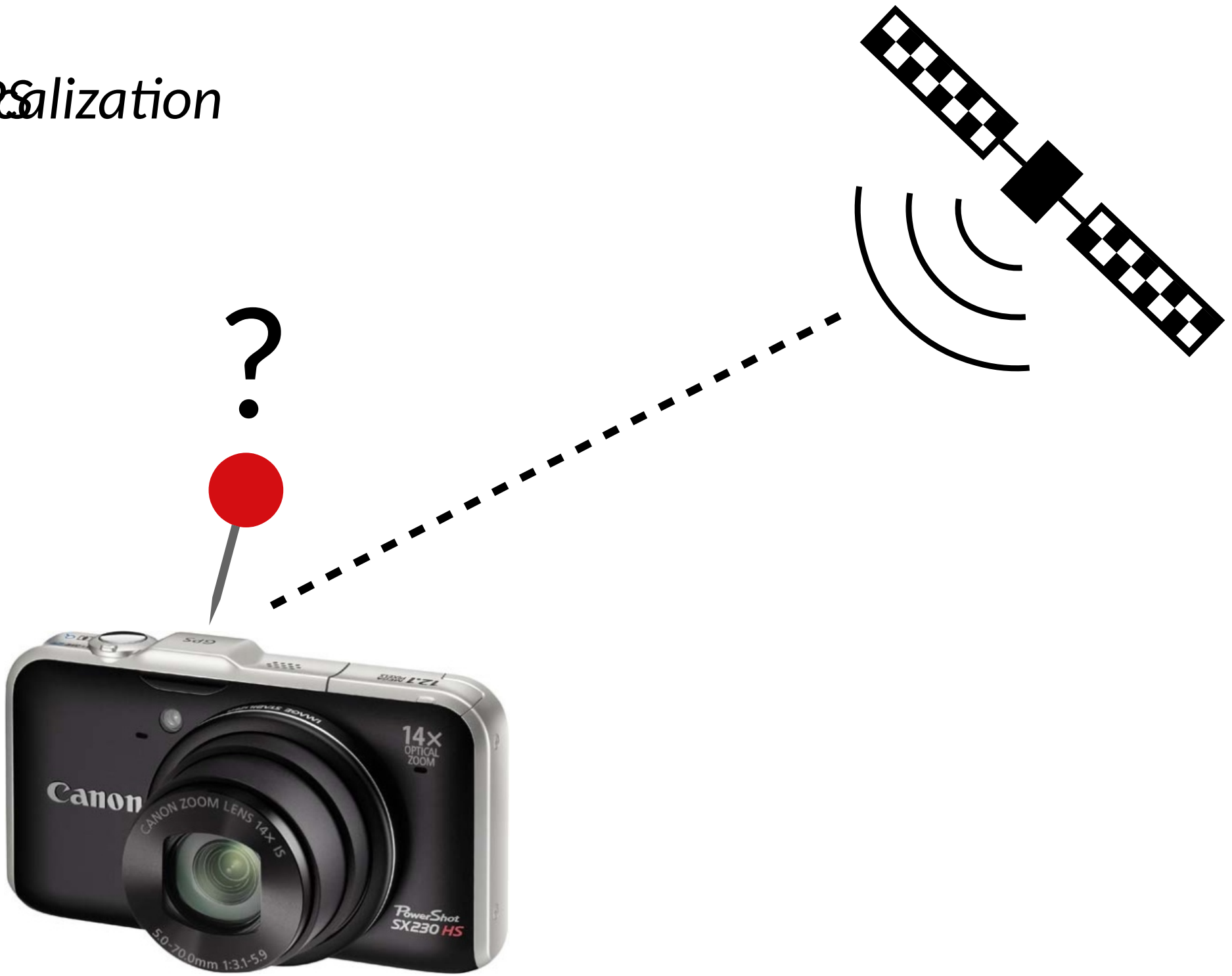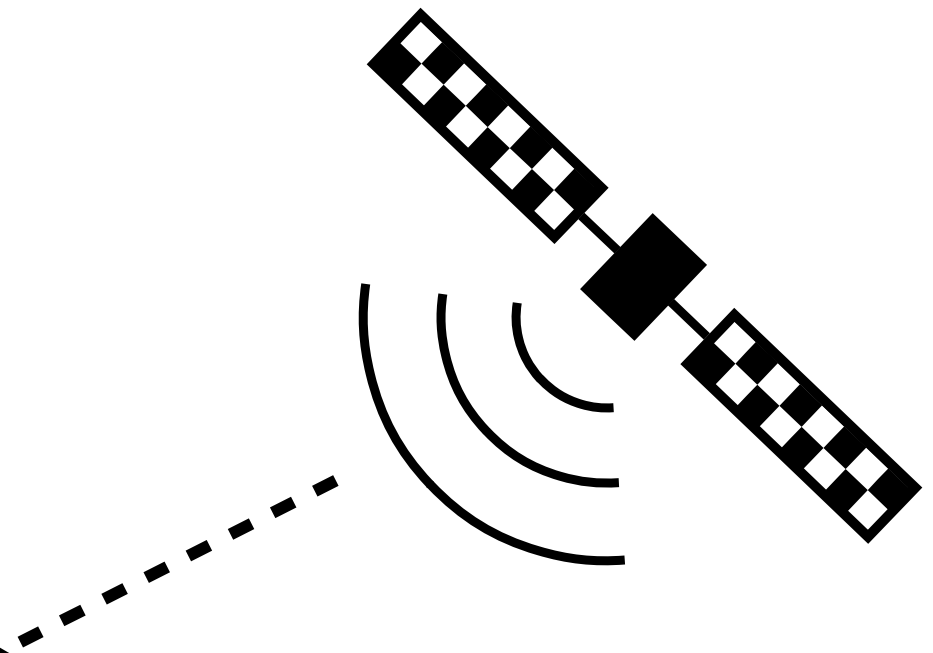# Indoor Localization with Aircraft Signals

Manuel Eichelberger, Kevin Luchsinger, Simon Tanner, Roger Wattenhofer
SenSys 2017 – Delft

GPS Localization
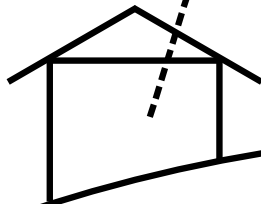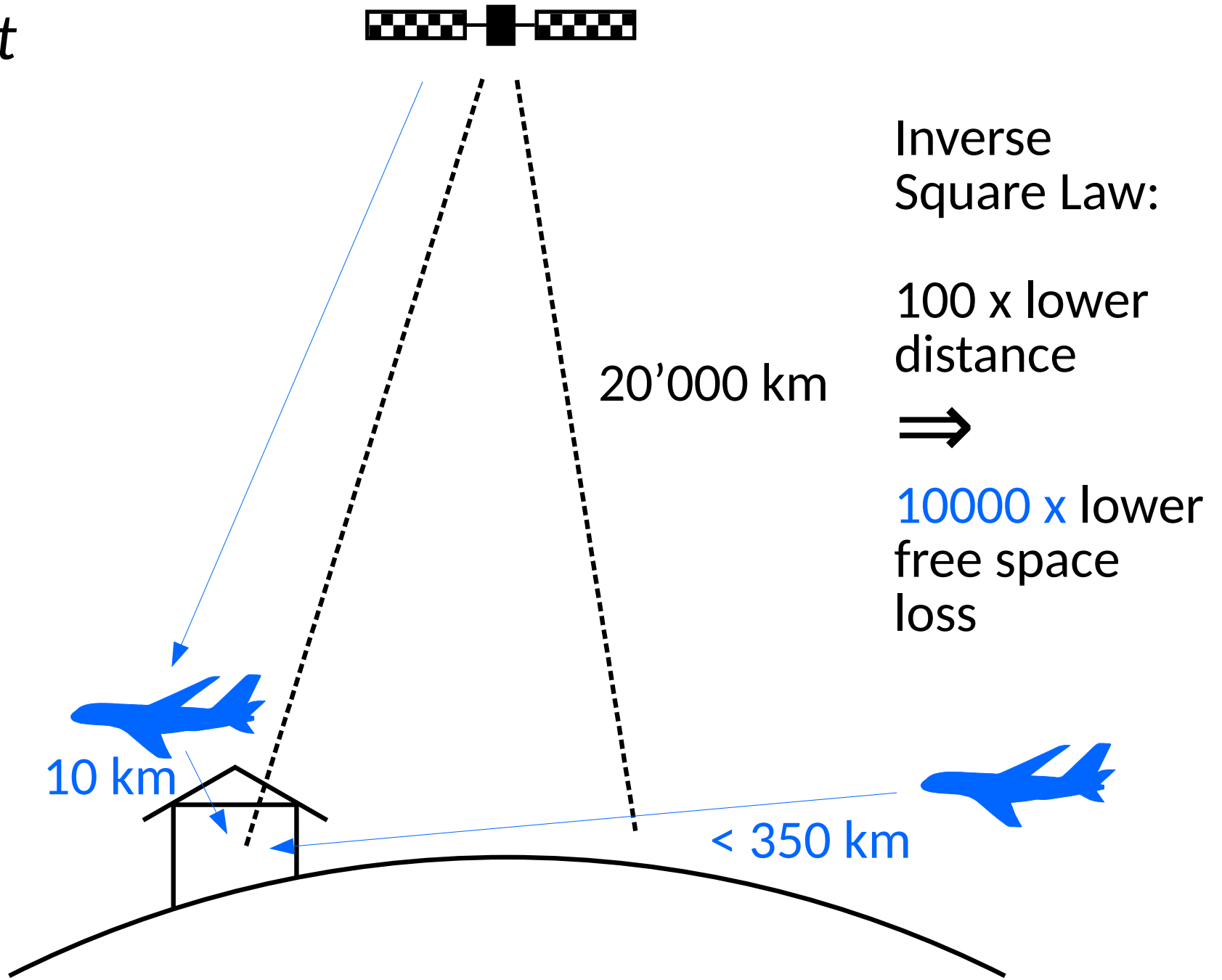
GPS

GPS

20'000 km

Signal 3000x weaker
than noise
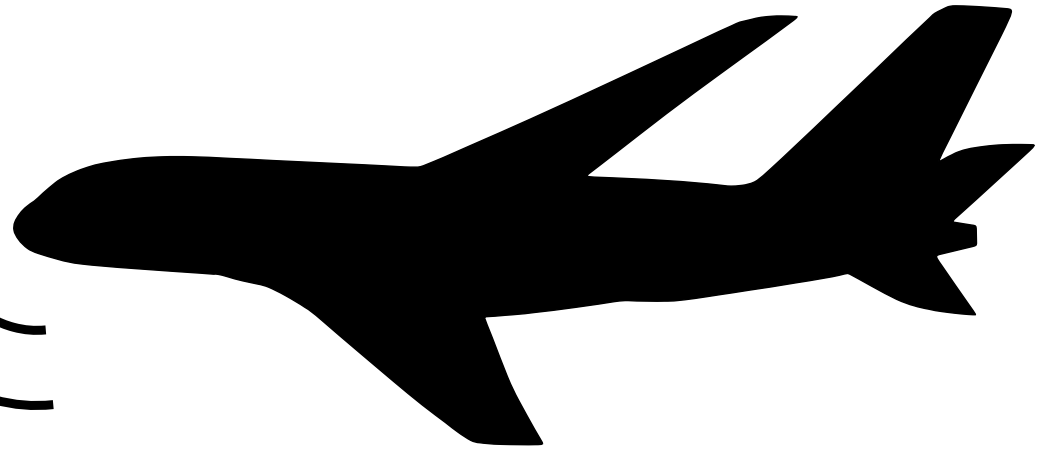
Signal 100x weaker
than noise

36 km
Felix Baumgartner

Aircraft

Inverse
Square Law:

100 x lower
distance

$\Rightarrow$

10000 x lower
free space
loss

20'000 km

10 km

< 350 km

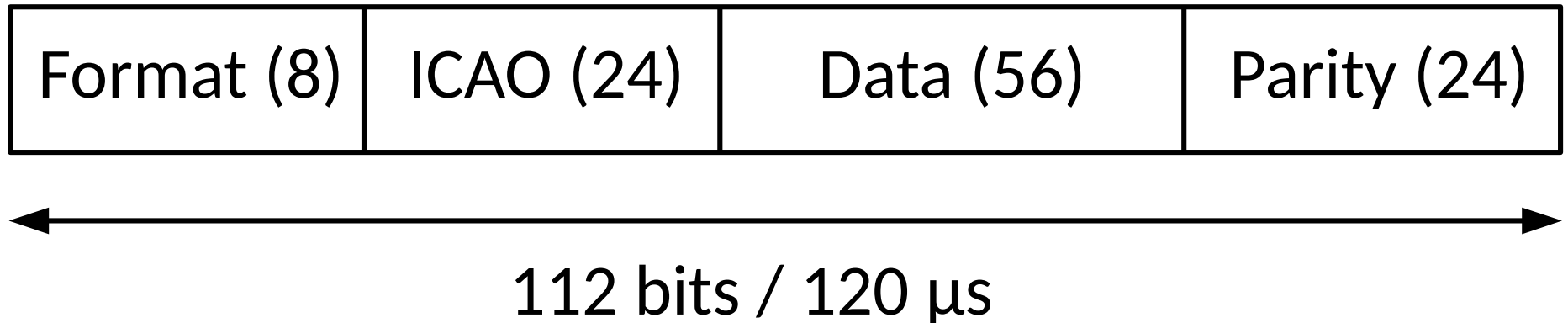# Air Traffic Surveillance

ADS-B: Aircraft regularly send position

Primary Radar
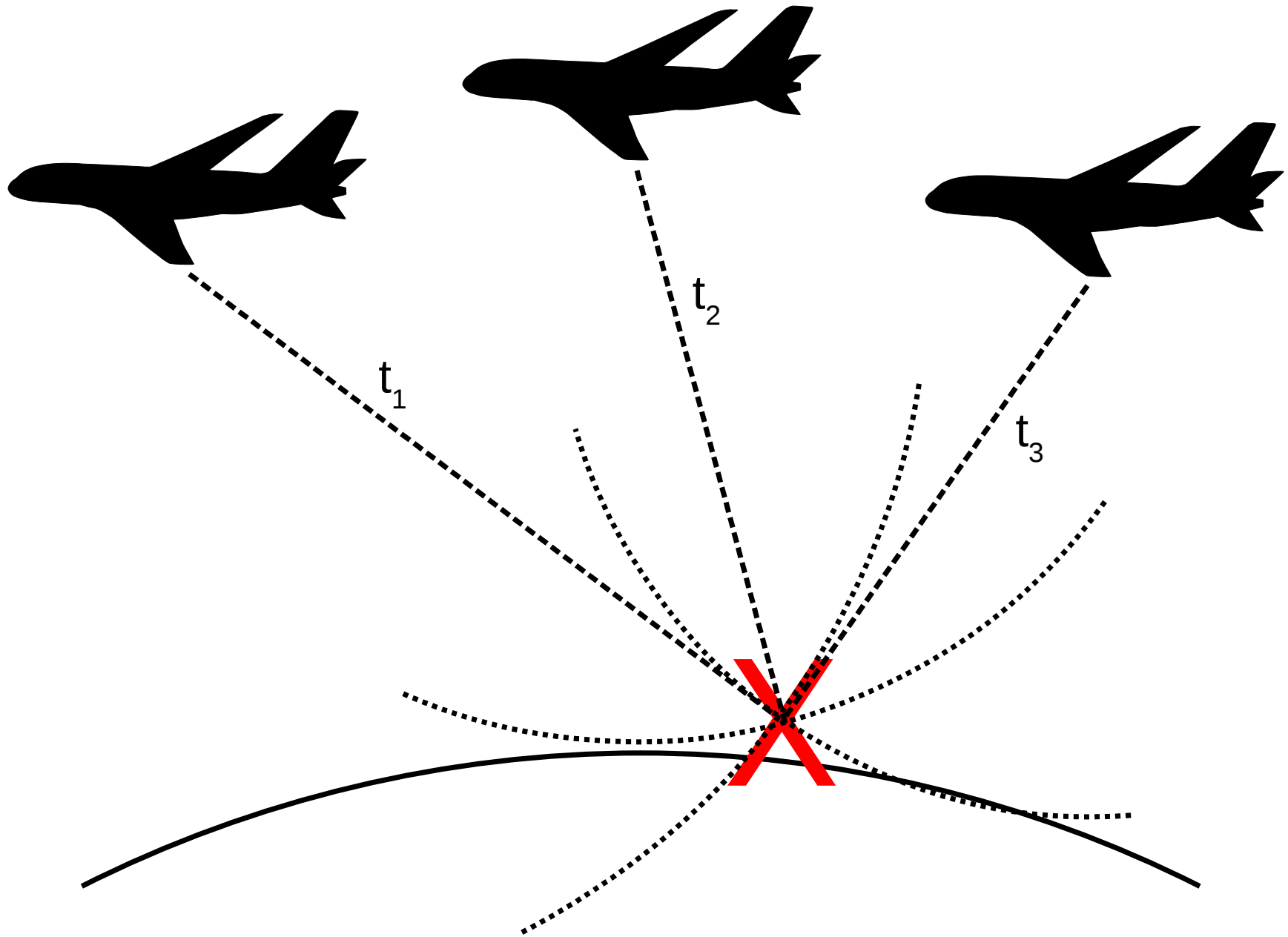
Secondary radar: Interrogations

ADS-B

- Different message types
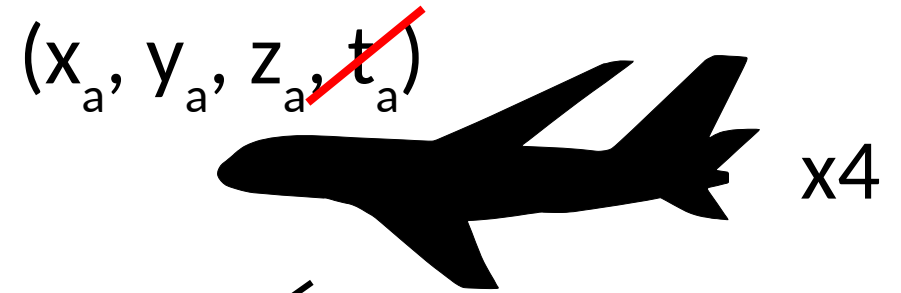- Position every 0.5 s
  - Random time variation +- 0.1 s

Format (8)	ICAO (24)	Data (56)	Parity (24)

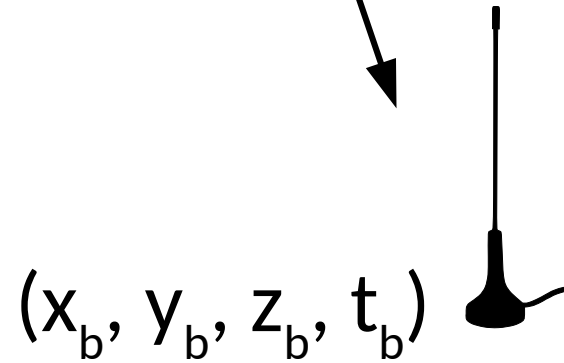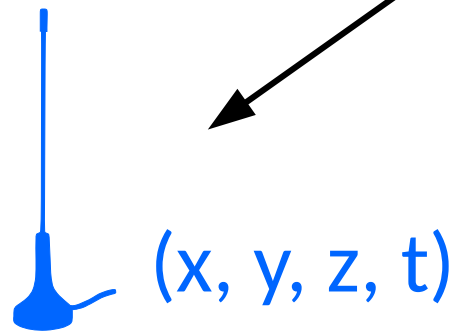← 112 bits / 120 µs →

Position Computation

Position Computation

- *Pseudoranges*
- $t_{travel} \cdot c = \| \mathbf{p}_{handset} - \mathbf{p}_{aircraft} \| + \Delta t_{handset} \cdot c$
- 4 unknowns: $\mathbf{p}_{handset}$, $\Delta t_{handset}$

System Overview

(x_a, y_a, z_a, t_a)

x4

- $t_a = t_b - \|a - b\| / c$

(x, y, z, t)

(x_b, y_b, z_b, t_b)

Hardware

- Low cost (ground stations and handset)
- No GPS receiver to synchronize time

Multiple Ground Stations

(x, y, z)
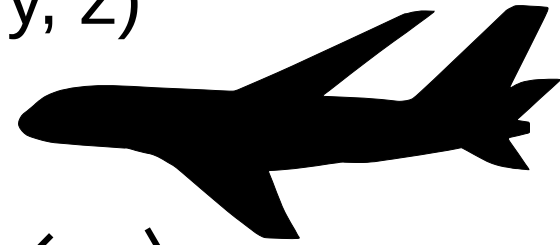
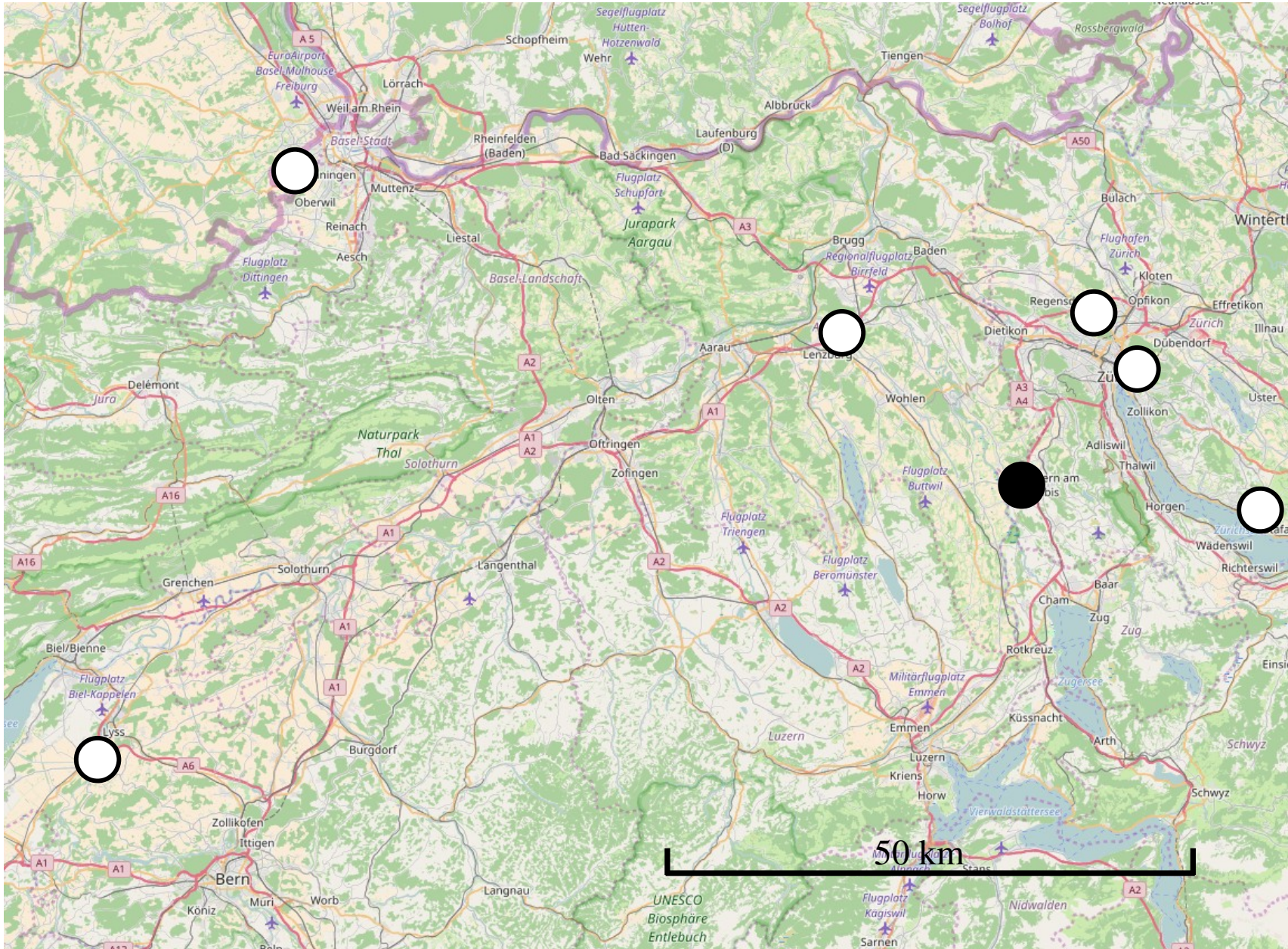- $t_a = t_1 - \|a - b_1\| / c$
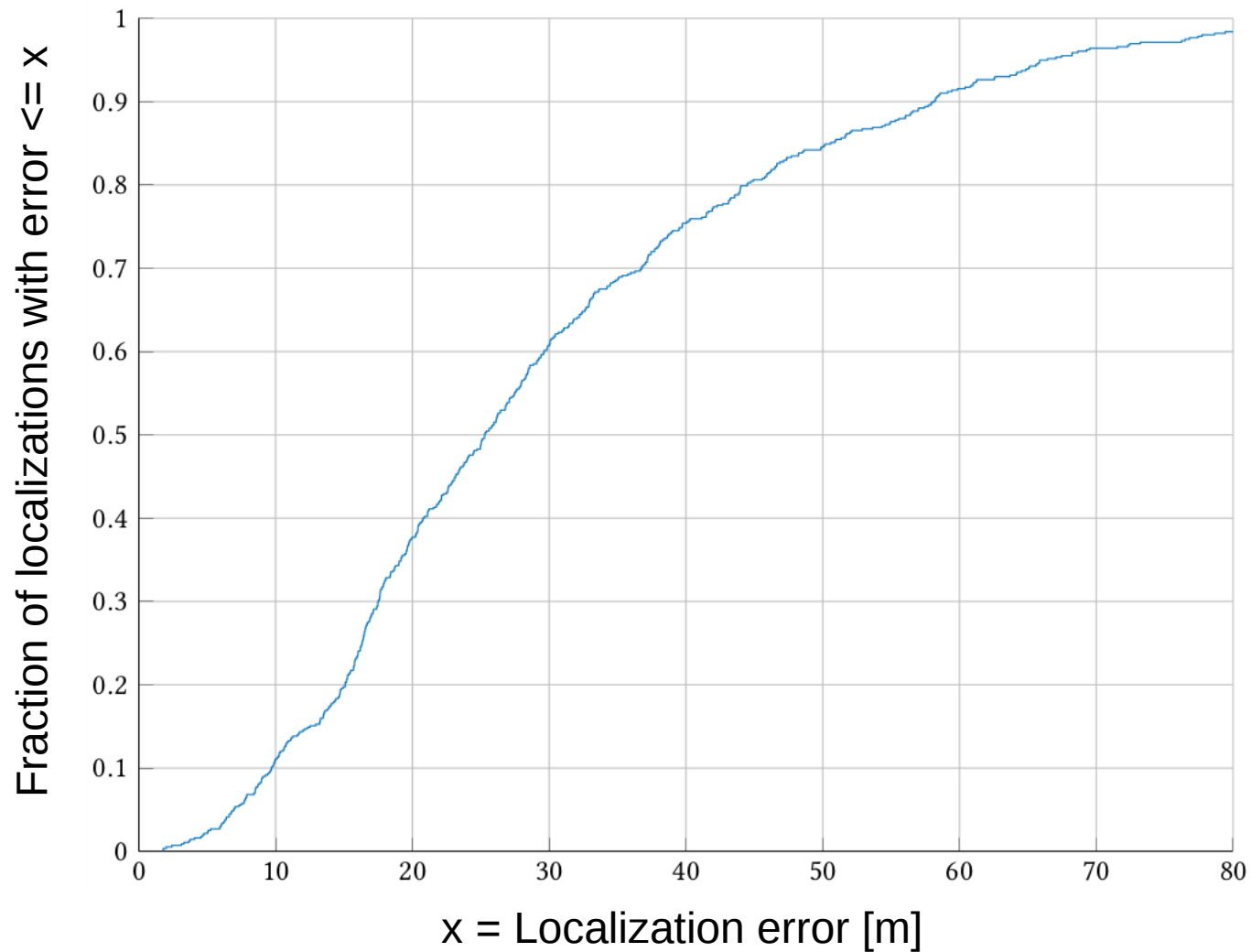- $t_a = t_2 - \|a - b_2\| / c + \Delta t_2$

(x, y, z, t_1)

(x, y, z, t_2)
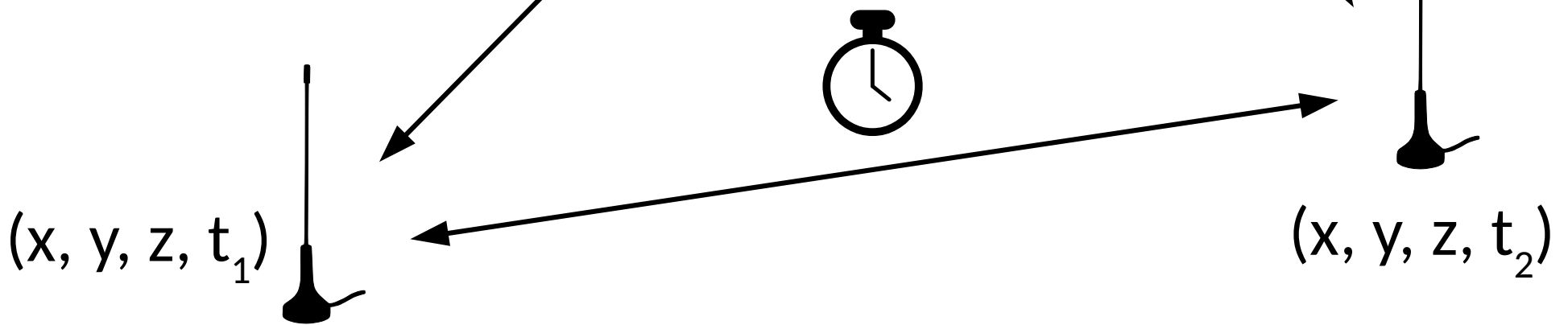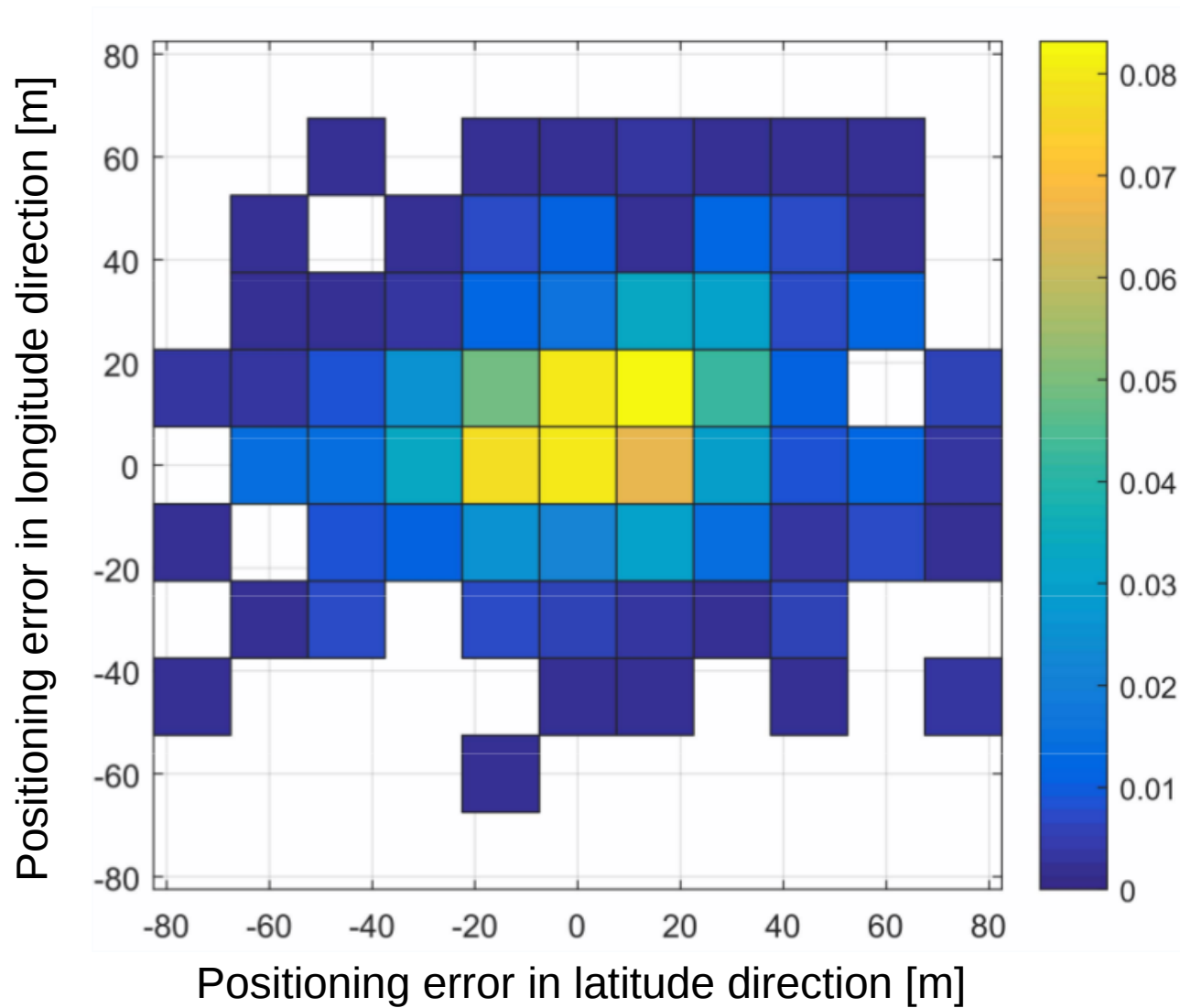
Proof of Concept

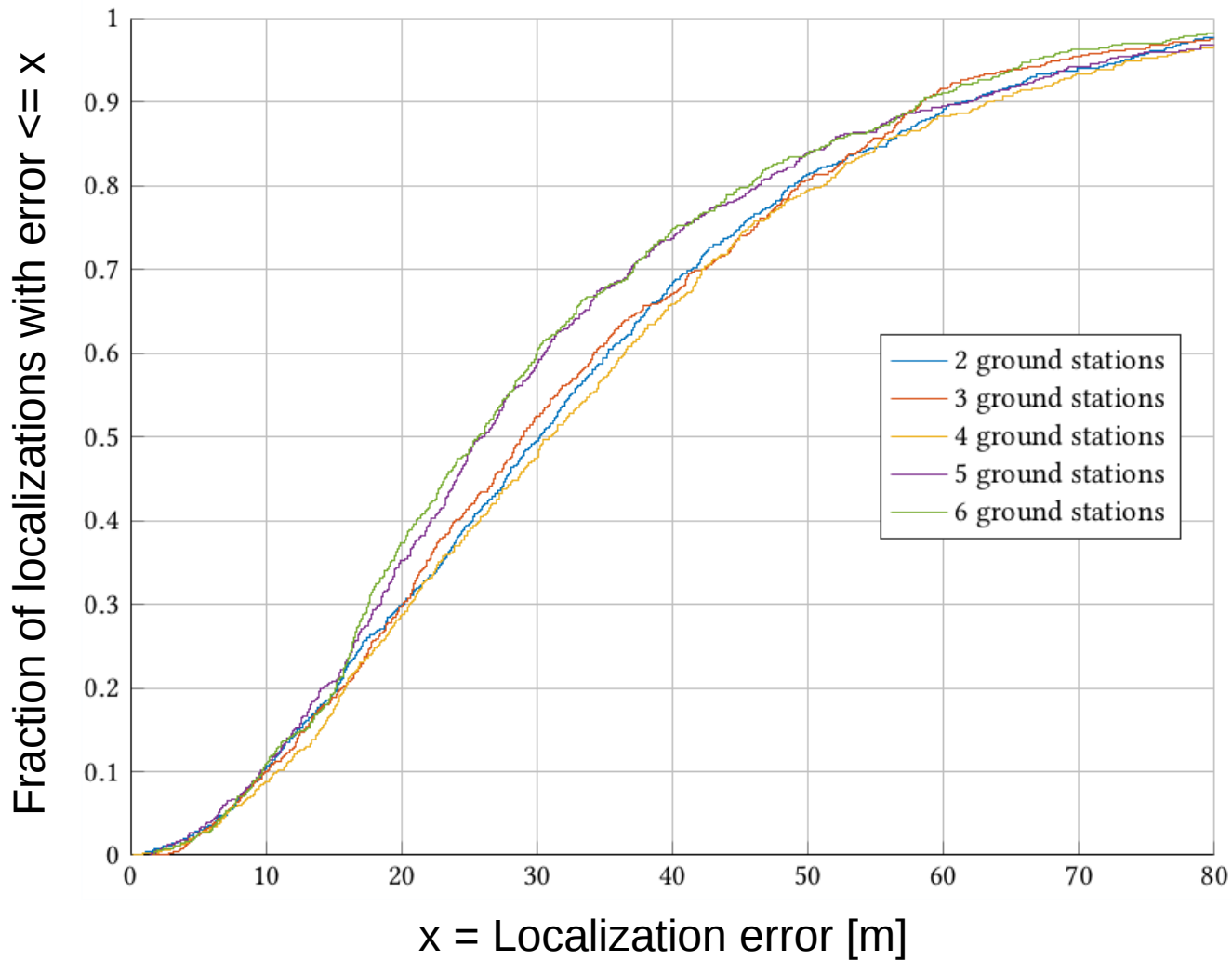# *Preliminary Results*

- Handset altitude known
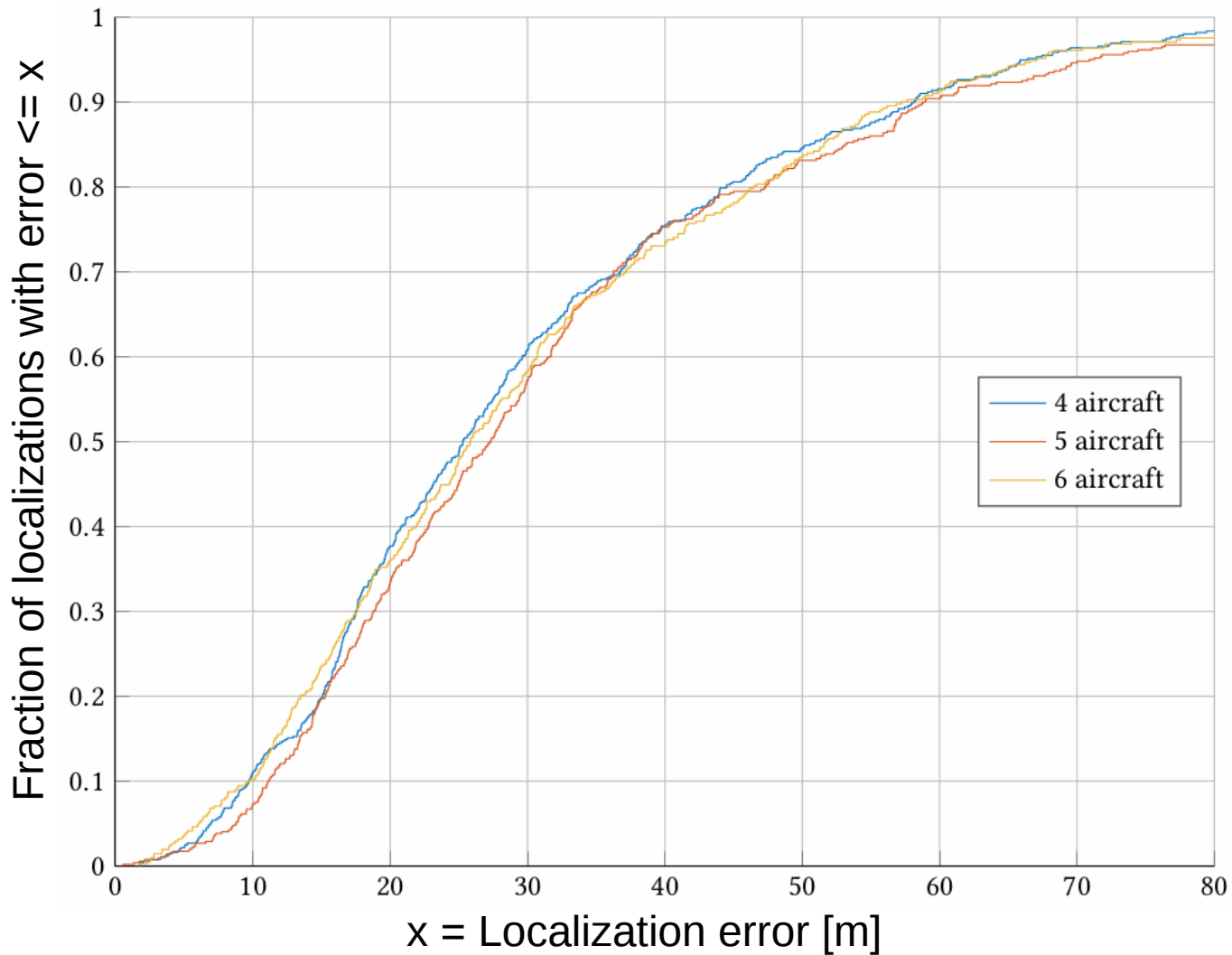
Preliminary Results

- Horizontal 2D histogram

Preliminary Results

- Number of ground stations
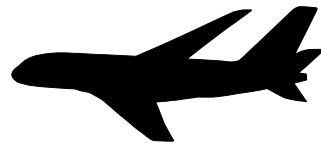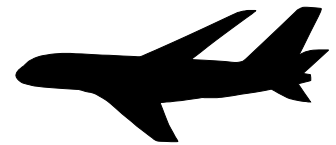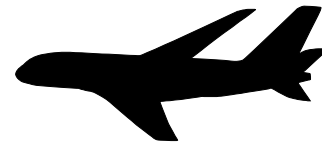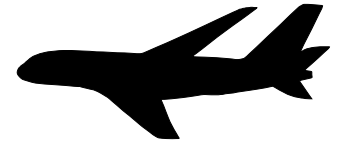
Preliminary Results

- Number of aircraft

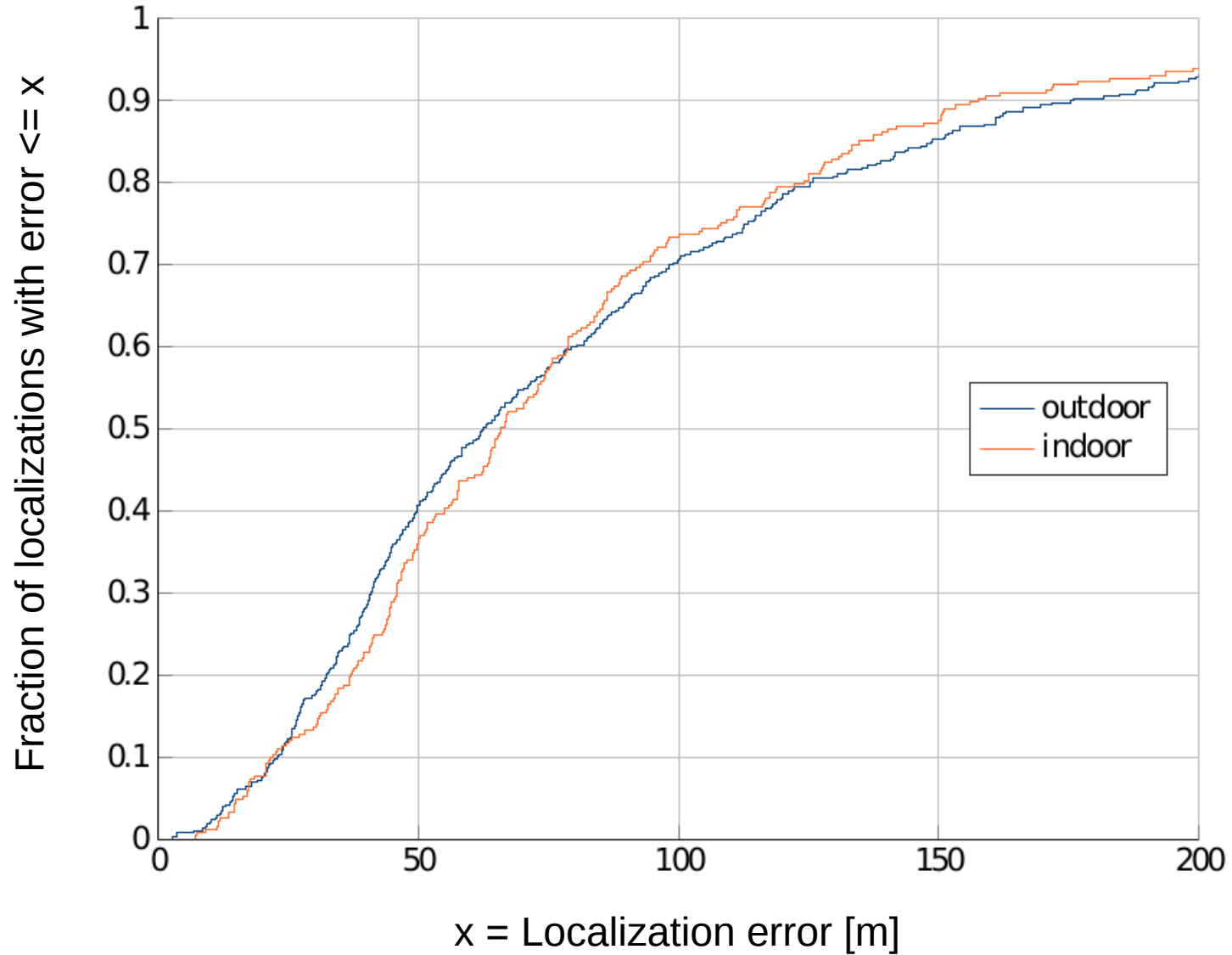# Variability

Variability

bad

good
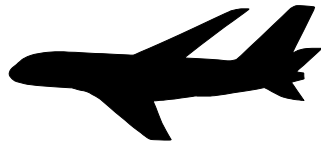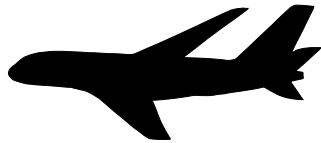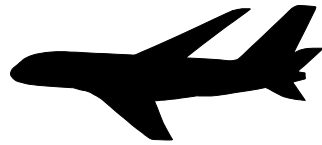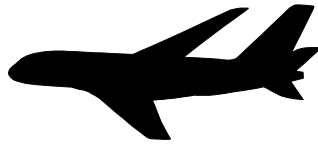
Variability
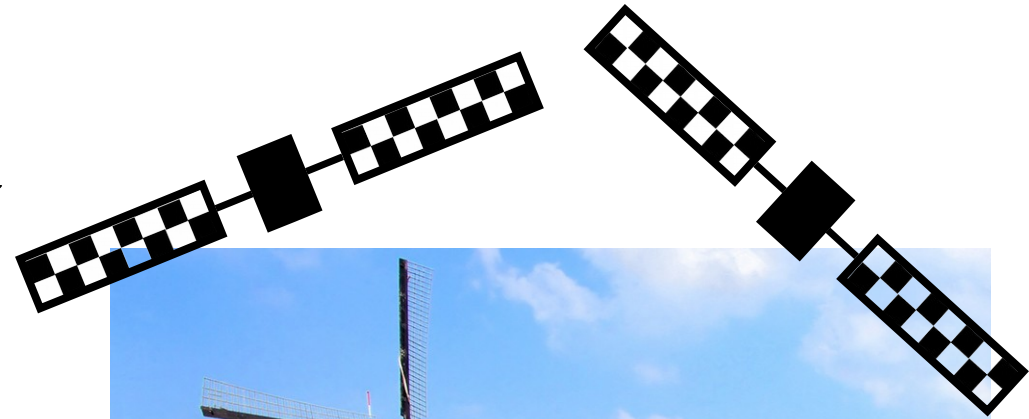
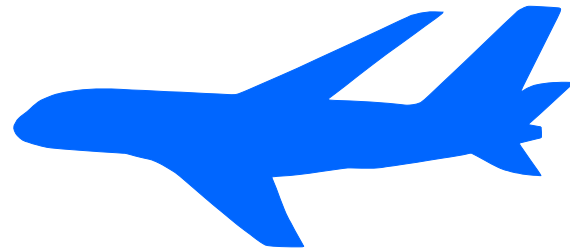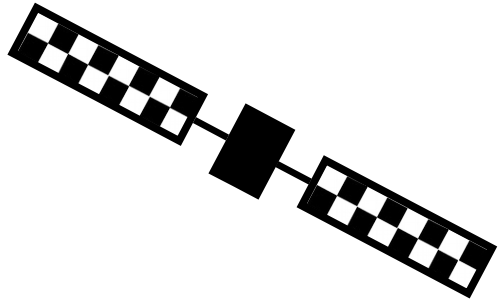# *Indoor positioning?*

Indoor positioning?

Applications

$$$

$
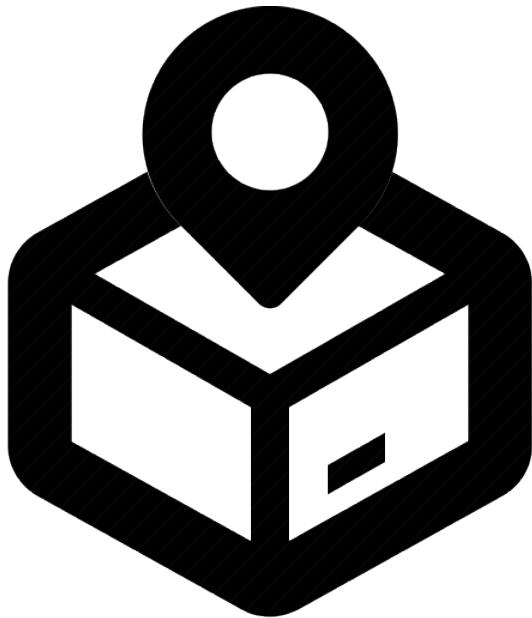
Wi Fi

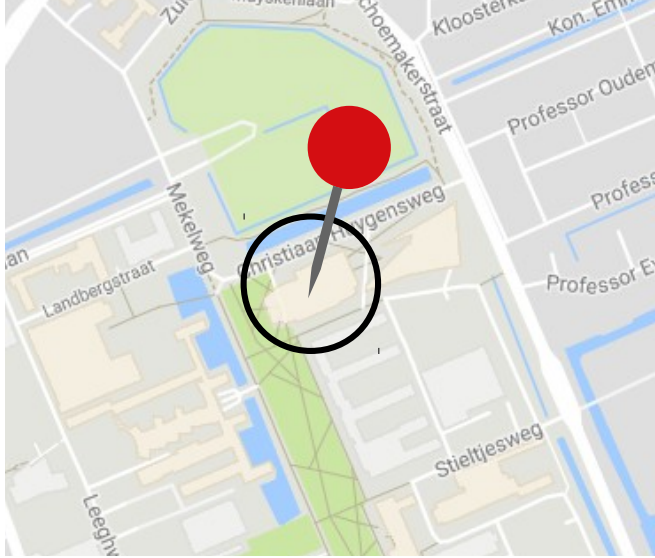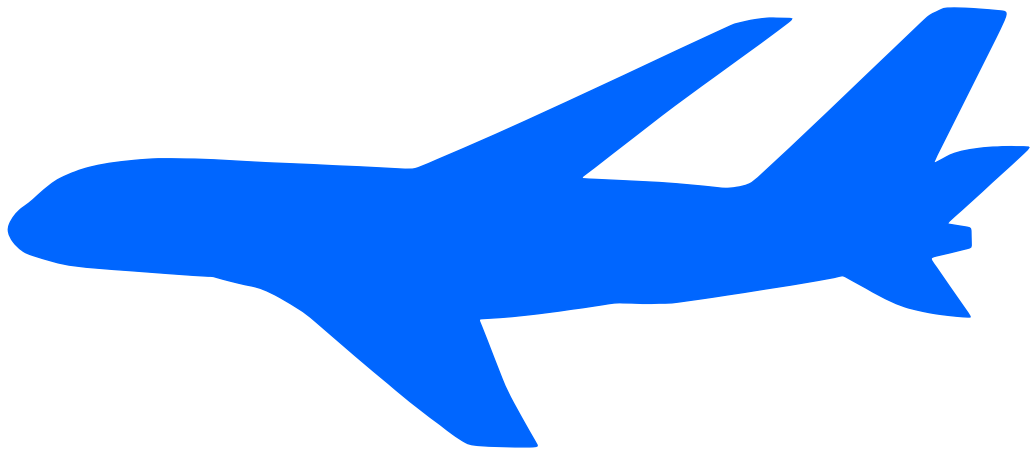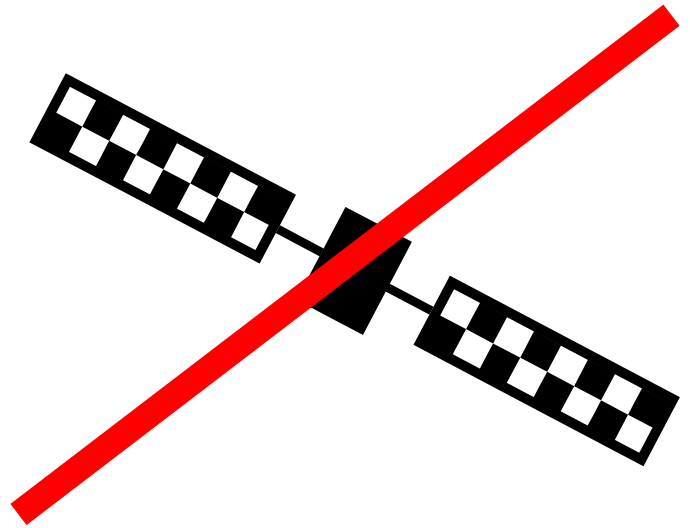AoE   < 1 m   Indoor
Accuracy

Applications

Zurich
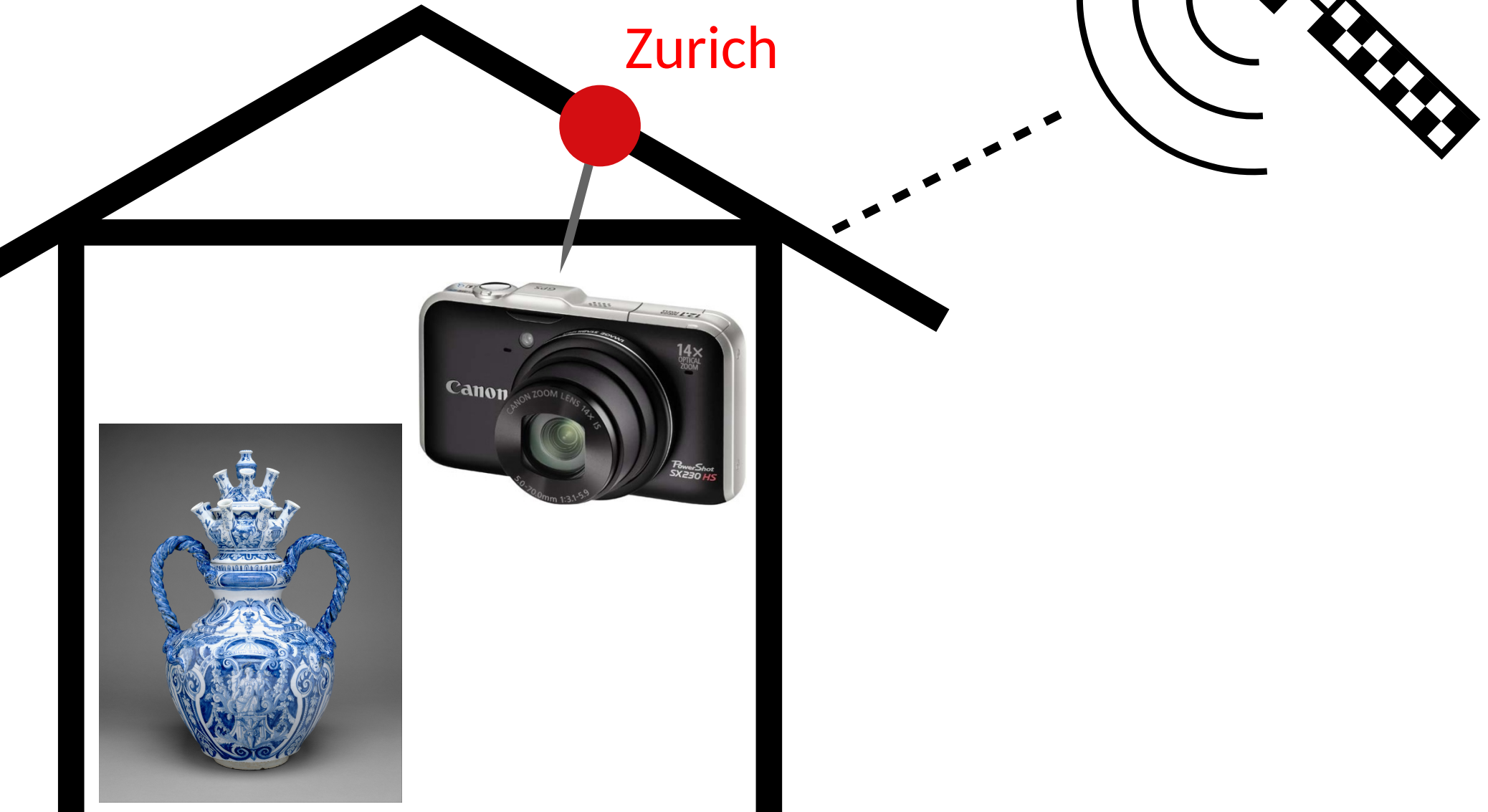
Applications

Summary

10000 x stronger signal

Indoor Localization with Aircraft Signals

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