C4ISTAR in Brazilian border security

A PROPOSAL OF A MOBILE SURVEILLANCE NETWORK TO INTEGRATE BRAZILIAN ARMY DEFENSE SYSTEM

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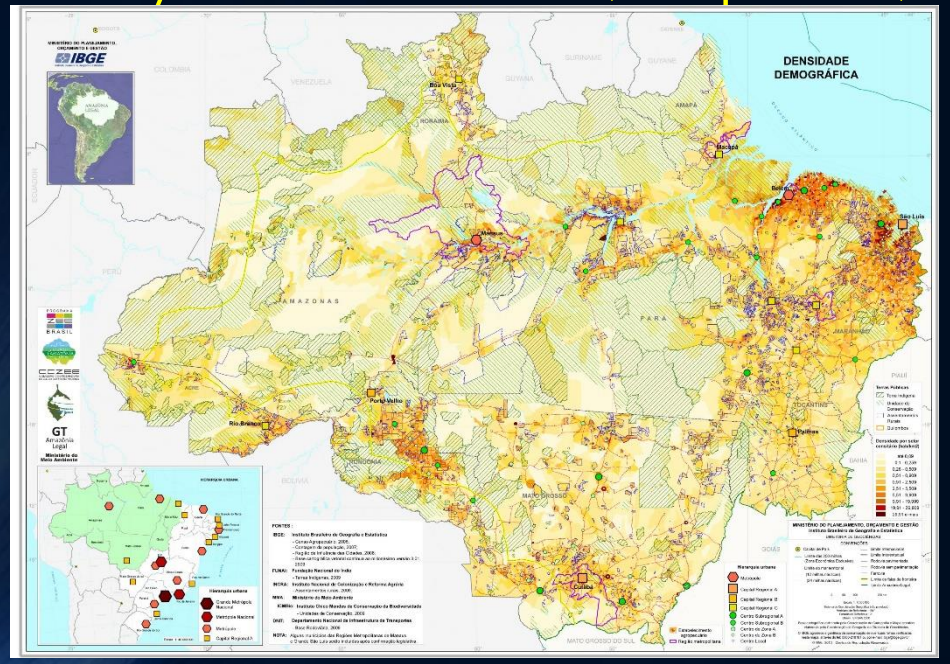
Introduction

Amazon: What is it and why it matters?

- More than 9,500 km of border
- Wild and rough environment
- Very difficult to move (and protect)



Source: IBGE, 2019 (https://www.mma.gov.br/destaques/item/8202-mapas-tem%C3%A1ticos)

Source: NASA, 2017 (https://www.nasa.gov/topics/earth/earthday/gall_earth_night.html)

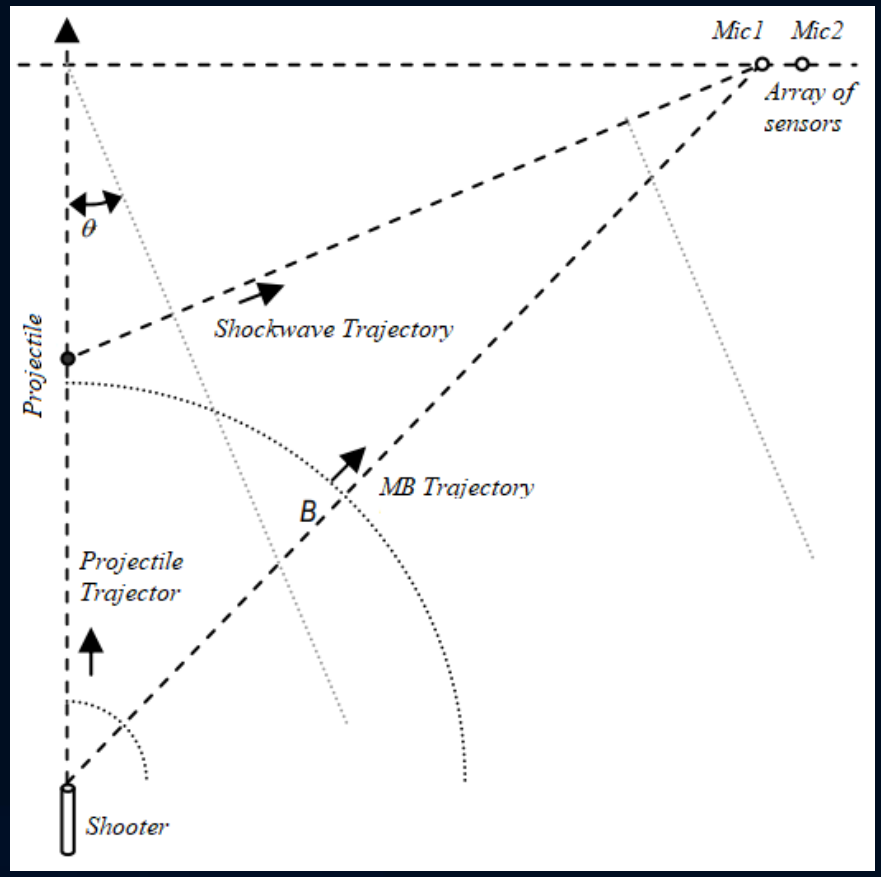
Integrated Border Monitoring System (SISFRON)

- Covers almost 17,000 km of border (150 km wide)
- $3 billion will be invested
- Integration with other protection systems (SIPAM) and agencies

Estimating Direction of Arrival (DoA) of a Gunshot

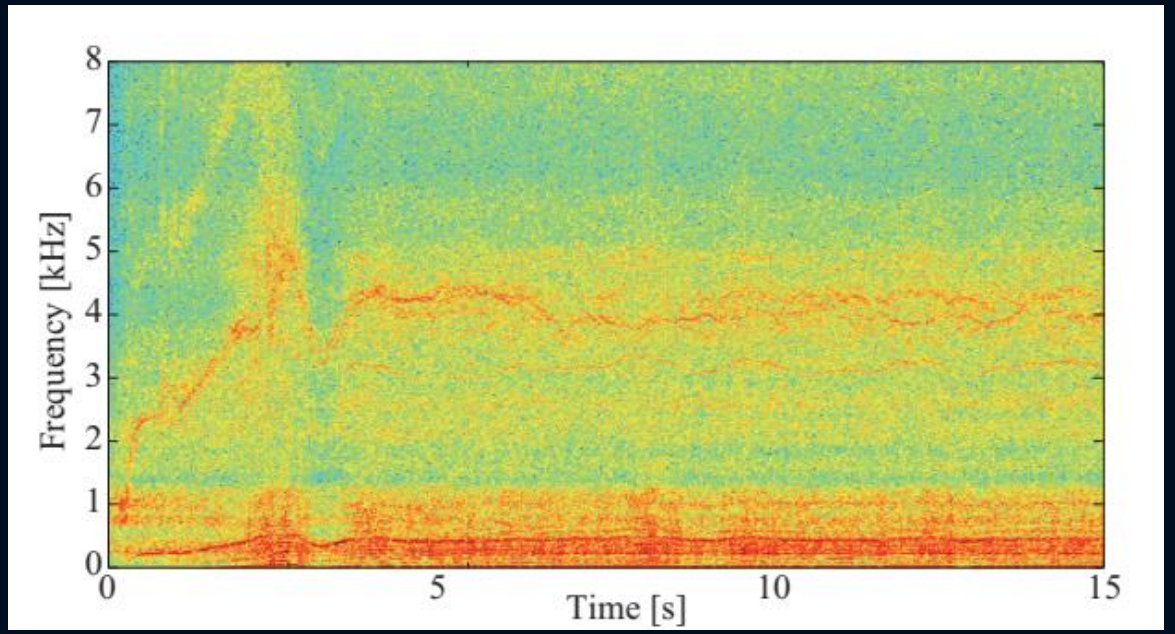
DoA Techinique

- Two main signatures used: Muzzle Blast (MB) and Shockwave
- MB gives shooter directions
- Shockwave provides trajectory information
- With elevated microphone, It is possible to estimate the shooter position with only MB
- Noise is a problem for MB only DoA
  - Use Exhaustive Search (ES) and Iterative Least Squares (ILS) algorithms
  - With heavily noisy gunshot signals, use combined ES and Searching Consistent Fundamental Loop (SCFL) algorithms
  - ES-SCFL depends on the number of sensors used



DoA with an UAV

- Drawbacks
  - Noise from propellers
  - Small distance among sensors
  - Limited payload
  - Hovering is unstable
  - Limited range precision (150 m, with 5 microphones)
- So, DoA with UAV is viable, but has limitations

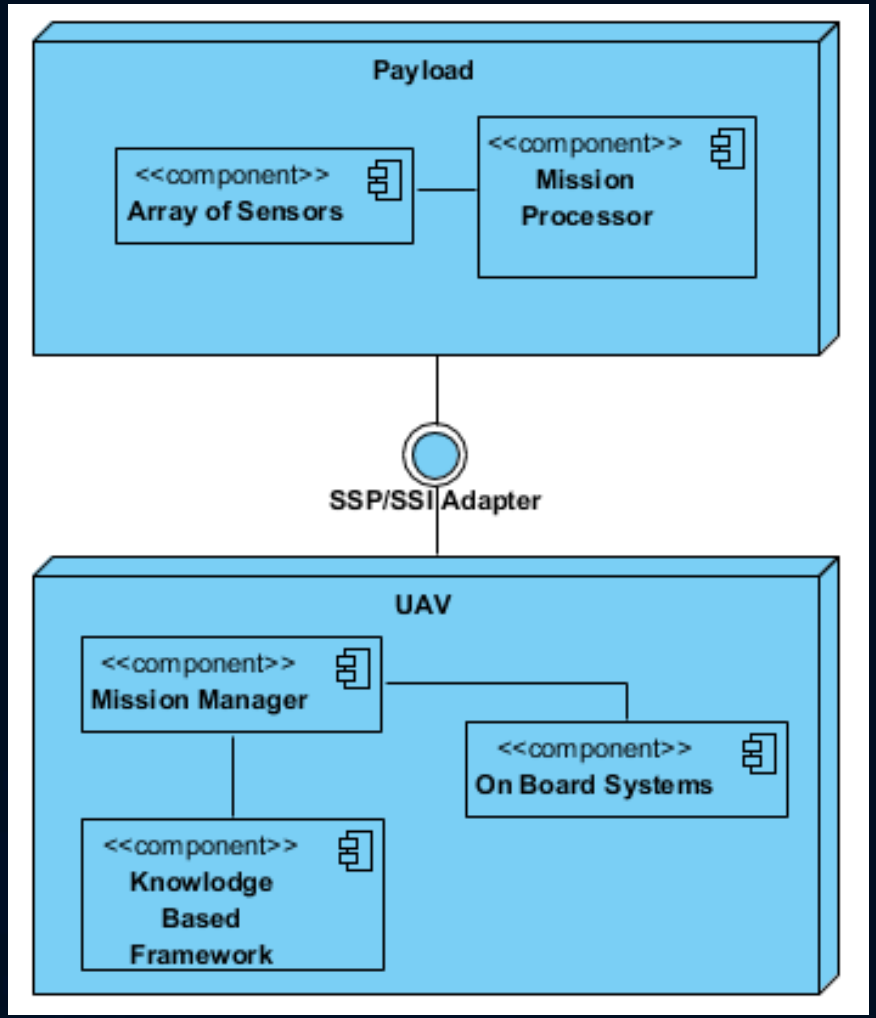


[Okutani, K., Yoshida, T., Nakamura, K., Nakadai, K. "Outdoor auditory scene analysis using a moving microphone array embedded in a quadrocopter," in Intelligent Robots and Systems (IROS), 2012 IEEE/RSJ International Conference on. IEEE, 2012, pp. 3288–3293]

MOSA framework

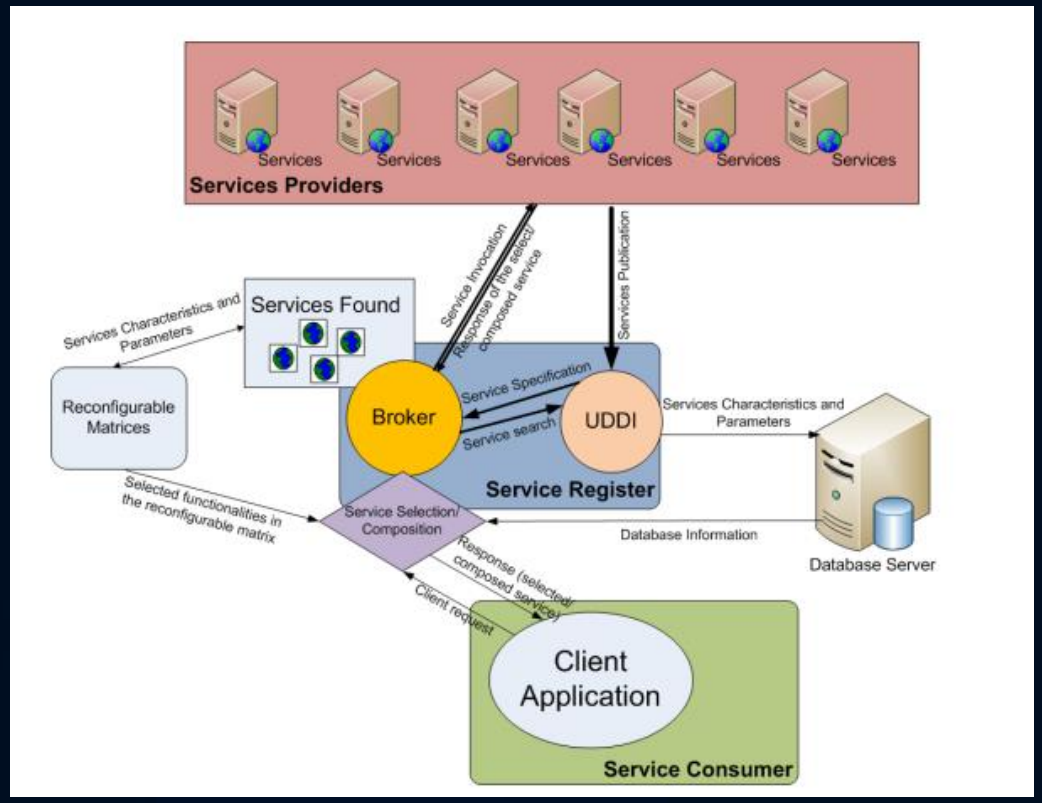
MOSA framework

- Allows decoupling between Mission and UAV
- Addresses mission changing on-the-fly
- Use within an UAV
- Intended for localized use
- Can manage different sensors
- Evaluate mission feasibility
- SOA based



MOSA framework

- Knowledge Base Framework is key to address mission changings
- Adds knowledge about domain application
- Allows mission designer to select the best service offered base on criteria

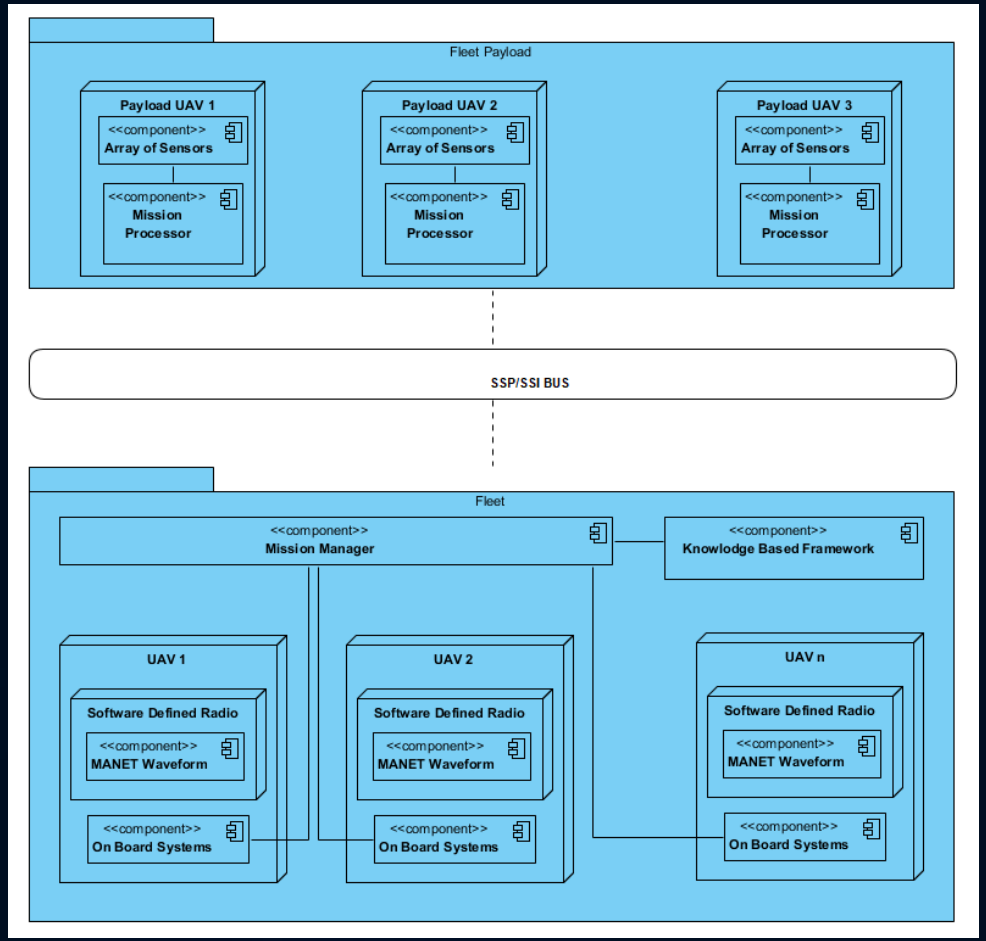


Source: MOSA – Mission Oriented Sensor Array: A Proposal. Pires *et al*

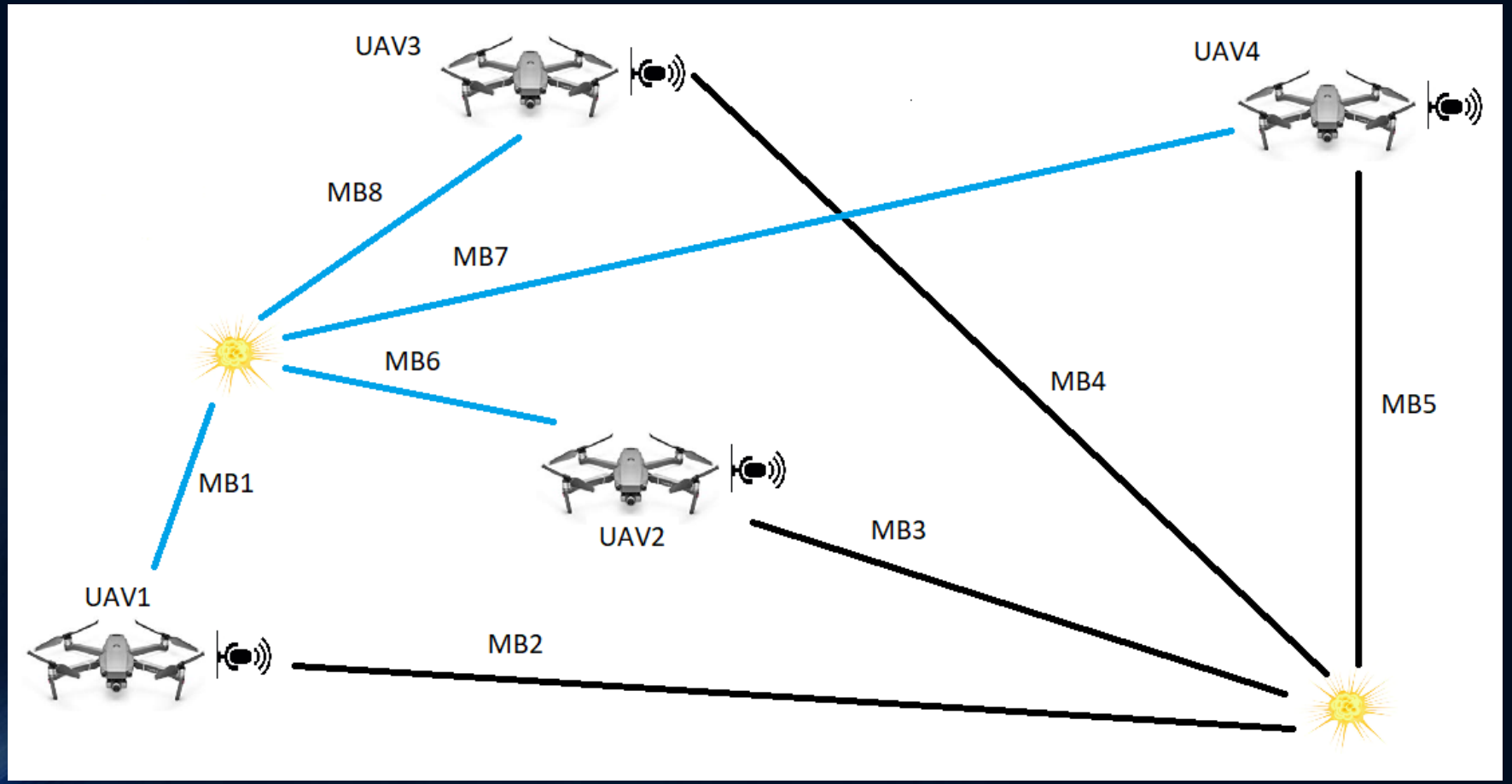
Mobile Surveillance Network Proposal

System Architecture

- All sensors available must be considered
- MOSA must be extended to operate distributed
- MOSA can demand route changing
- Payload and Mission Manager communicates through a bus stablished using MANET



Running into an event



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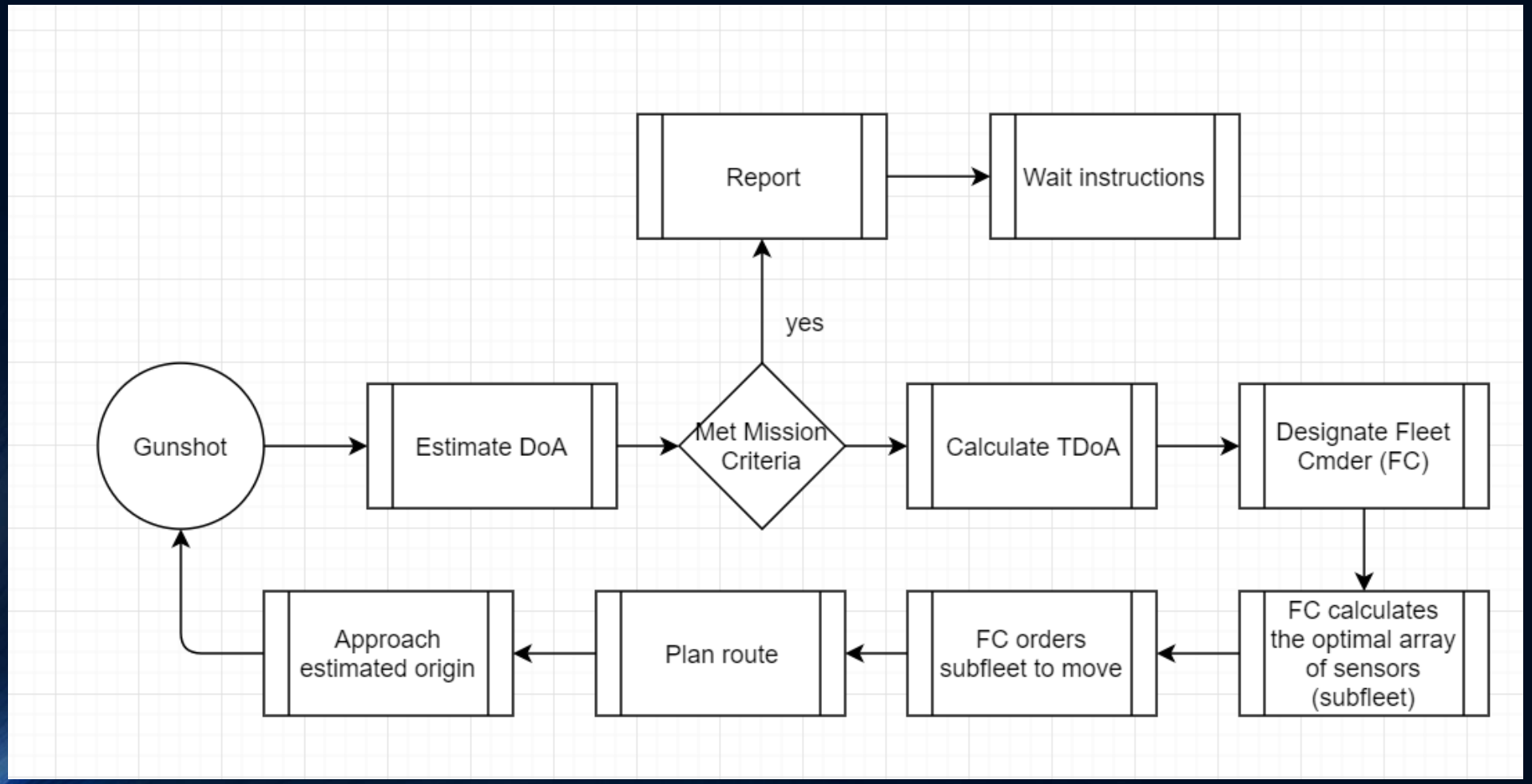
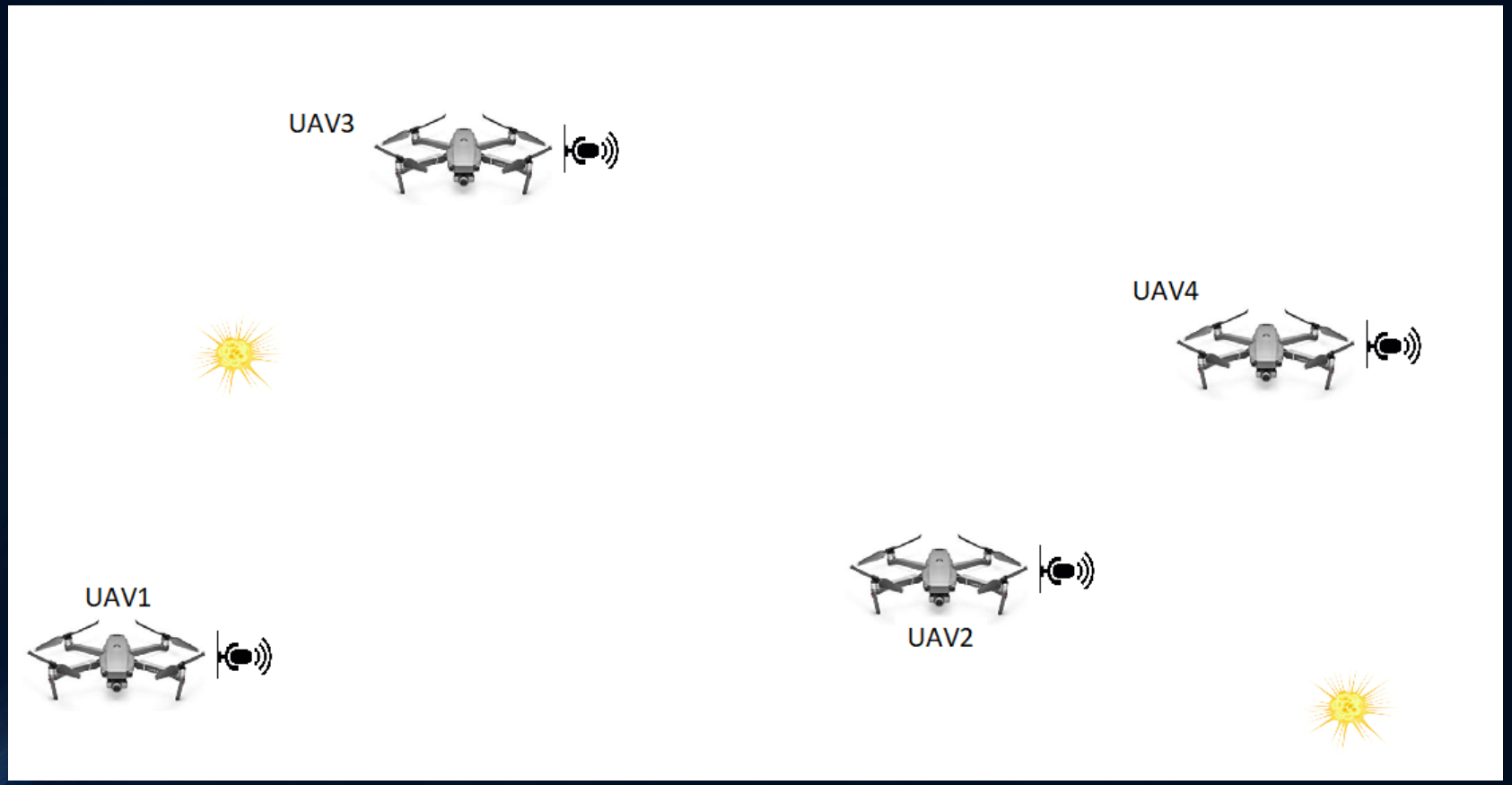


Running into an event



Running into an event

- As only part of the fleet should be mobilized, more then one simultaneous event could be verified
- Some communications issues must be considered
  - Network must be self-organized
  - Communication should be secure and robust (is a military application)
  - Communications must be reconfigurable on-the-fly. So, an SDR useful
  - MOSA will also control de communications parameters

Benefits

- Covers a larger area
- Could address multiples simultaneous events
- Could improve precision due to use of more sensors
- Number of sensors employed could be adjusted as needed
- Range o detection is far greater

Conclusion

- Using a fleet of UAV to make DoA of a gunshot demands turn MOSA distributed
- The MSN enhance the situational awareness of Brazilian Defense System
- MSN could be applied in other environments, but the DoA algo must be correctly adjusted
- MSN could be enlarged or diminished on-the-fly. MANET is a key here

Future Works

- Simulate the MSN
- Expand the MSN to use multiple sensors types, allowing different mission to be accomplished by the same MSN
- Improve MOSA with AI algo, allowing an optimal resource allocation with heterogeneous array of sensors
- Test it

Questions?

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