



GATEMAN Workshop

8th SESAR Innovation Days

2. ConOps for GNSS Interference Air Navigation Threat Management
Alberto de la Fuente
[GMV]

Salzburg 3rd December 2018



Founding Members



Summary

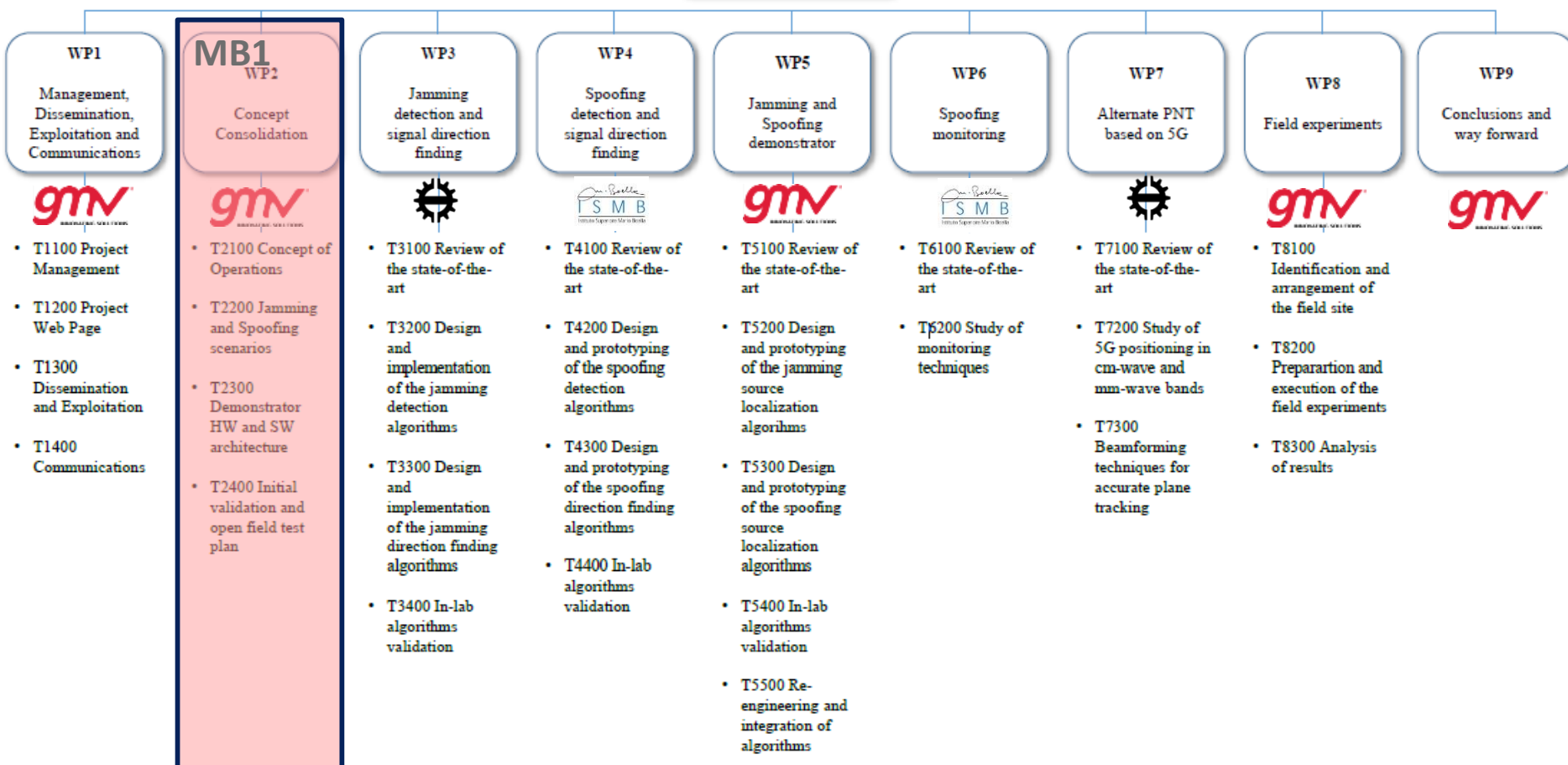


1. **Context in GATEMAN**
2. Assumptions
3. Detection & Localization Techniques
4. Modes of Operation
5. Airborne Implementation
6. Benefits

1. Context in GATEMAN

WPs vs Objectives (MB)

GATEMAN



Summary



1. Context in GATEMAN
2. **Assumptions**
3. Detection & Localization Techniques
4. Modes of Operation
5. Airborne Implementation
6. Benefits

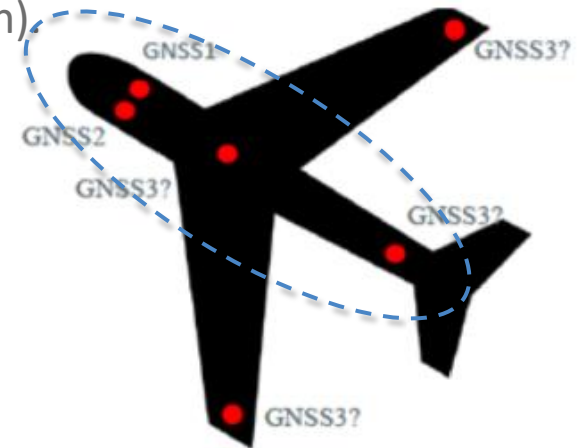
2. Assumptions

Assumptions on the RFI source:

- Source on-ground (2D localization).
- Static or quasi-static source (negligible speed compared to the aircraft).
- 1 single source.

Assumptions on the aircraft (detection and localization based on existing aircraft equipment with minor retrofit):

- Omnidirectional GNSS antennas.
- GNSS antennas on top of the fuselage (used for navigation).
- 3 GNSS antennas (existing aircrafts are equipped with 2).
- Layout of GNSS antennas.

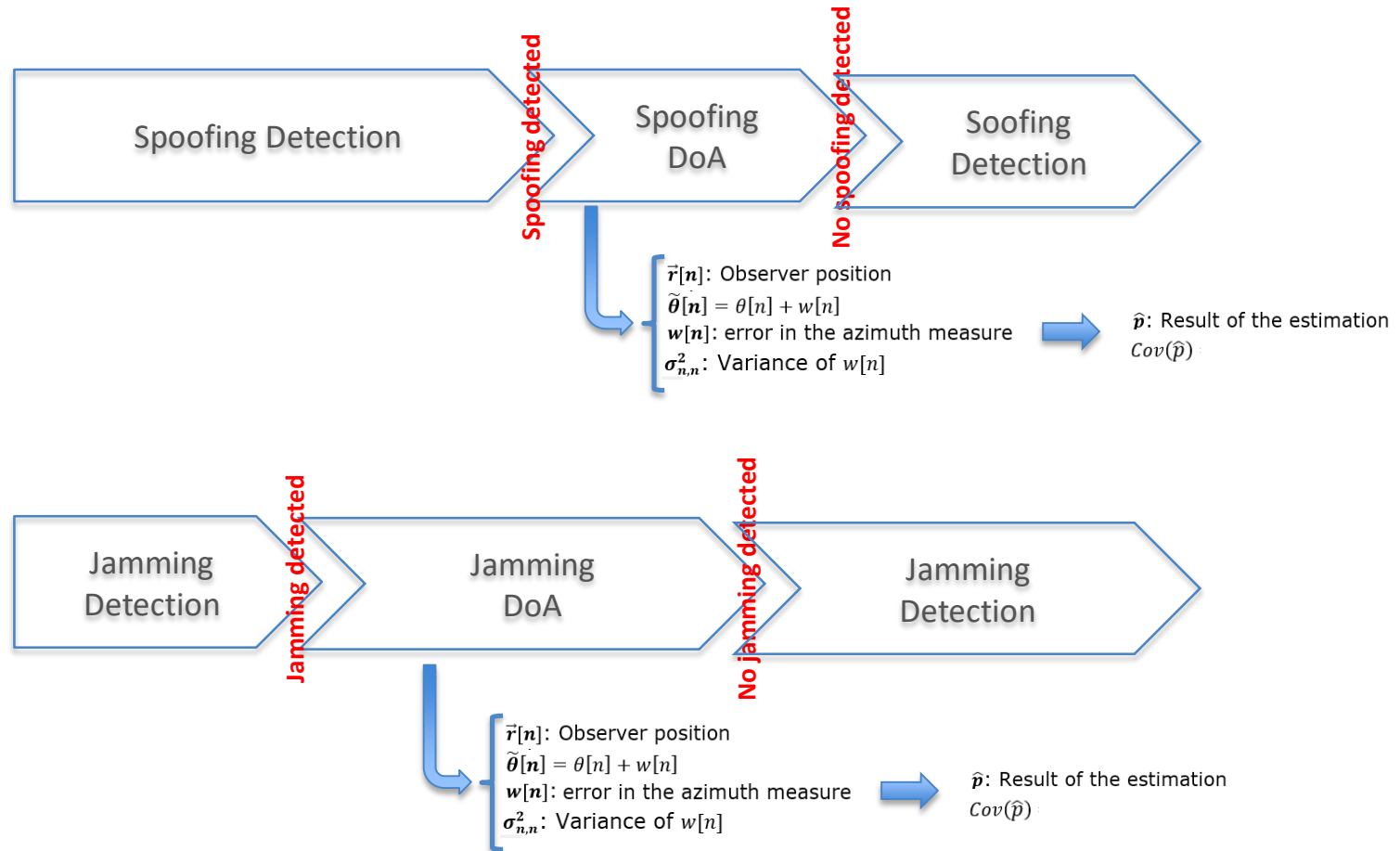


Summary



1. Context in GATEMAN
2. Assumptions
- 3. Detection & Localization Techniques**
4. Modes of Operation
5. Airborne Implementation
6. Benefits

3. Detection & Localization Techniques



Summary

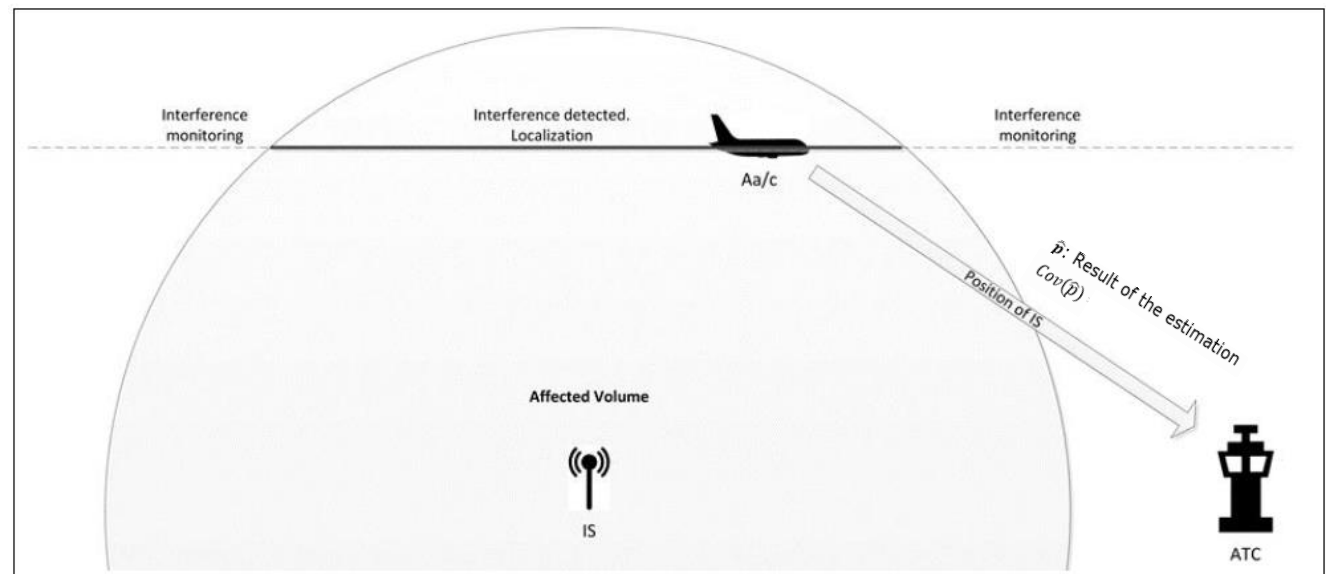


1. Context in GATEMAN
2. Assumptions
3. Detection & Localization Techniques
- 4. Modes of Operation**
5. Airborne Implementation
6. Benefits

4. Modes of Operation

Detection & Autonomous Localization (D&AL)

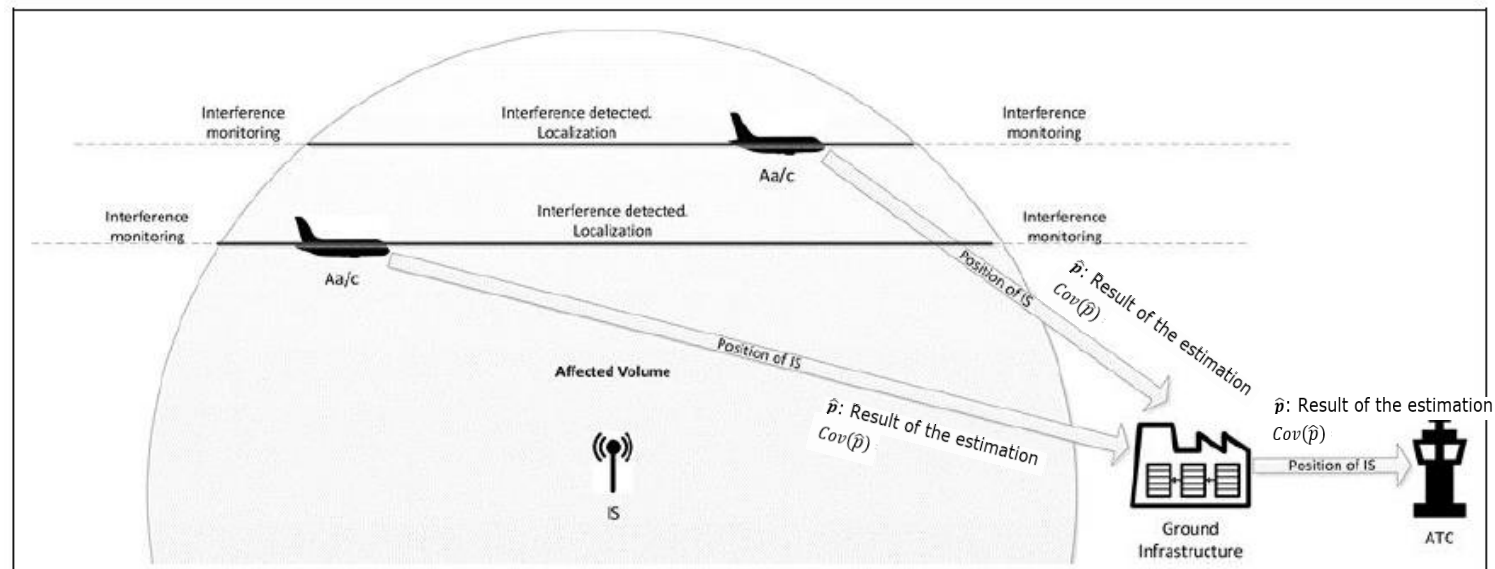
- 1 aircraft affected by the interference (Aa/c) detects, localize and reports the position of the Interference Source (IS).
- if +1 aircrafts are affected, they report to ATC the position of the source computed independently.



4. Modes of Operation

Detection & Collaborative Localization (D&CL)

- 1 aircraft affected by the interference (Aa/c) detects, localize and reports the position of the source (IS) to the Ground Infrastructure (GI).
- if +1 aircrafts are affected, they report the position of the source computed independently.
- GI computes a reliable and more accurate estimation of the position.



4. Modes of Operation

Detection & Enhanced Collaborative Localization (D&eCL)

- 1 aircraft affected by the interference (Aa/c) detects, localize and reports the position of the source (IS) and raw data to the Ground Infrastructure (GI).
- if +1 aircrafts are affected, they report the position of the source computed independently and the raw data recorded on-board.
- GI computes a reliable and more accurate estimation of the position.

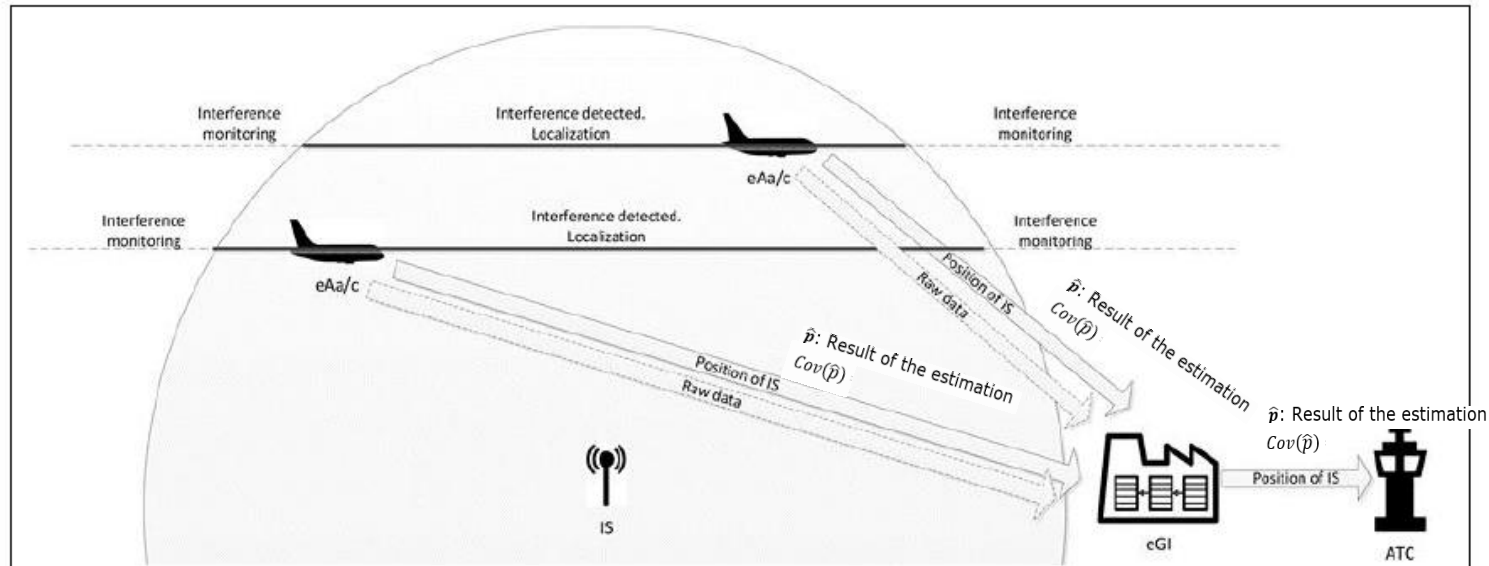
Raw Data:

$\vec{r}[n]$: Observer position

$\hat{\theta}[n] = \theta[n] + w[n]$

$w[n]$: error in the azimuth measure

$\sigma_{n,n}^2$: Variance of $w[n]$



Summary



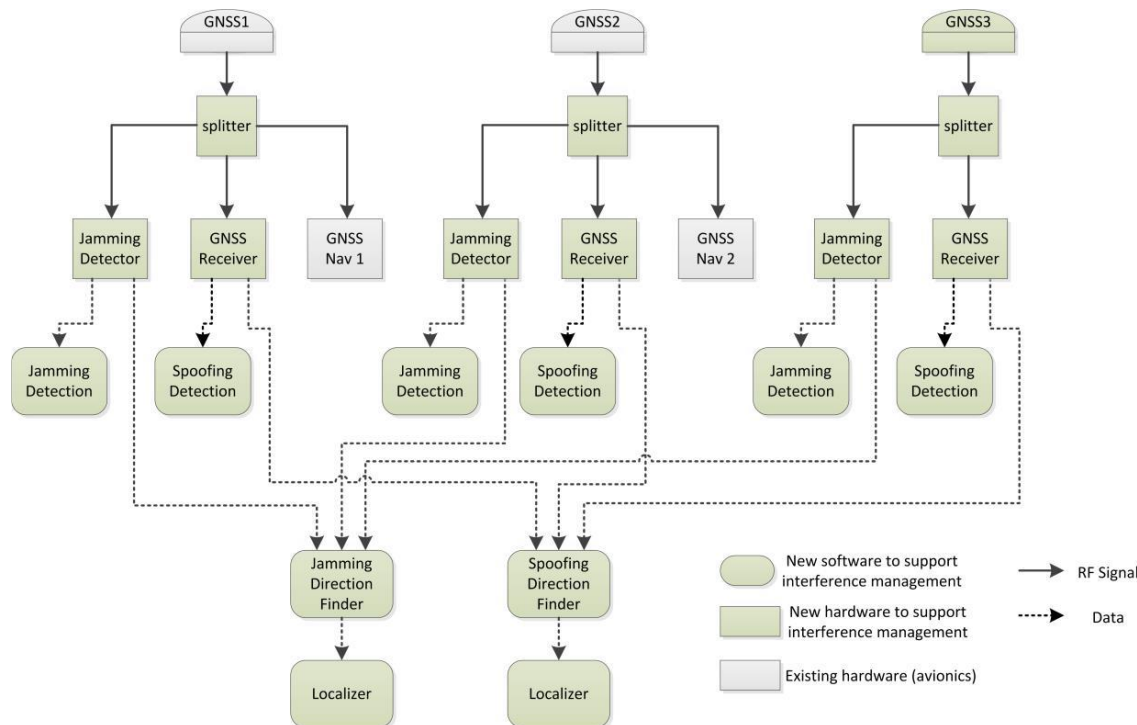
1. Context in GATEMAN
2. Assumptions
3. Detection & Localization Techniques
4. Modes of Operation
- 5. Airborne Implementation**
6. Benefits

5. Airborne Implementation

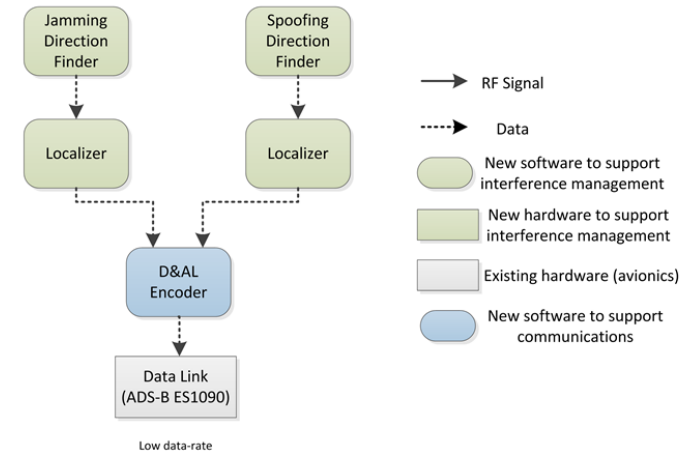
Detection & Autonomous Localization (D&AL)

Detection & Collaborative Localization (D&CL)

Data Processing



Data-link (comms)

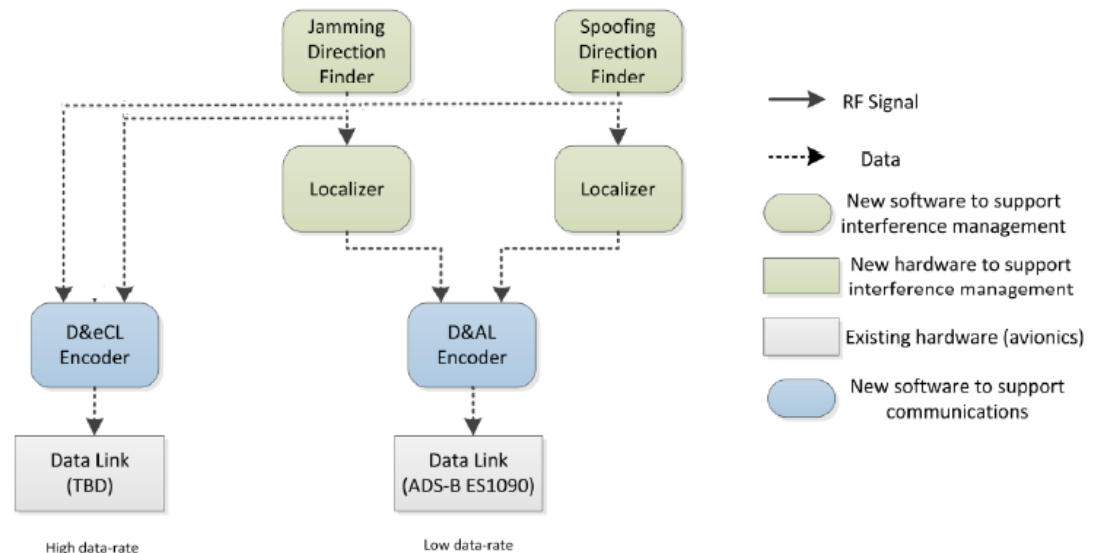


5. Airborne Implementation

Detection & Enhanced Collaborative Localization (D&eCL)

Data Processing (no change)

Data-link (comms)



5. Airborne Implementation



Mode	Airborne (Data Processing)	Airborne (Data Link)	Ground Infrastructure
Detection & Autonomous Localization (D&AL)	Same	Low-rate	None
Detection & Collaborative Localization (D&CL)			Basic
Detection & Enhanced Collaborative Localization (D&eCL)		Low-rate & High-rate	Improved

Summary



1. Context in GATEMAN
2. Assumptions
3. Detection & Localization Techniques
4. Modes of Operation
5. Airborne Implementation
6. **Benefits**

6. Benefits

Jamming effects => GNSS navigation is degraded or lost (*availability issue*).

Consequences => avionics falls back to a less precise navigation mean, and ADS-B surveillance is degraded.

Impact:

- approaches with higher minima (for less precise navigation mean) might not be available due to weather conditions => *diversions and missed approaches*.
- increase traffic separation => *extra workload at ATC and reduced capacity at airport*.

Mitigation:

- New GNSS receivers (COTS) implements techniques to 'remove' some types of jamming.
- Fast localization of the source to deactivate it, reduces the duration of the impact.
- A-PNT.

MB1

MB2

6. Benefits

Spoofing effects => GNSS navigation is misleading (*integrity issue*).

Consequences => pilot is not aware. ATC is aware thanks to surveillance means (other than ADS-B).

Impact:

- ATC and pilot have different information, and they cannot know which one is valid => *situational awareness is compromised*
- GNSS navigation is not valid any more. Same impact as described for jamming.

Mitigation:

MB1

- Fast localization of the source to deactivate it, reduces the duration of the impact.

MB3

- Spoofing monitoring.

6. Benefits



The concept of integrated GNSS RFI Threats Management System provides these benefits:

- The **pilot** increases its **situational awareness** with respect to spoofing interferences thanks to its detection (not an integrity issue any more).
- **ATC** mitigates the operational impact of interference thanks to **rerouting traffic** to areas not affected by the interference or not clearing approaches based on GNSS. These benefits are possible thanks to the localization of the source and the estimation of the affected volume.
- The ANSP and the **National RF Spectrum Agency** receive very accurate information about the localization of the source, which significantly reduces the time required to **deactivate the interference**.



GATEMAN

Thank you very much for your attention!



This project has received funding from the SESAR Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No [number]



Founding Members



The opinions expressed herein reflect the author's view only.

Under no circumstances shall the SESAR Joint Undertaking be responsible for any use that may be made of the information contained herein.