CYBER SECURITY AND RESILIENCE SYMPOSIUM | TOWARDS A RESILIENT AVIATION CYBERSPACE

AMMAN, JORDAN | 15-17 OCTOBER 2019

Assessment of Potential Cyber Threats in Next Generation Air Traffic Surveillance Systems and Mitigations Techniques.

Ahmed Abdel Wahab El Marady

Senior Air Navigation Inspector, CNS/ATM, Egyptian Civil Aviation Authority
Member of ICAO Secretariat Study Group on Cyber security, sub-group on Air Navigation matters
Ahmed.abdel-wahab@civilaviation.gov.eg

Agenda

☐ Next gen. Air traffic surveillance (ADS-B)

☐ Potential Security threats in ADS-B

☐ Hazard / Consequences of security threats in ADS-B

☐ Mitigations techniques

　1. Comparison between ADS-B and other Surveillance sensors (WAM)

　2. Data Fusion with consistency check

　3. Velocity/ position prediction

　4. AoA and sector antenna

　5. Received Power strength vs range correlation

　6. TDoA vs Range Correlation

　7. Artificial intelligent and machine learning

Role of Surveillance

7.3 billion passengers are expected by 2034: require accurate surveillance

Source: IATA forecasts passenger demand to double over 20 years. [Online]. Available: www.iata.org/passenger-forecast.

Role of Surveillance

- Ability to accurately determine, track and update the position of aircraft

Separation standard

How efficiently air space can be utilized

- An indication of any unexpected aircraft movements

Surveillance

☐ Primary Surveillance Radar (PSR)

☐ Secondary Surveillance Radar (SSR)

☐ Multilateration (MLAT)

☐ Automatic Dependent Surveillance – Broadcast (ADS-B)

CYBER SECURITY AND
RESILIENCE SYMPOSIUM
TOWARDS A RESILIENT AVIATION CYBERSPACE

AMMAN, JORDAN | 15-17 OCTOBER 2019

ICAO 2019
75 YEARS OF
CONNECTING
THE WORLD

Next gen. Air traffic surveillance (ADS-B)

- **Low cost receivers**
- **Extremely Accurate**
- **High update rate**
- **Can Reduce min separation**
- **More Information**
  - **Identity of the aircraft**
  - **Can provide heading, speed**

Broadcast
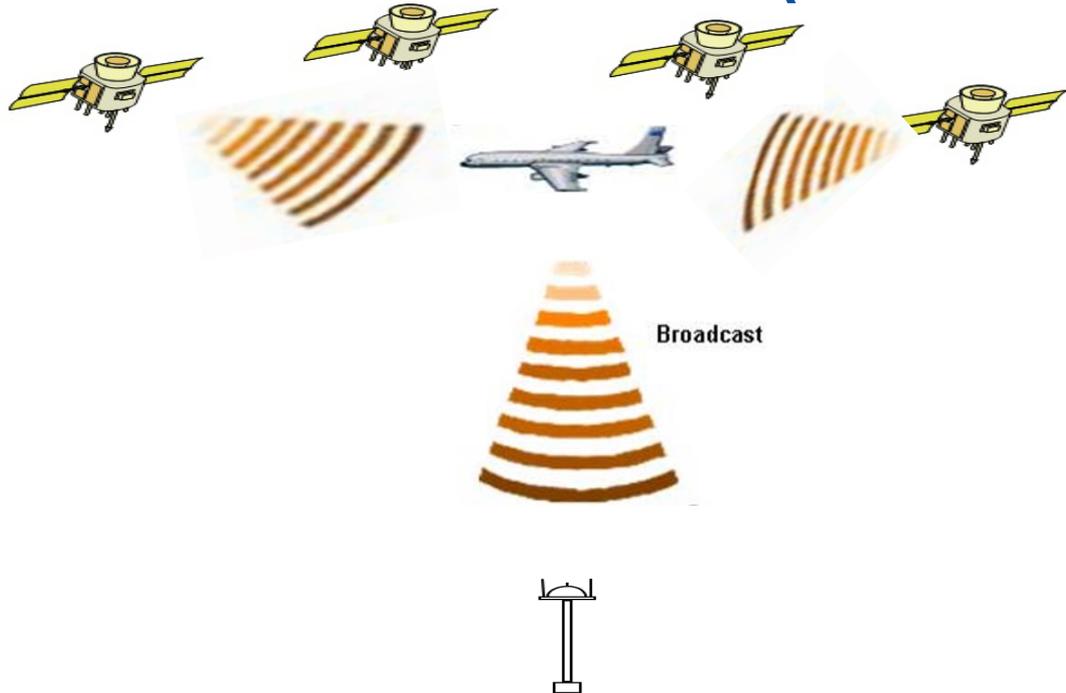
Type	Comparison			
	Cost	Accuracy	Update rate	Security
ADS-B	Very Low	High	High	Low

Eavesdropping

Jamming

Spoofing

Potential Security threats in ADS-B

Broadcast

1090 MHZ
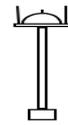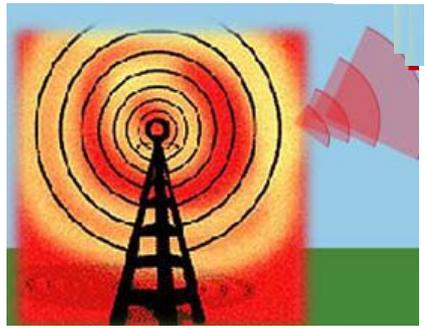
Potential Security threats in ADS-B

❑ Jamming

❑ Spoofing (adding fake targets, modification of real messages)
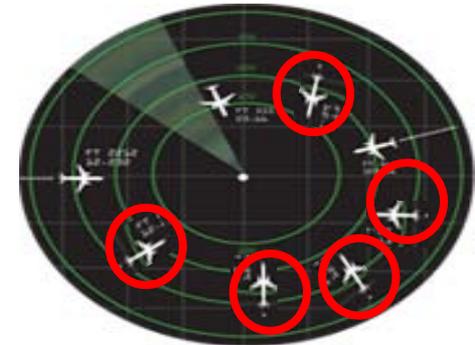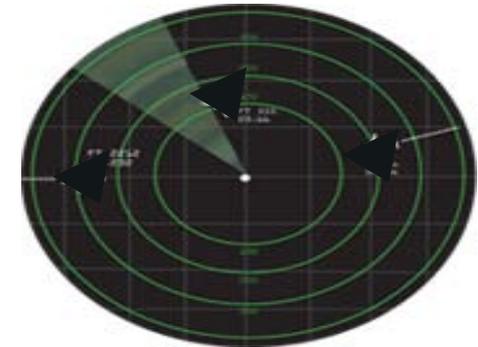
Hazard/ Consequences of security threats in ADS-B

Hazard	Worst case consequences
Jamming	<u>Partial/full loss of traffic picture</u>
Spoofing	"fake" tracks. **Increases Air Traffic Controller (ATCO) workload**

1. Comparison between ADS-B and other Surveillance sensors (WAM)

● **ADS-B message report**

● **ADS-B message report**

● **WAM message report**

Reject

Accept

Disadvantages

● **WAM message report**

2. Data Fusion with Consistency check

ADS-B signal →

MLAT signal →

Correlation

Yes
No spoofing is detected → **MLAT/ADS-B data fusion** → **49 %**

No
Spoofing is detected

Disadvantages
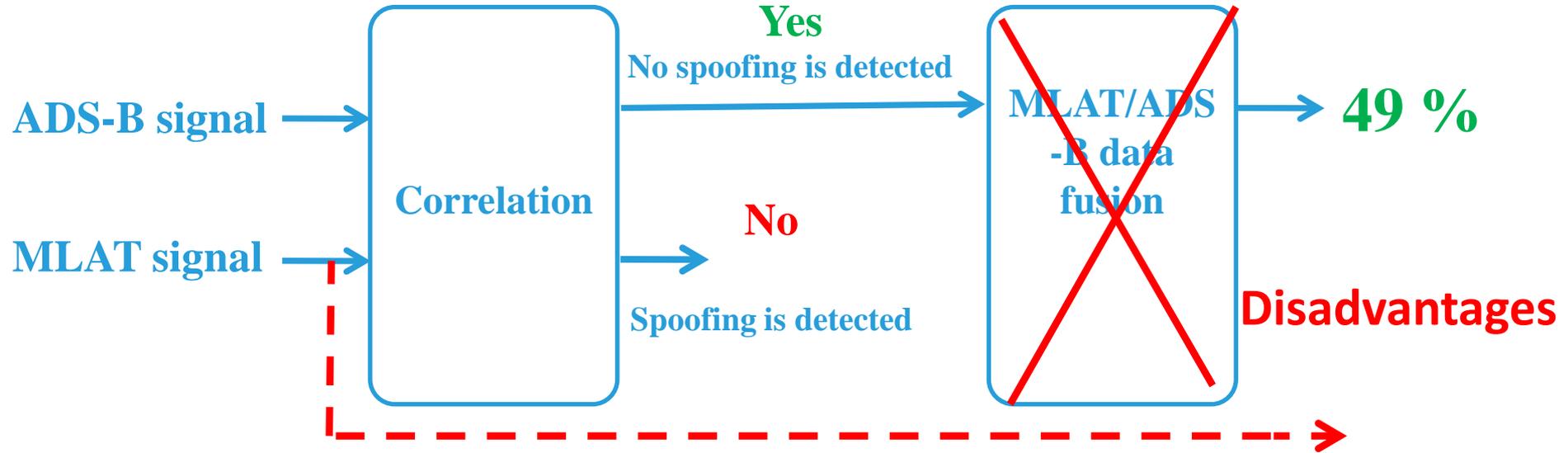
Source: Enhancing accuracy and security of ADSB via MLAT assisted-flight information system, in: 2017 12th International Conference on Computer Engineering and Systems (ICCES)

3. Velocity/ position prediction

Predicted location

Prior locations

ADS-B message report

Accept

ADS-B message report
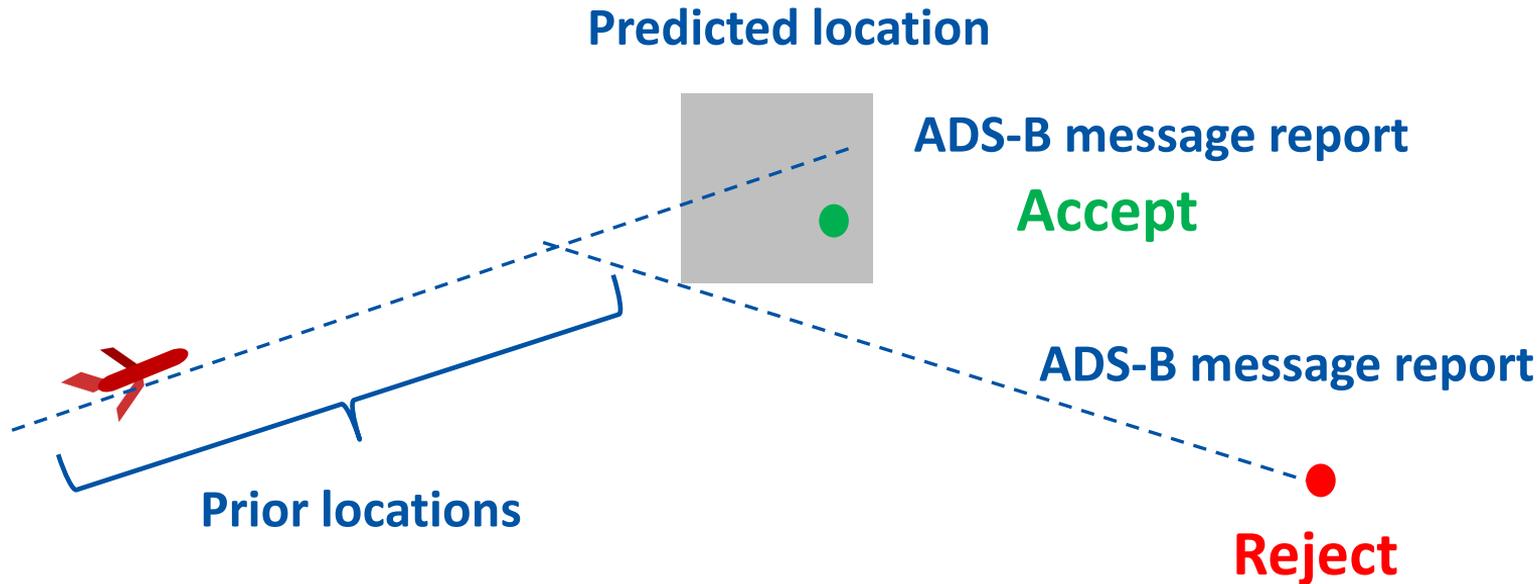
Reject

3. Velocity/ position prediction

Frog Boiling attack

Actual Trajectory

Accept

Prior locations

Fake ADS-B trajectory

ICAO MID
CYBER SECURITY AND RESILIENCE SYMPOSIUM
TOWARDS A RESILIENT AVIATION CYBERSPACE
AMMAN, JORDAN | 15-17 OCTOBER 2019
ICAO 2019
75 YEARS OF CONNECTING THE WORLD
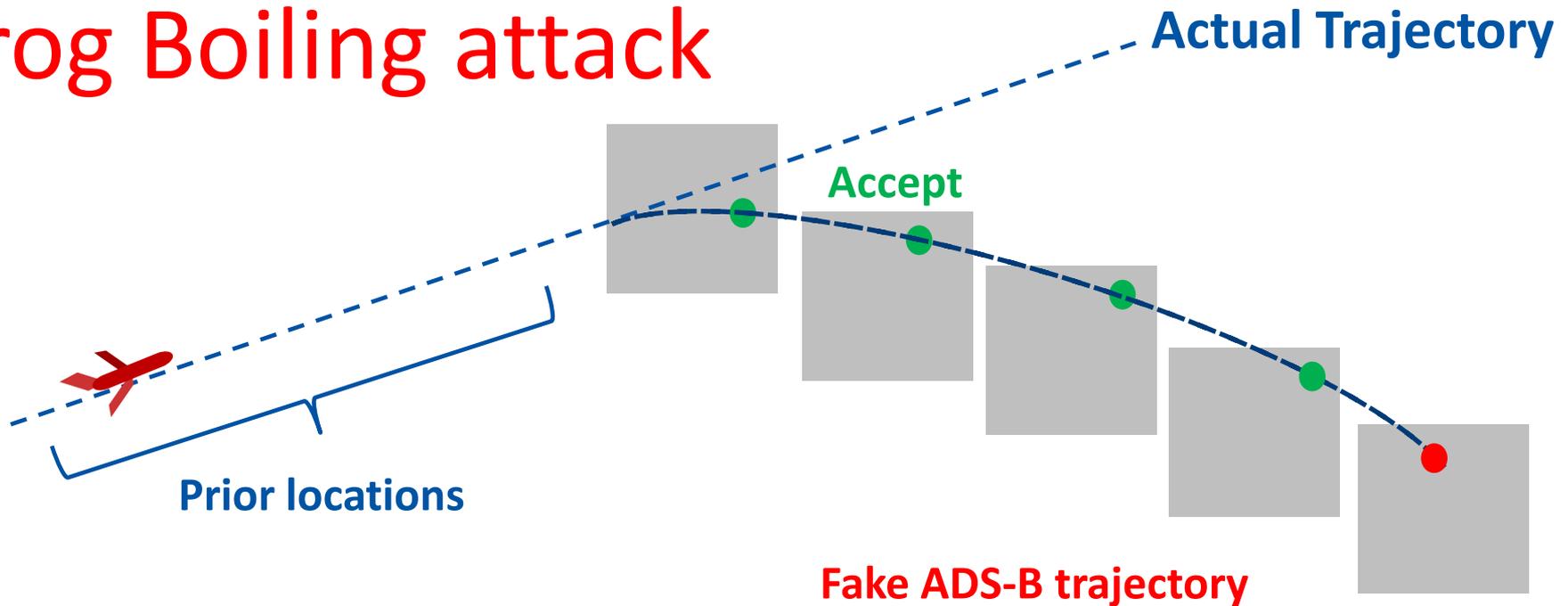
4. AoA, Sector Antenna

4. AoA, sector antenna
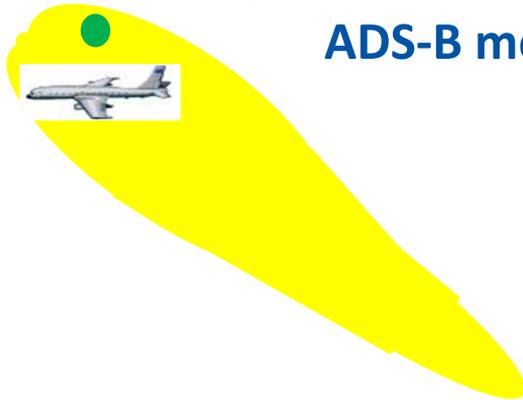
Accept

Reject

ADS-B message report

ADS-B message report
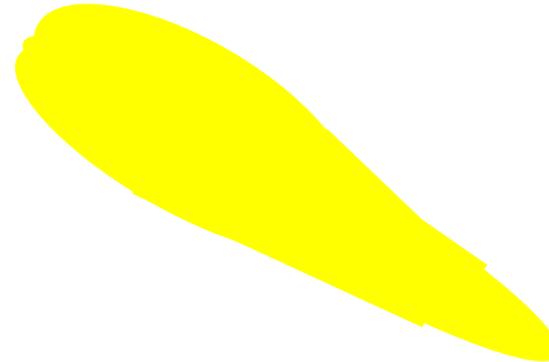
Disadvantages

5. Received Power strength vs range correlation

ADS-B message report

Reject

Position estimated from received power

Accept

?

P$_2$

Rx 2

P$_3$

Rx 3

P$_1$

Rx 1

P$_4$

Rx 4
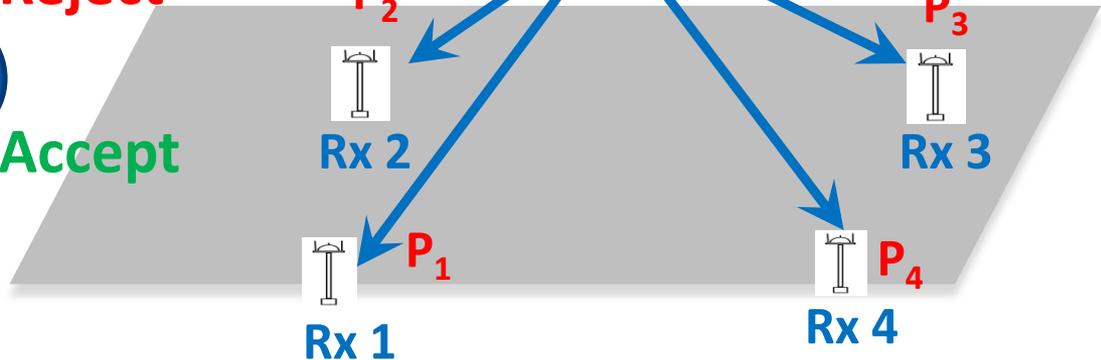
Disadvantages

6. TDoA vs Range Correlation

ADS-B message report

Reject

Accept

Position estimated from TDoA

?

t_2 Rx 2

t_3 Rx 3

t_1 Rx 1

t_4 Rx 4

ICAO MID

CYBER SECURITY AND RESILIENCE SYMPOSIUM
TOWARDS A RESILIENT AVIATION CYBERSPACE
AMMAN, JORDAN | 15-17 OCTOBER 2019

ICAO 2019
75 YEARS OF CONNECTING THE WORLD
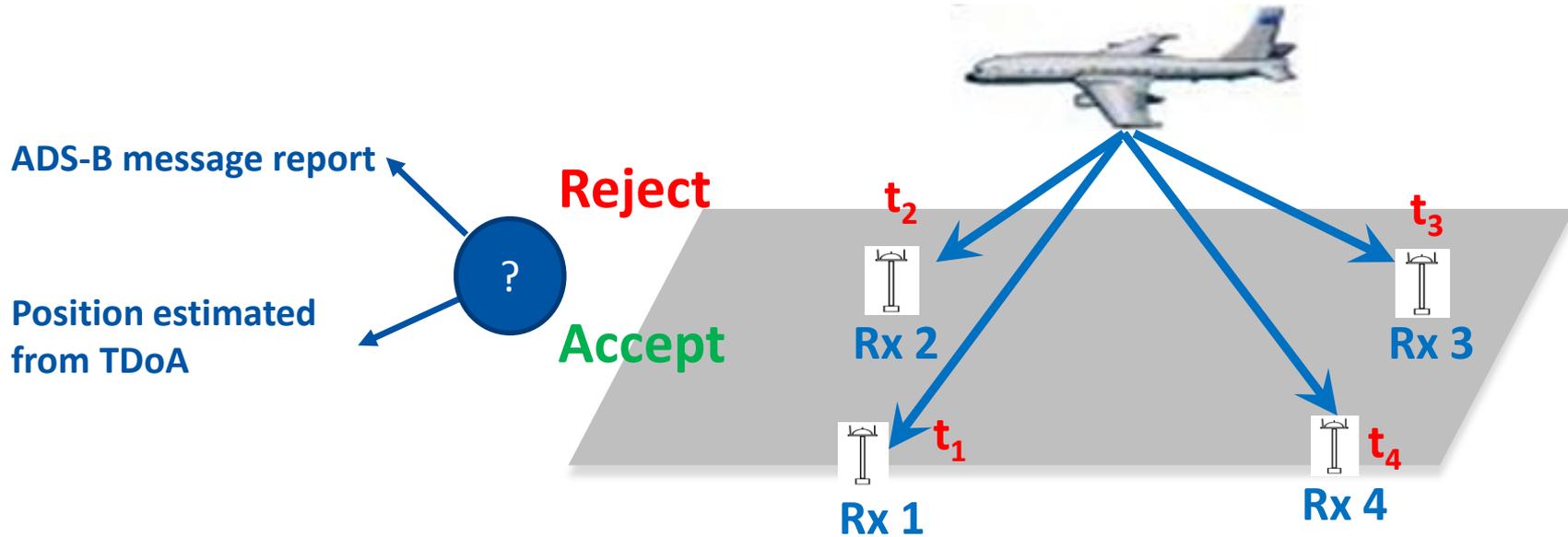
6. TDoA vs Range Correlation

Disadvantages

Synchronization

Multi-path environment

Low Accuracy

Rx 1

ICAO MID

CYBER SECURITY AND RESILIENCE SYMPOSIUM
TOWARDS A RESILIENT AVIATION CYBERSPACE
AMMAN, JORDAN | 15-17 OCTOBER 2019

ICAO 2019
75 YEARS OF CONNECTING THE WORLD
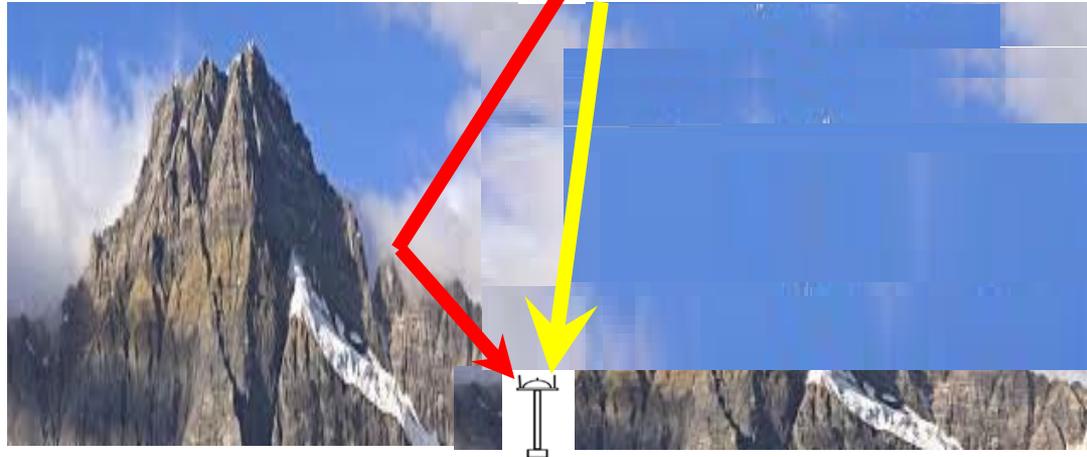
7. Artificial intelligent and machine learning

Offline training phase

Fingerprint Map

Longitude

Latitude

ICAO MID

CYBER SECURITY AND
RESILIENCE SYMPOSIUM
TOWARDS A RESILIENT AVIATION CYBERSPACE

AMMAN, JORDAN | 15-17 OCTOBER 2019

ICAO 2019
75 YEARS OF
CONNECTING
THE WORLD
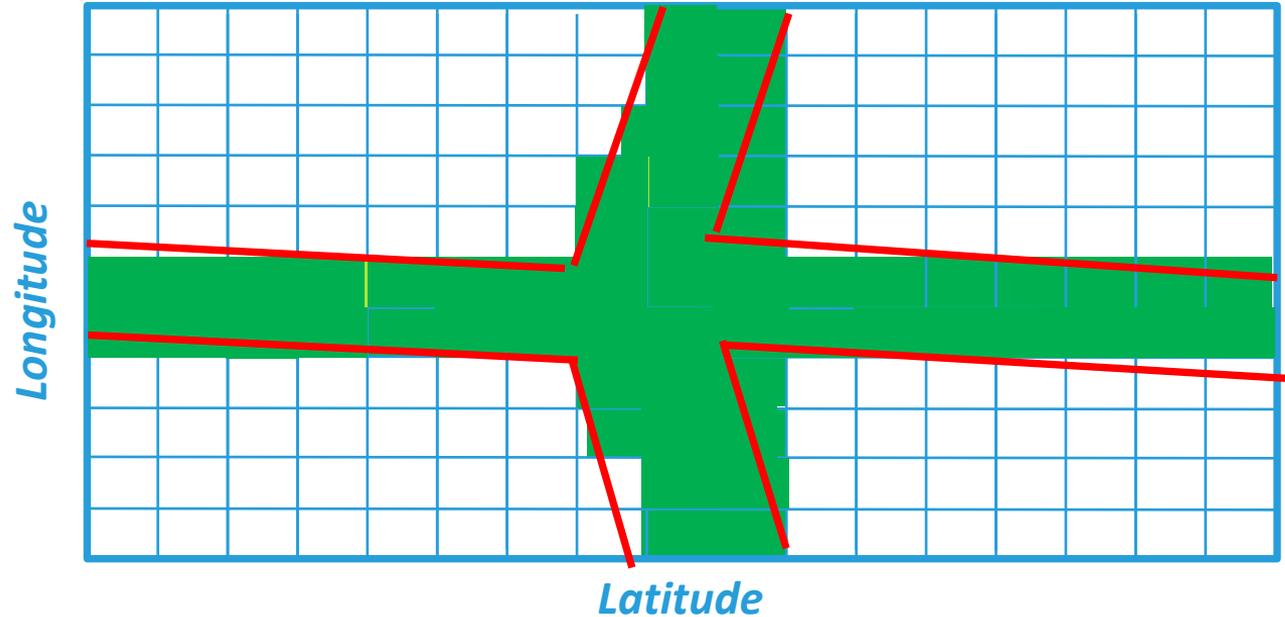
7. Artificial intelligent and machine learning

Online localization phase

Determine the best location matches Incoming fingerprint

Area of Interest

ICAO MID

CYBER SECURITY AND RESILIENCE SYMPOSIUM

TOWARDS A RESILIENT AVIATION CYBERSPACE

AMMAN, JORDAN | 15-17 OCTOBER 2019

ICAO 2019

75 YEARS OF CONNECTING THE WORLD
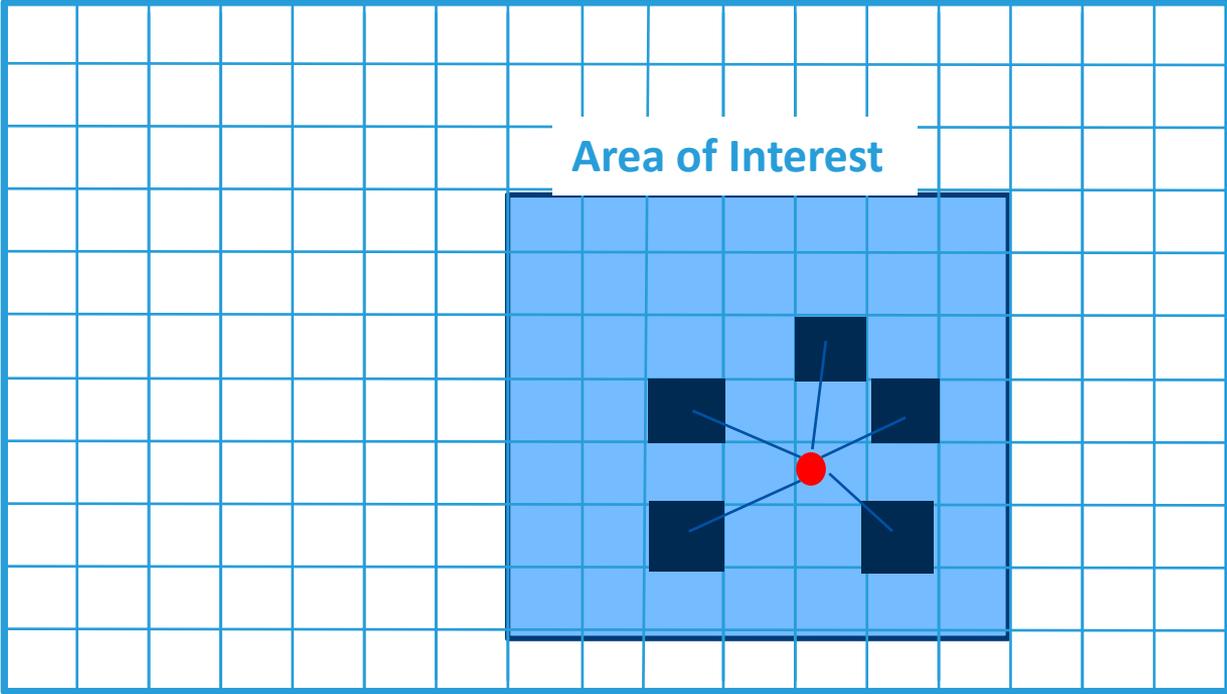
7. Artificial intelligent and machine learning

Advantages

- ❑ **Determining location of aircraft regardless ADS-B massage report**

- ❑ **Works well in less Synchronization**

- ❑ **Works well in Multi-path environment**

- ❑ **High localization Accuracy**

Conclusion

- ❑ **Coverage**

- ❑ **Accuracy**

- ❑ **Reliability**

- ❑ **Availability**

- ❑ **Quality of service**

- ❑ **Trust**

Communication
Navigation
Surveillance

How to measure it

How to enhance it