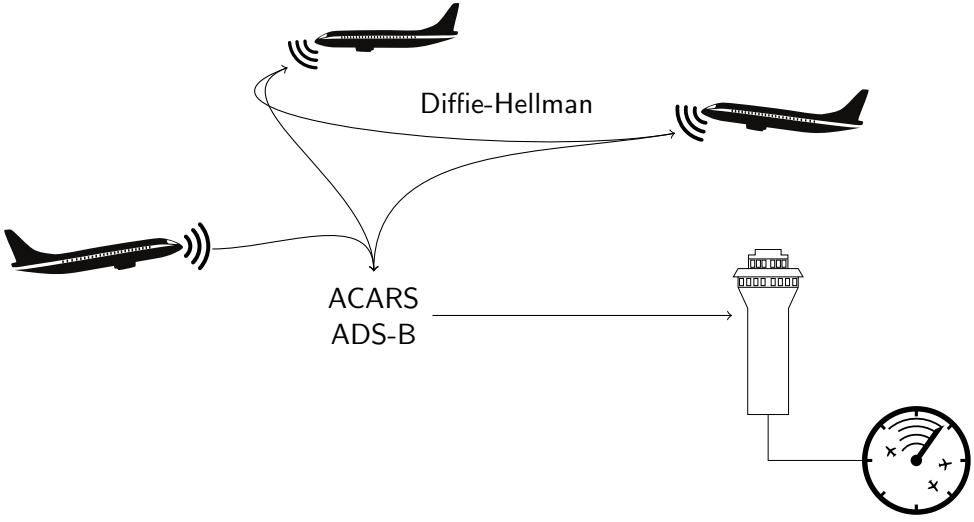

ACARS: Aircraft Communication Addressing and Reporting System
ADS-B: Automatic Dependent Surveillance-Broadcast

Evaluation of a wireless physical security method for flying objects based on the frequency selectivity of the propagation channel

Adrián Expósito García, Héctor Esteban González, Lorenzo Rubio Arjona, Martin Kubisch, Dominic Schupke

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Contents

- High-Rate Uncorrelated Bit Extraction (HRUBE) [Patwari et al., 2010].
- [Ben Hamida et al., 2009] identifies weakness of existing key generation algorithms.
- [Ye et al., 2010] uses Rayleigh and Rician models to generate richly scattering environments.

Contents

Assumptions taken

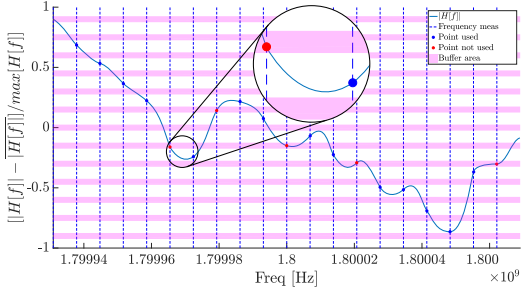
- Information reconciliation is part of system design, an important aspect in key generation, nevertheless, out of scope in this research. [Patwari et al., 2010]
- Synchronous measurements.
- Absence of noise:

$$|H_{\mathcal{AB}}[f]| = |H_{\mathcal{BA}}[f]|$$

- Eavesdropper agent is passive.

Robust Slice Algorithm

1. $\mathcal{A}$ or $\mathcal{B}$ is defined as the master node.
2. $k[n]$ is calculated based on:
   - 2.1 d_{buff}
   - 2.2 d_{key}
   - 2.3 $|H[f_n]|$
3. Non-used sampling frequencies are shared from the master node.
4. Key is then generated on both sides excluding the non-used sampling frequencies.



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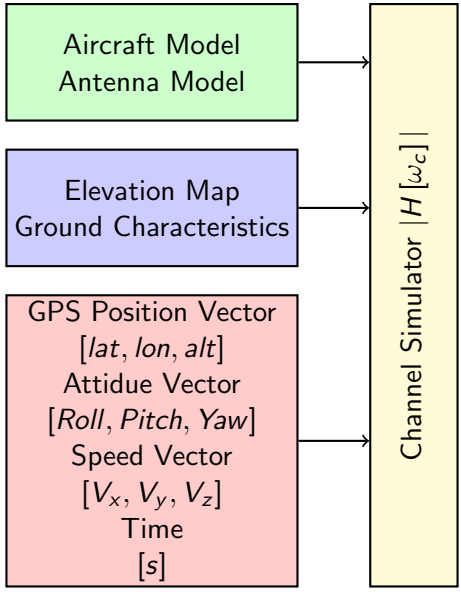

Aircraft Model
Antenna Model
Elevation Map
Ground Characteristics
GPS Position Vector
$[lat, lon, alt]$
Attidue Vector
$[Roll, Pitch, Yaw]$
Speed Vector
$[V_x, V_y, V_z]$
Time
$[s]$
Channel Simulator $|H[\omega_c]|$

Contents

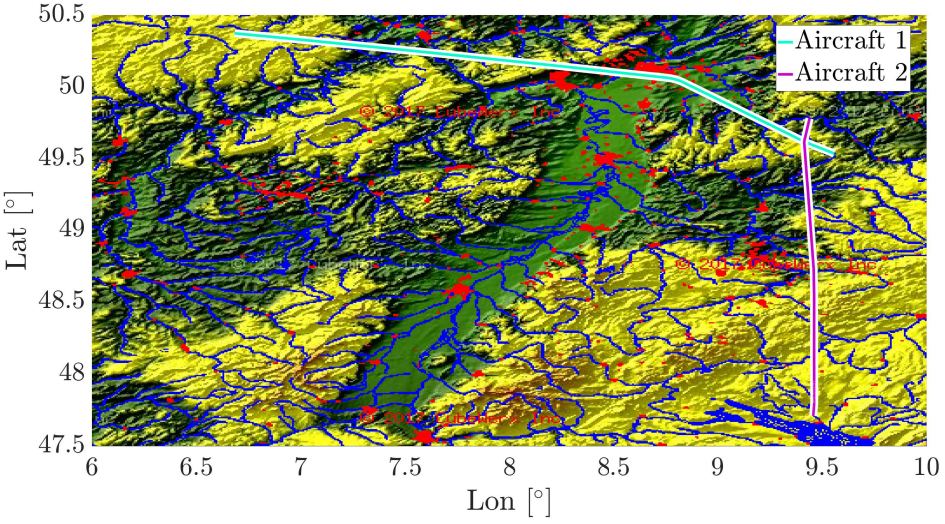
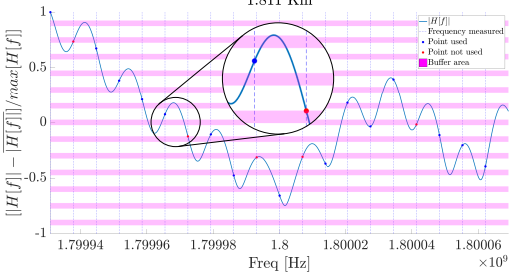
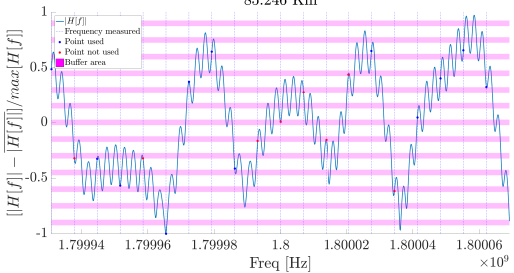
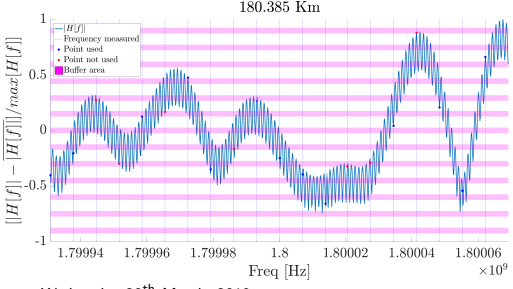


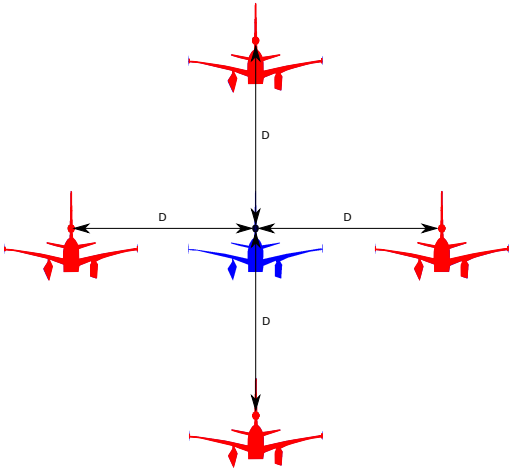
Figure: Trajectory [C.Edinger and A.Schmitt, 2013]

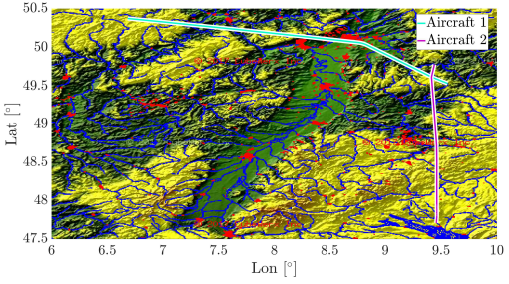


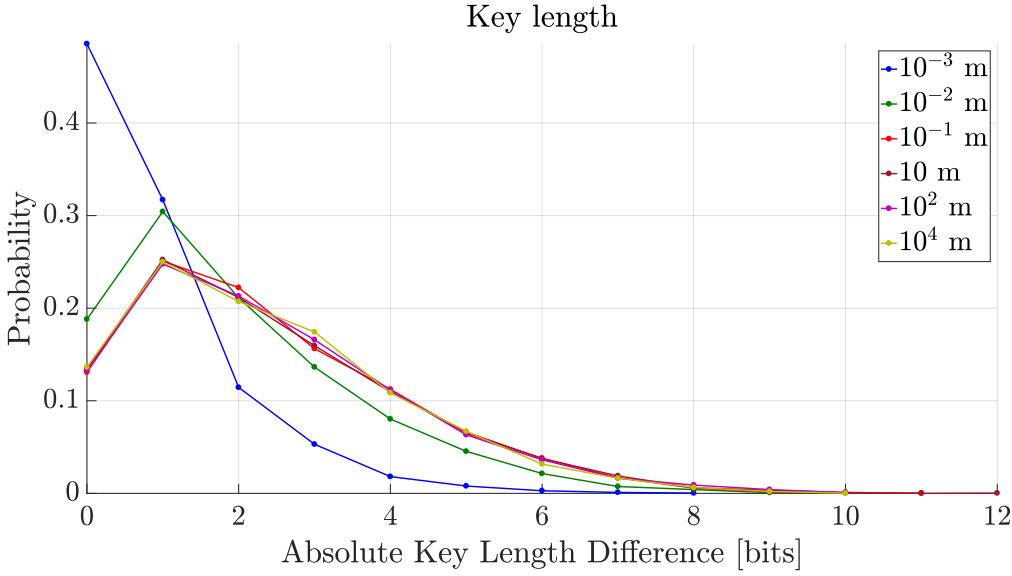


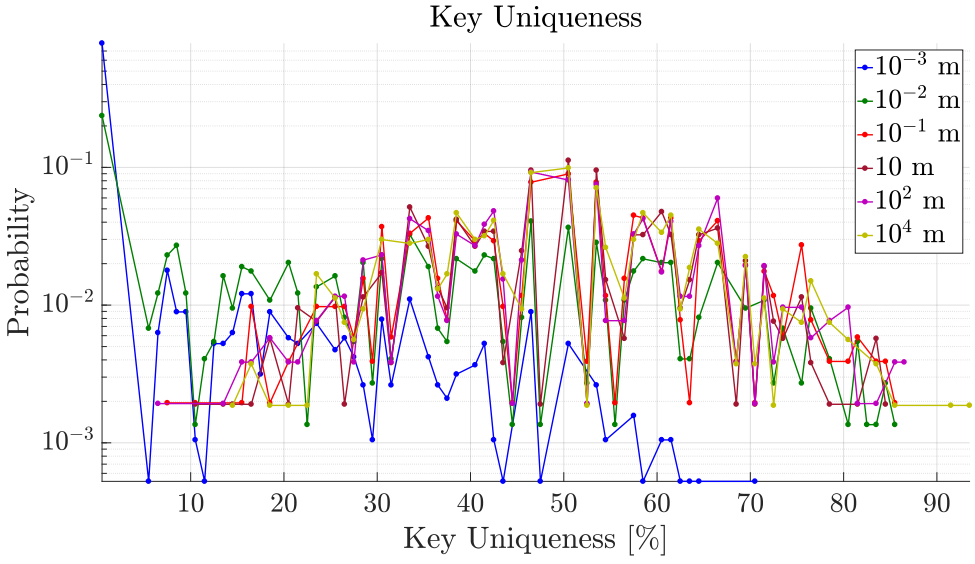


Distance	Generated Key	Length of generated key
180 km	1100011011000011	16 bit
85 km	101100101011101	15 bit
1.81 km	01111101000110	14 bit


D
D
D
D


Aircraft 1
Aircraft 2
Lat [°]
Lon [°]
50.5
50
49.5
49
48.5
48
47.5
6
6.5
7
7.5
8
8.5
9
9.5
10


Key length
Probability
Absolute Key Length Difference [bits]
0
0.1
0.2
0.3
0.4
0
2
4
6
8
10
12
10^{-3} m
10^{-2} m
10^{-1} m
10 m
10^{2} m
10^{4} m


Key Uniqueness
Probability
Key Uniqueness [%]
10^{-1}
10^{-2}
10^{-3}
10
20
30
40
50
60
70
80
90
10^{-3} m
10^{-2} m
10^{-1} m
10 m
10^{2} m
10^{4} m

Contents

- By means of simulation, it has been proven that:
  - An eavesdropper will generate the same key only at 0.01 m from $\mathcal{A}$ or $\mathcal{B}$.
  - Channel possess sufficient randomness to generate keys.
  - PHYSEC is a viable and secure wireless physical security method for flying objects.
- Open research paths:
  - Test PHYSEC on real conditions.
  - Study scenarios such as approach or taxi.

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