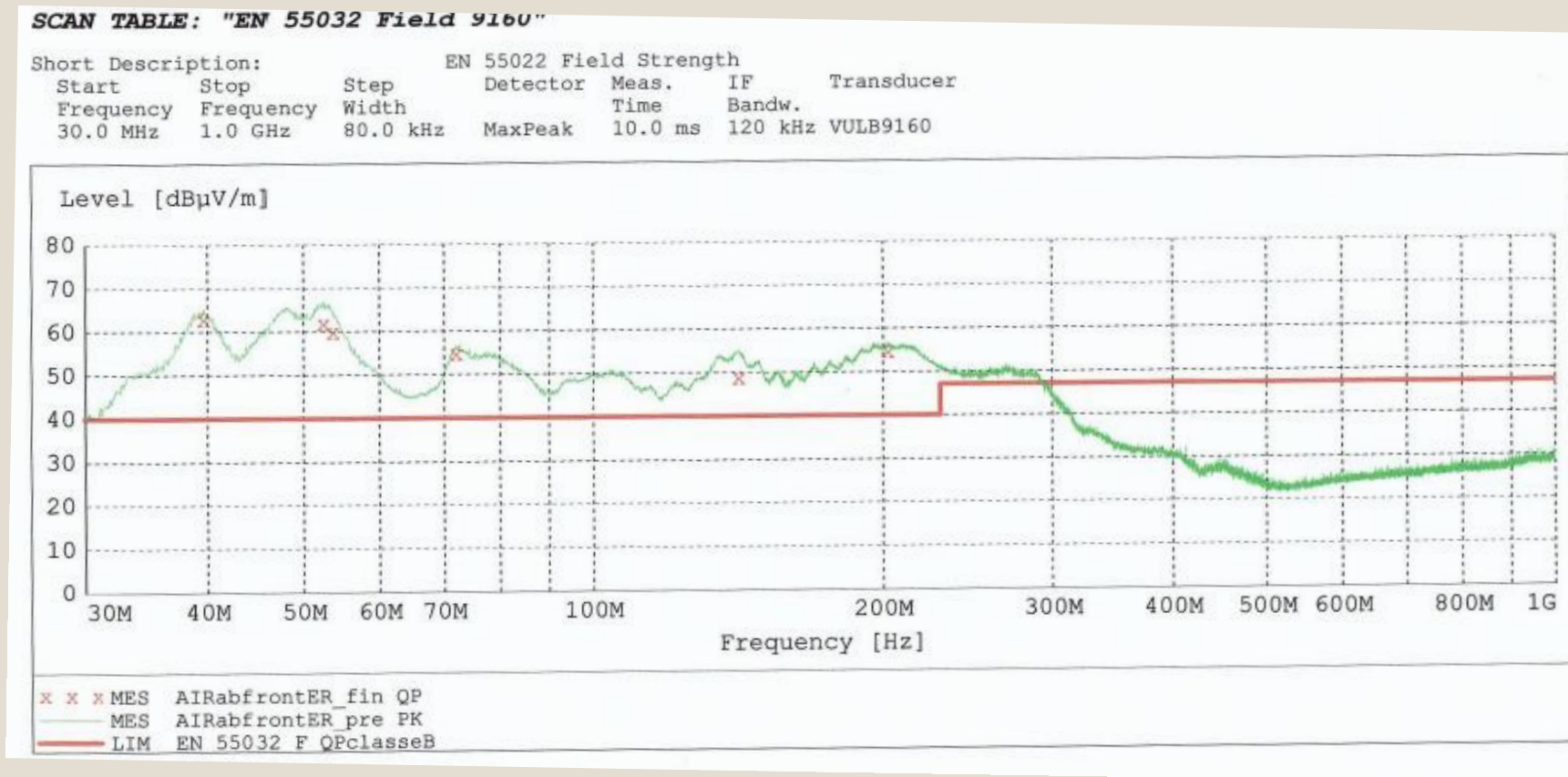
- Coverage issue were reported at gate C-19 at the ORD airport in August 2017
 - RF survey at the gate reported an average noise floor around -110 dBm
 - However, when the directional antenna was pointed toward the passenger level, the noise floor would elevate to around -80 dBm.
 - Unable to initially isolate the source of the interference.
- Second visit using DF equipment isolated source to LED lights in a vendor's stall signage
 - On/Off test was performed, noise floor varies by 30-40 dB

Broadband Noise Interference Mechanisms

- Design?
 - Meeting necessary national regulatory requirements?
 - Was it checked, certification missing/falsified, thrown away with the box?
 - Even if it is meeting the requirements, is it still a problem?
 - Aggregate interference
- Fault condition?
 - Degradation of performance?
 - Defective device?
- Effect on VDLM2
 - High noise trips CSMA channel occupied level
 - Sometimes high enough to prevent full VDLM2 message decode

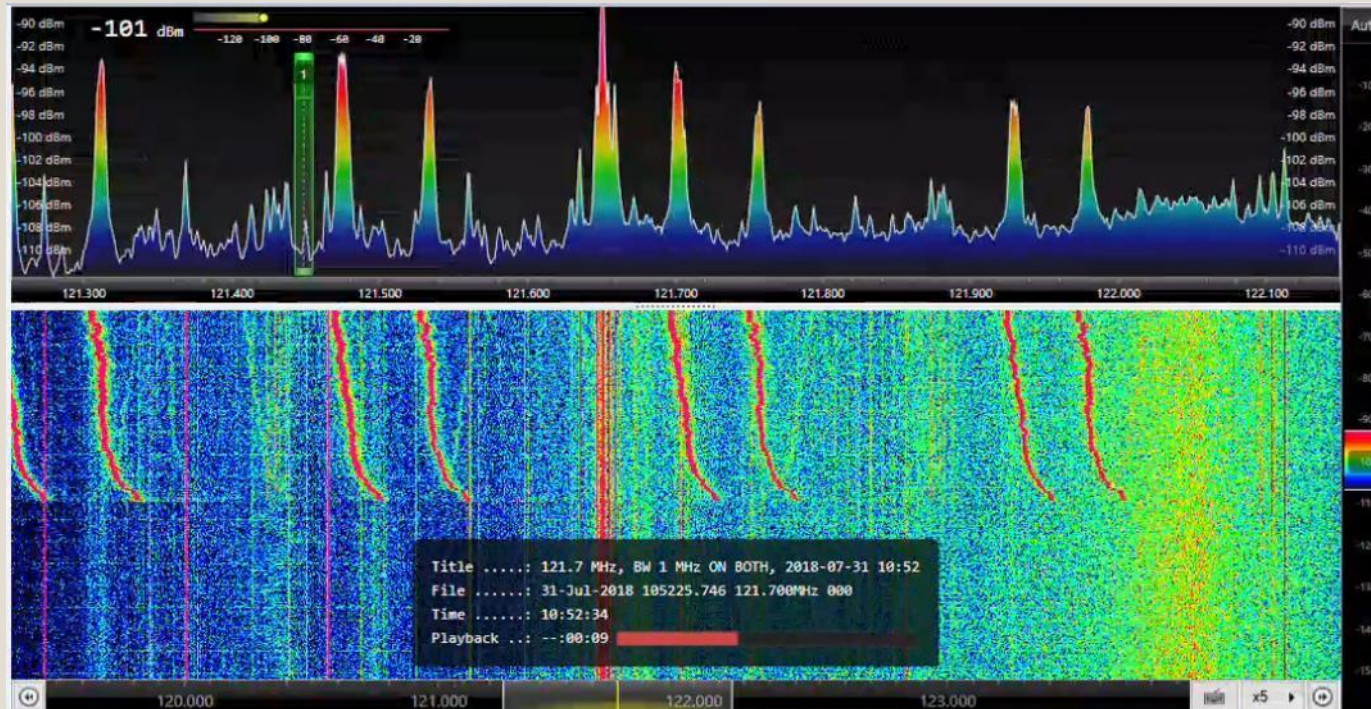
Airbus Testing

- Airbus took two LED bulbs for testing in 2018
 - Radiated emissions test results



Voice Channels Also Affected

- Several examples over the last few years
 - Generally a squelch break issue
- Reports from US, India, Australia



Options?

- Mitigate

- Change the bulb/LED driver
 - Owner's permission/property access/who pays
- Training in identification
 - Voice fine/VDLM2 not working, day/night difference, DF equipment/techniques
- Move away
 - Alternate gate

- Resolve

- Better education/certified bulbs
 - Make sure bulbs are FCC/ECC compliant
- Modify VDL standard
 - CSMA modulation detection?
- Modify unintentional emissions standards for LEDs
 - Affects other users

Summary

- Complicated issue
 - RFI mitigation a mixture of education, identification, mitigation techniques and regulations
- Key priorities is focus on mitigation techniques and long-term education
 - No magic bullet solution
- DO NOT THROW AWAY THE FAULTY BULB!
 - More faulty LED examples needed for testing
 - Please provide them to the CSP

Questions?