TÉCNICO LISBOA

LoRa Networking In Mobile Scenarios Using UAV Gateways

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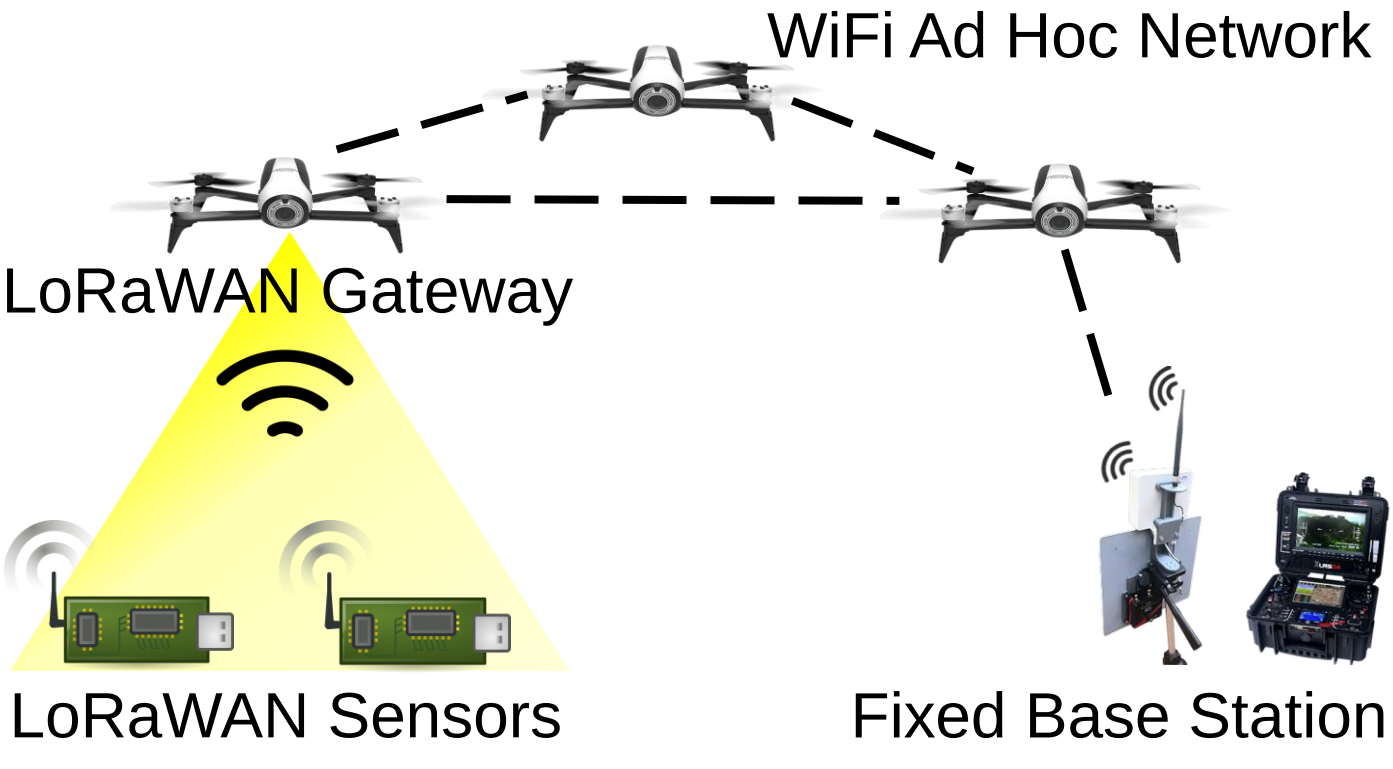
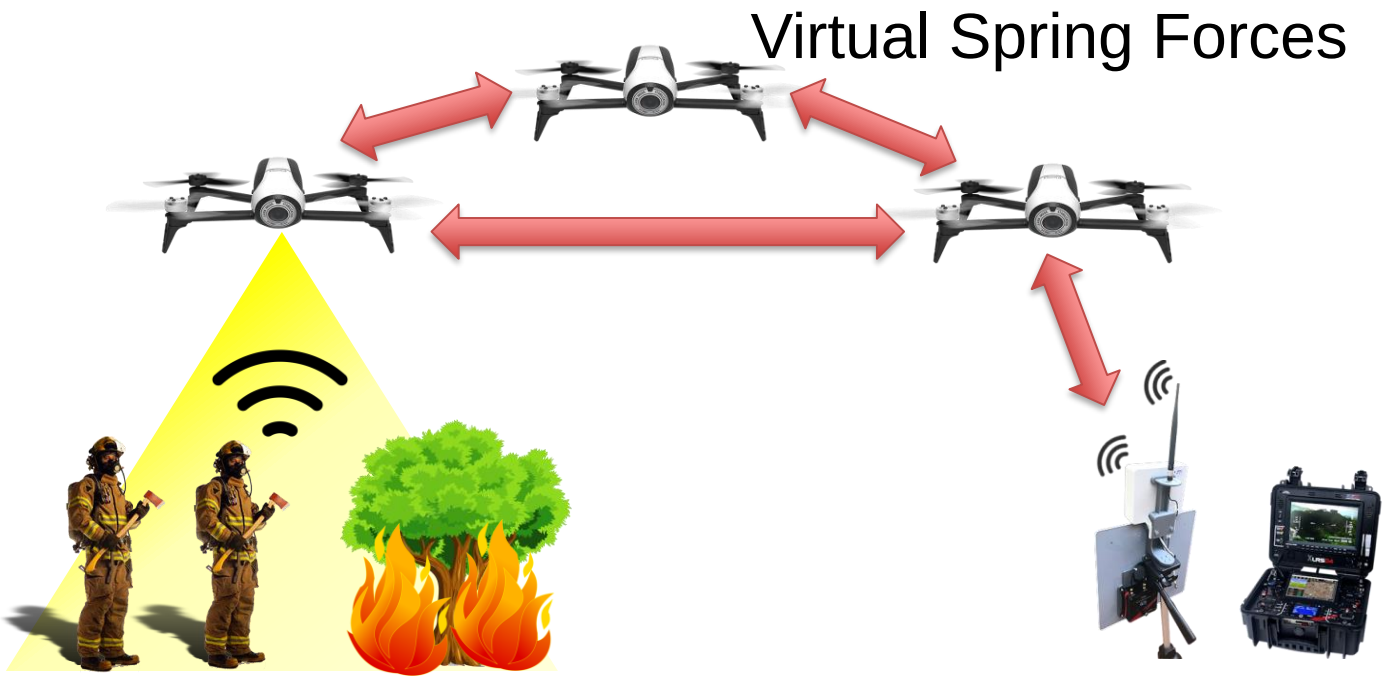
Outline

- Introduction
- UAV Mobility Algorithm
- Simulation Model
- Results
- Conclusions and Future Work

Problem Description



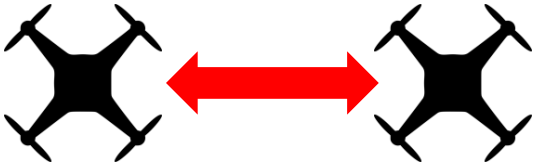
Contributions



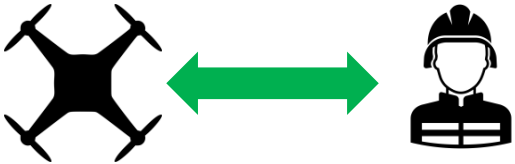
Rescuers in Wildfire Scenario

Related Work: DF Algorithm

- Comparison with DF spring forces algorithm proposed by Di Felice et al.
- Weights of forces assigned differently

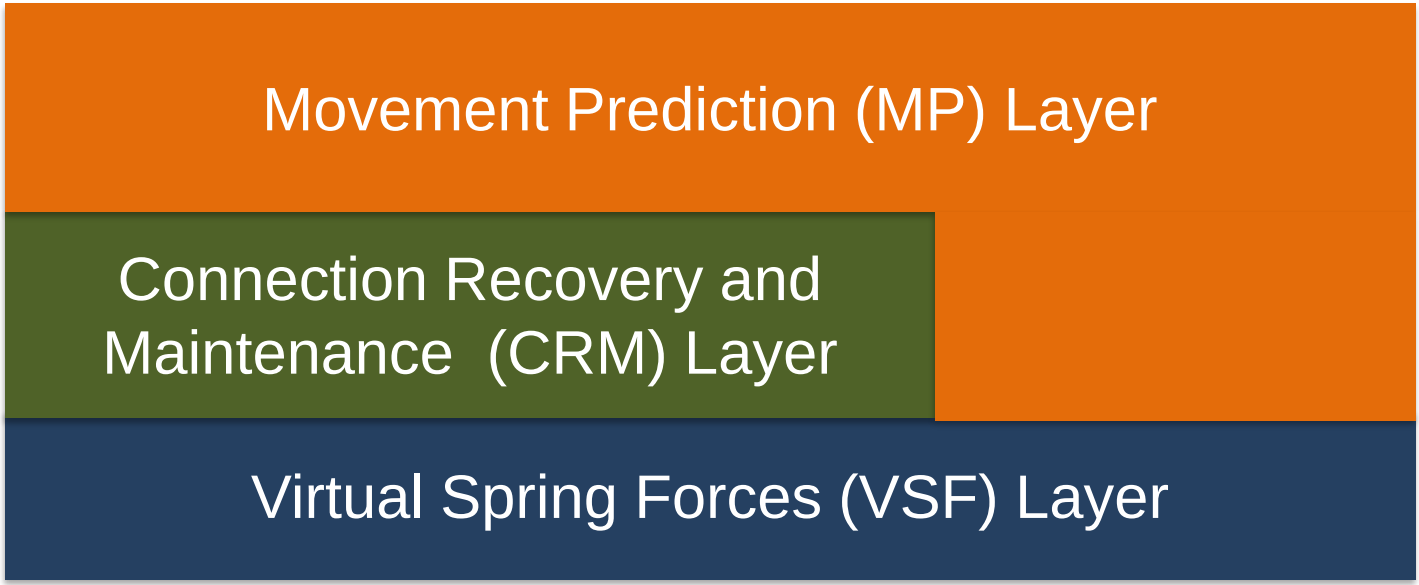


Fixed Weight



$$k_{AtG} = \frac{n_i}{\max(n_j)\forall j \in Neigh_i}$$

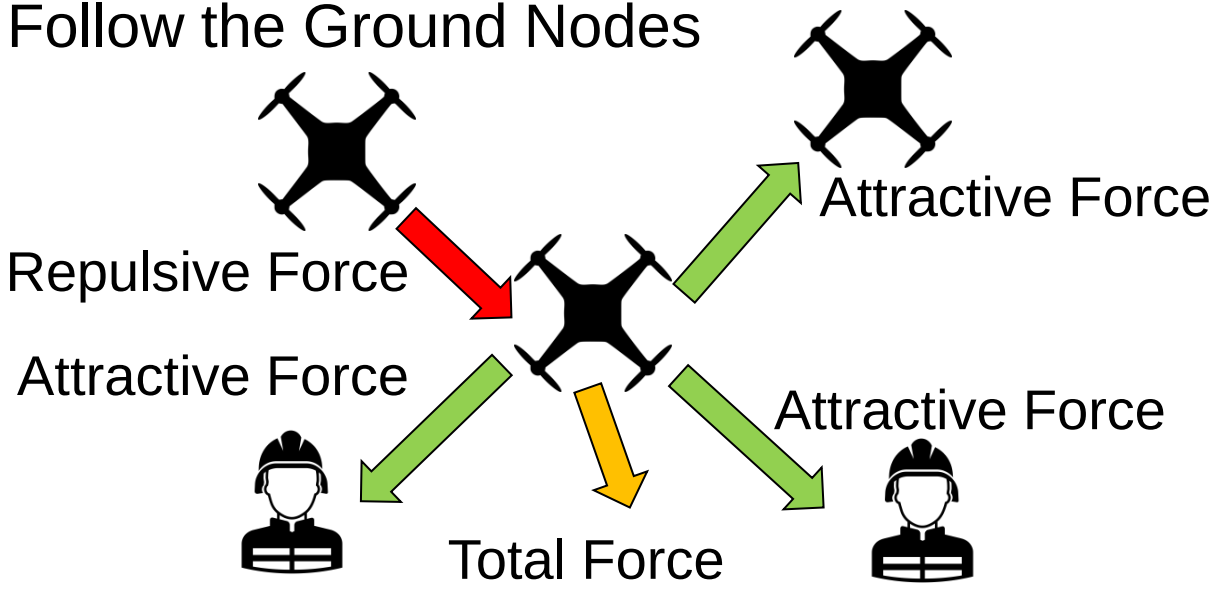
Layers of the algorithm



VSF Layer (1)

Objectives

- Avoid collisions, limit disconnections of drones
- Follow the Ground Nodes

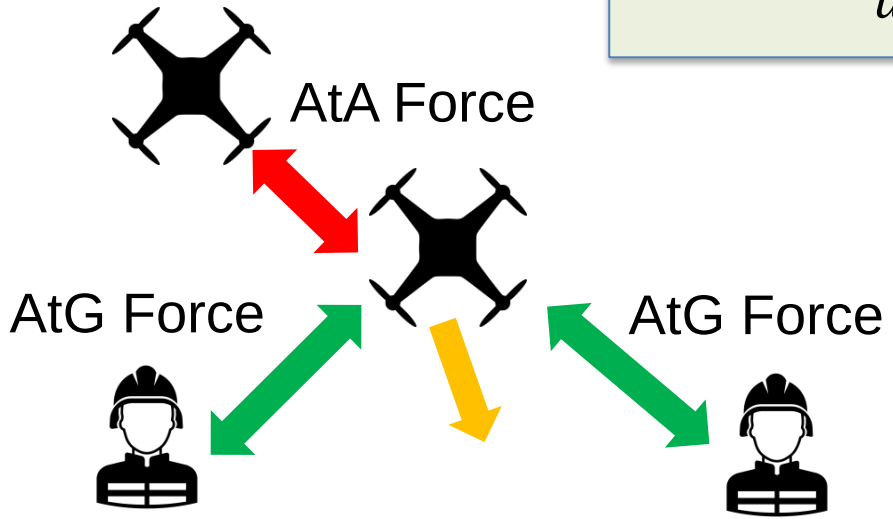


VSF Layer (2)

$$\vec{F} = K \cdot (LB_{ij} - LB_{req})$$

$$K_{AtA} = K_p \left(\frac{N_{neighs}^{max}}{n_{neighs}} \right)$$

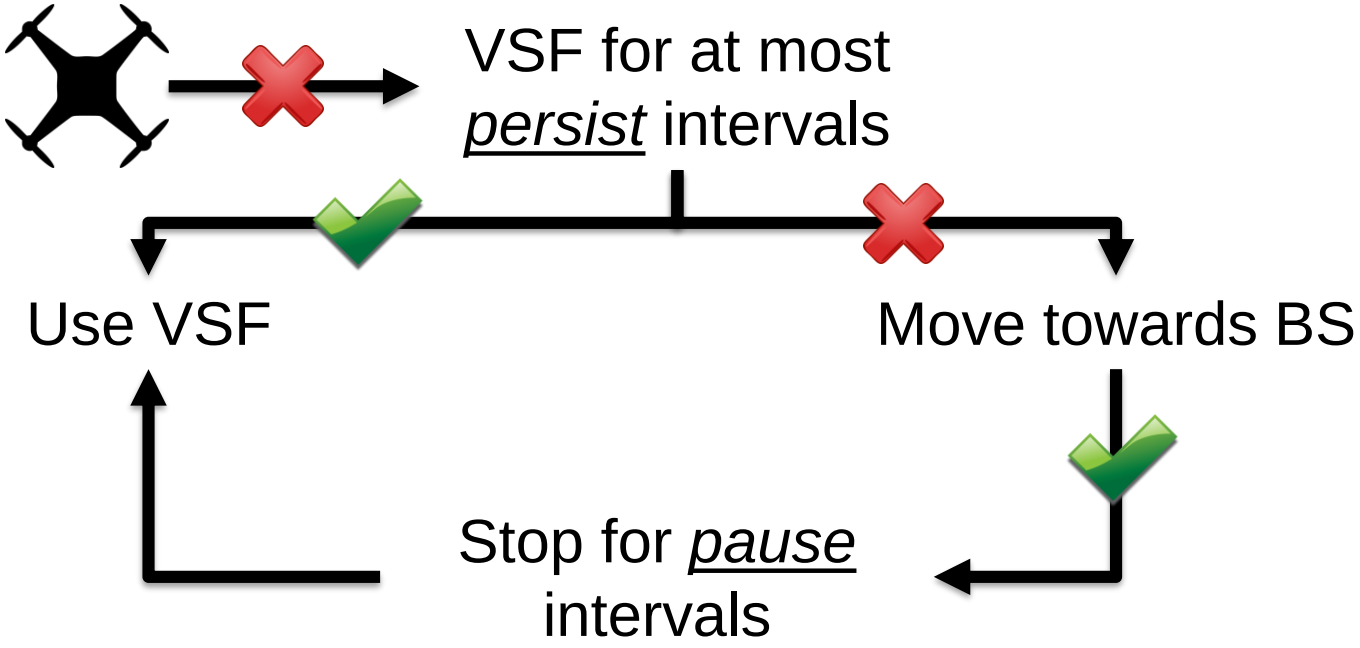
$$K_{AtG} = \frac{u_{max}}{u_j}$$



CRM Layer (1)

Problem		Solution
Isolation of drones	→	Move towards BS
Avoid further disconnections	→	Limit mobility of drones closer to BS
Preserve coverage of GNs	→	Allow short disconnections
Better drone distribution	→	Exploit redundant drones

CRM Layer (2)


VSF for at most *persist* intervals
Use VSF
Move towards BS
Stop for *pause* intervals

MP Layer (1)

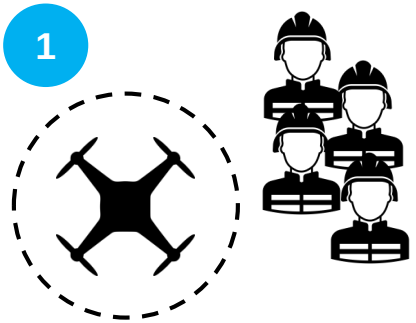
Objective

- Recover isolated Ground Nodes

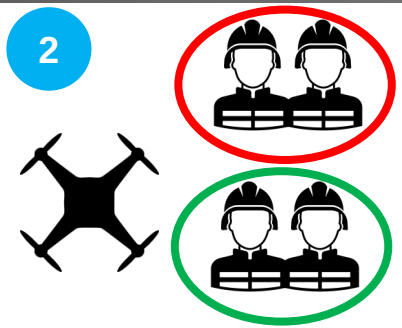
Metodology

- k-means + silhouette
- Prediction, kinematic equations
- Virtual Forces

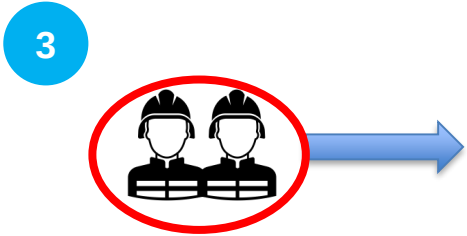
MP Layer (2)



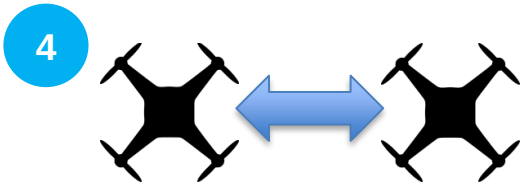
Track lost GNs



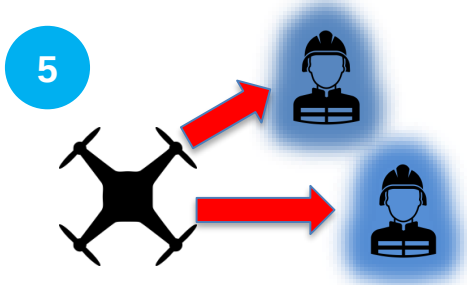
Create clusters



Estimate velocity



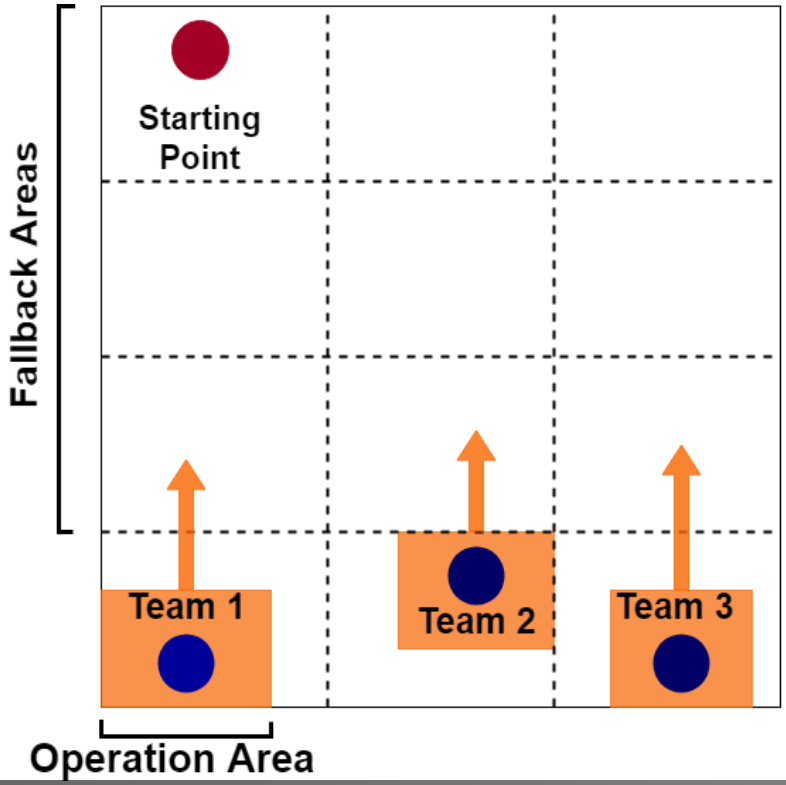
Send information to other drones



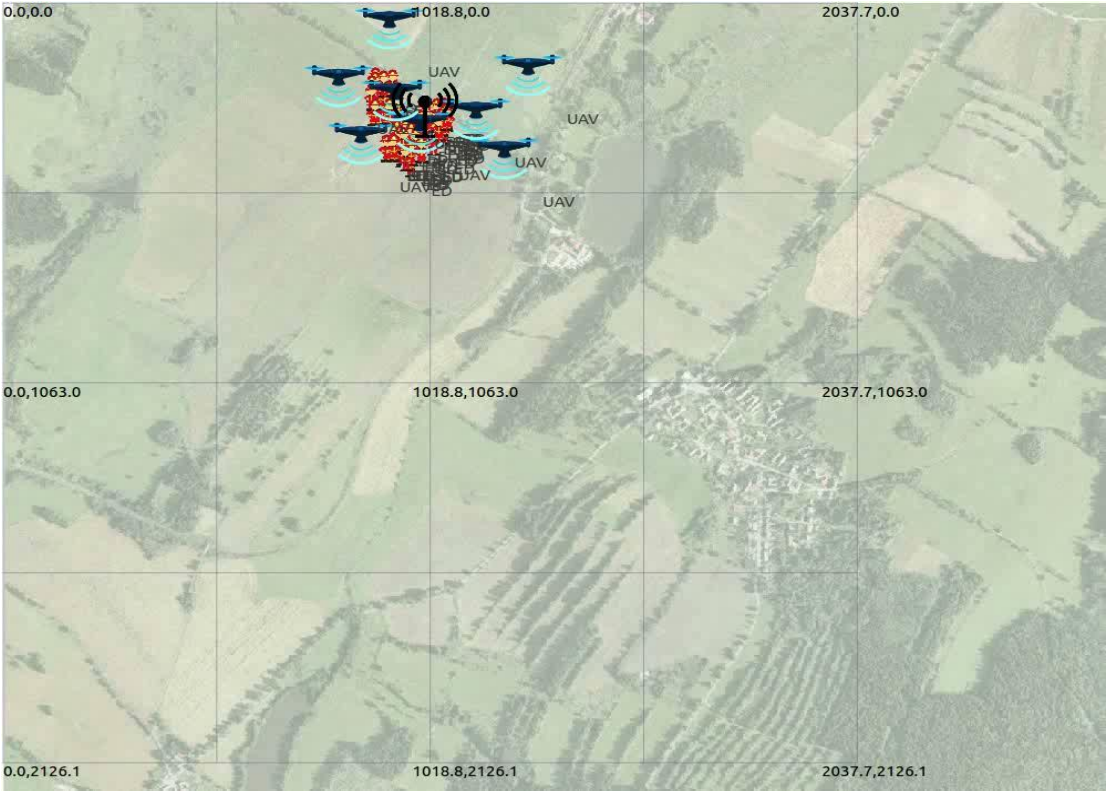
Create holograms, Generate forces

Simulation Model

- New ns-3 *loravsf* module
- New mobility model of rescuers based on teams



Simulation Example

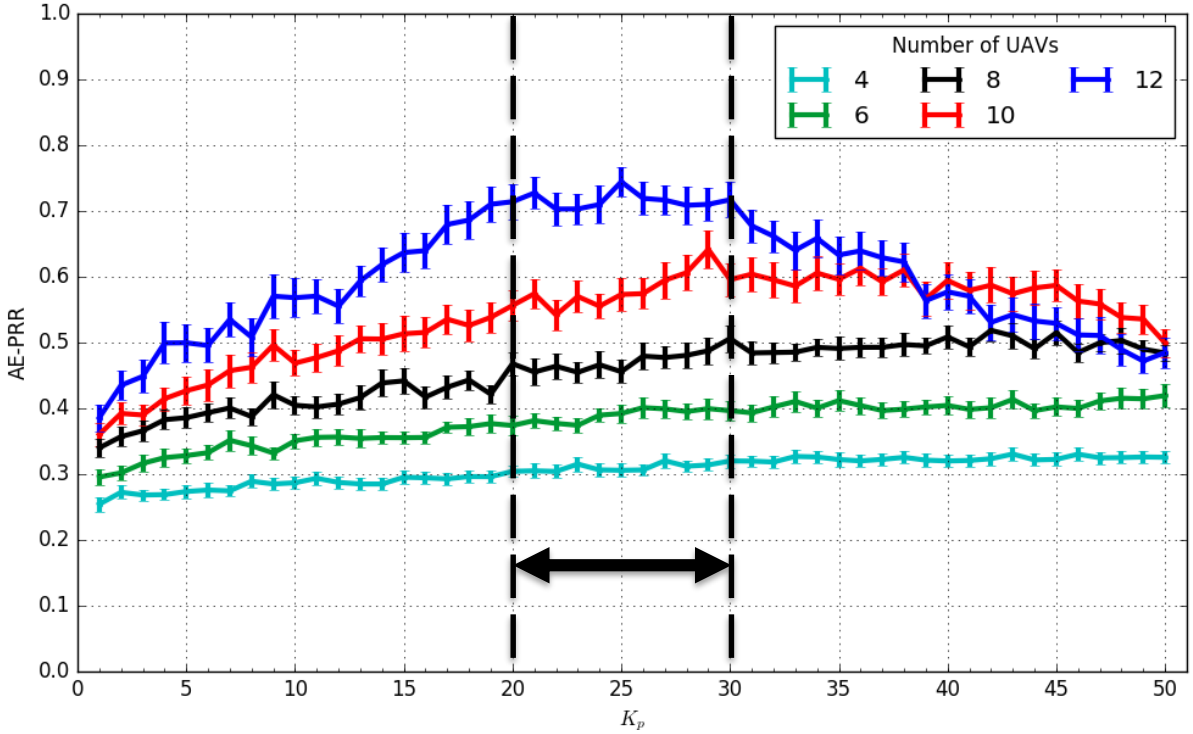


Simulation Parameters

LoRa Spreading Factor	7
Packet Size	10 bytes
Packet Period	30 s
Number of Teams	1-5
Units Per Team	20
Number of Drones	4-6-8-10-12
Simulation Time	2000 / 3000 s
Simulation Area (m^2)	2000x2000 / 2500x2500

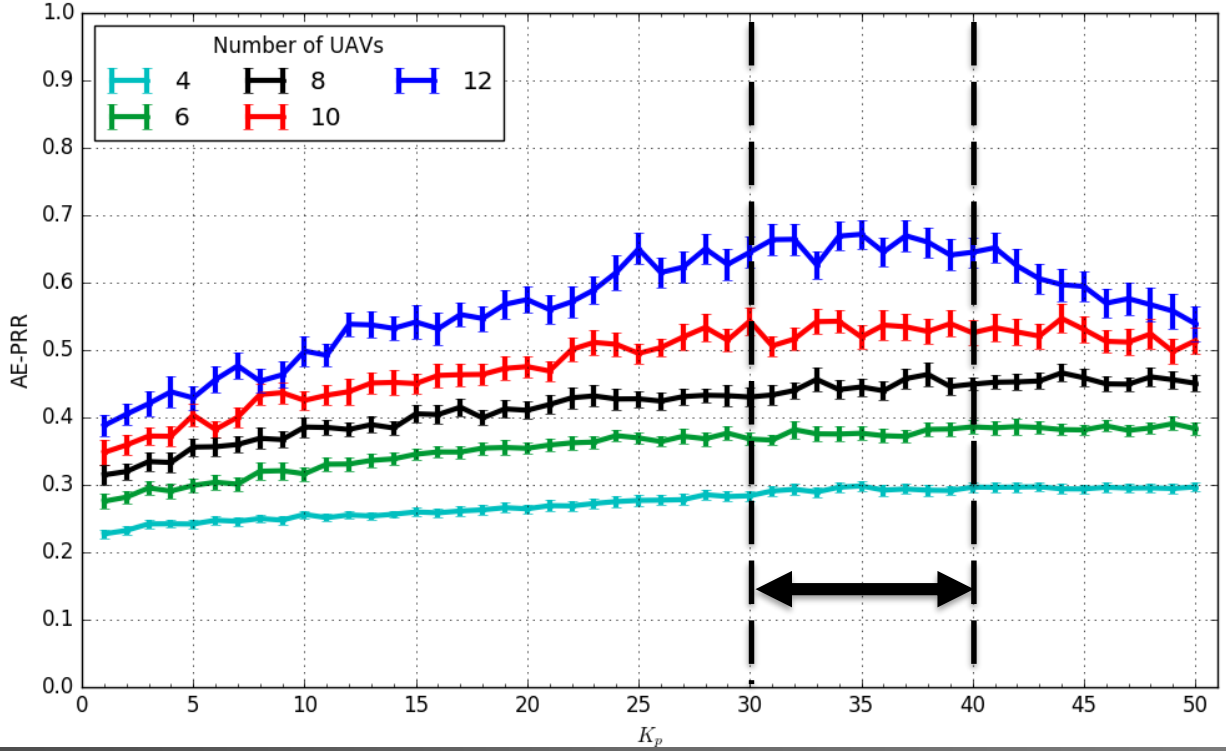
Impact of K_p on PRR (1)

3 Teams of 20 GNs



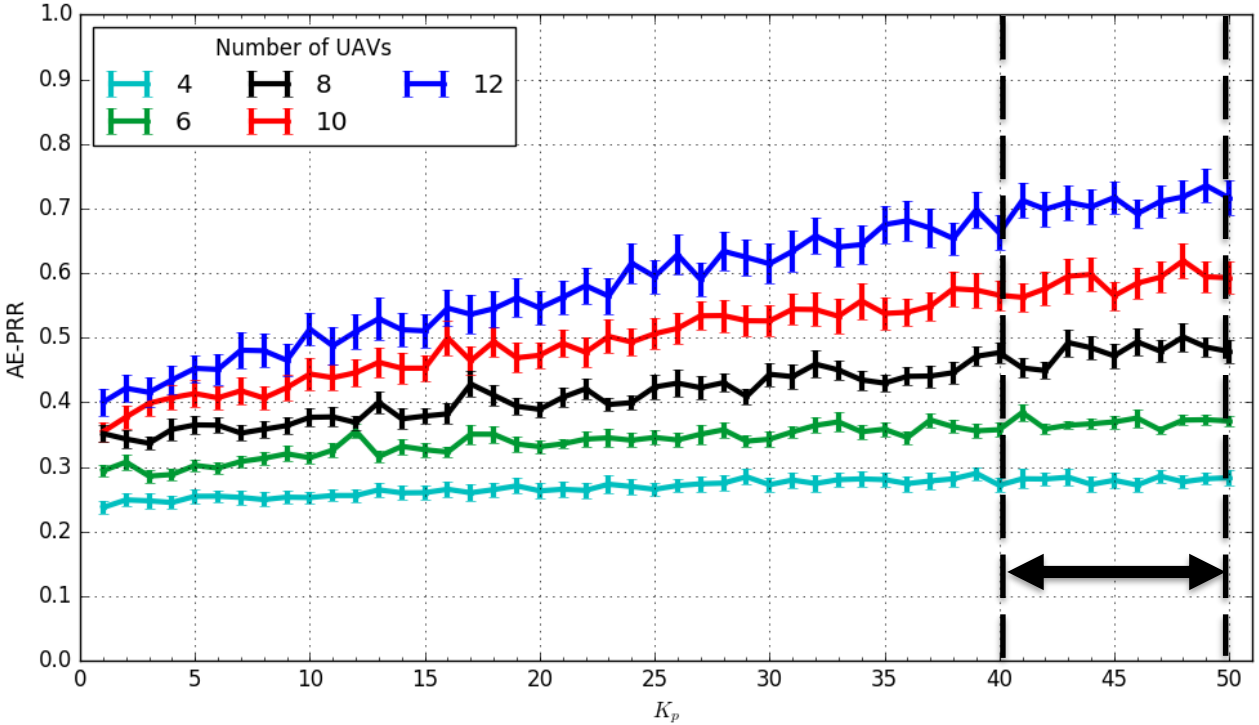
Impact of K_p on PRR (2)

5 Teams of 20 GNs



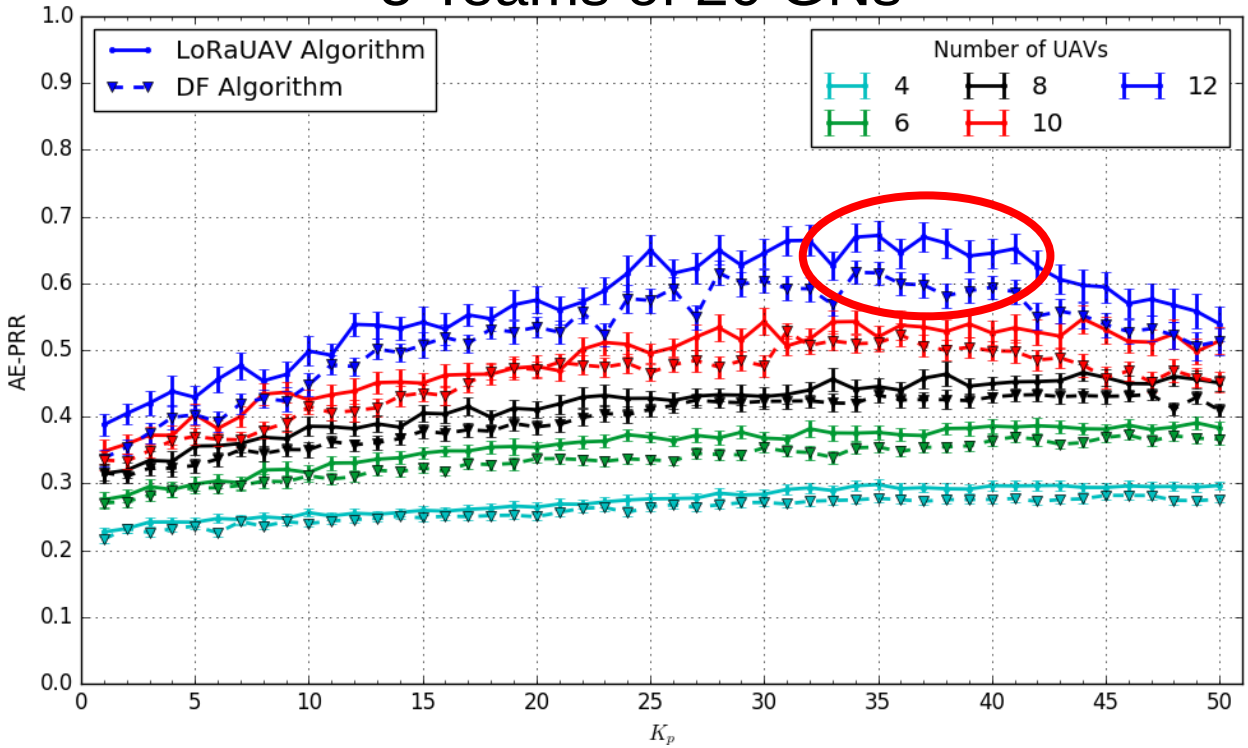
Impact of K_p on PRR (3)

3 Teams of 40 GNs



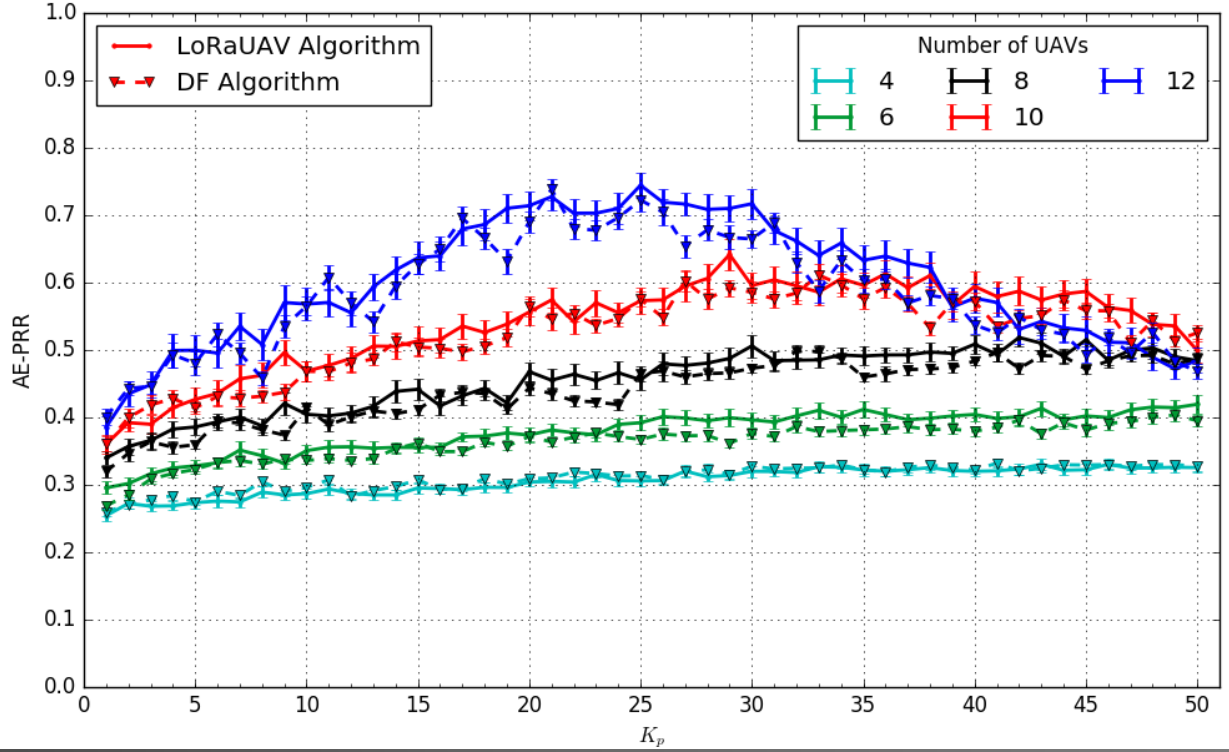
LoRaUAV VSF vs DF VSF (1)

5 Teams of 20 GNs



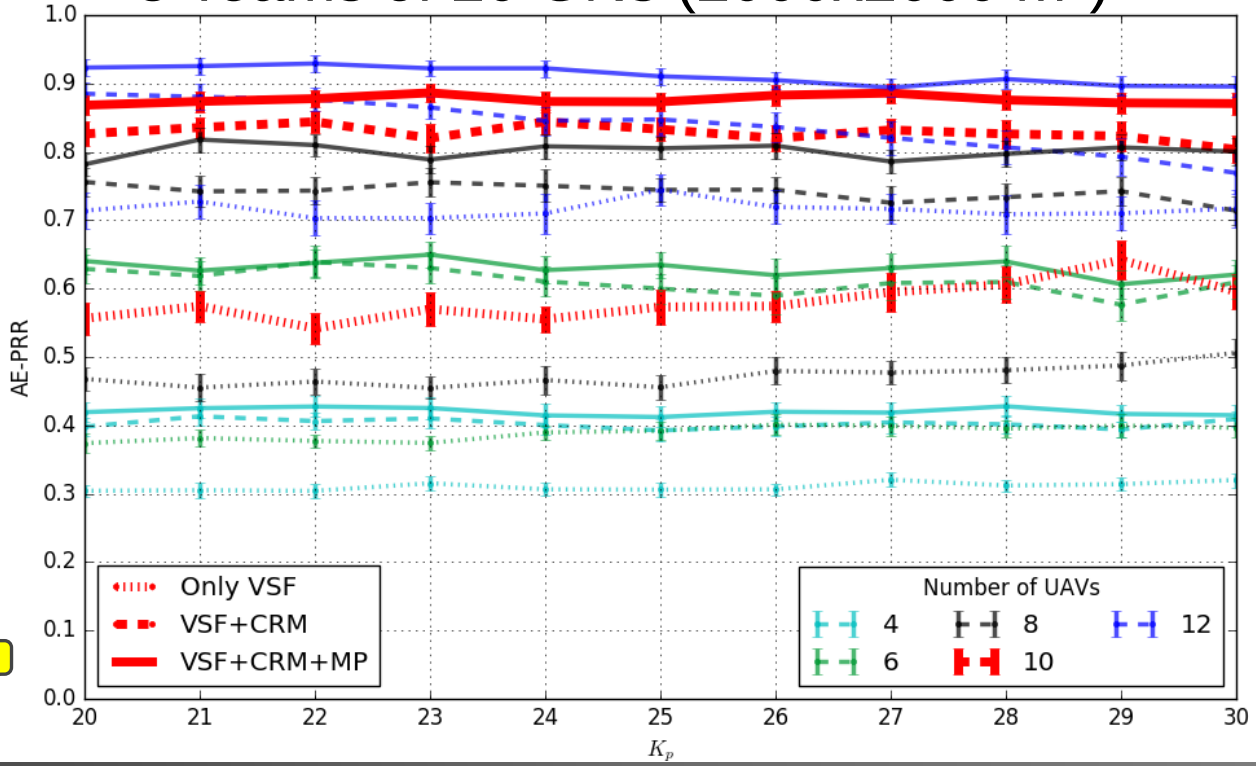
LoRaUAV VSF vs DF VSF (2)

3 Teams of 20 GNs

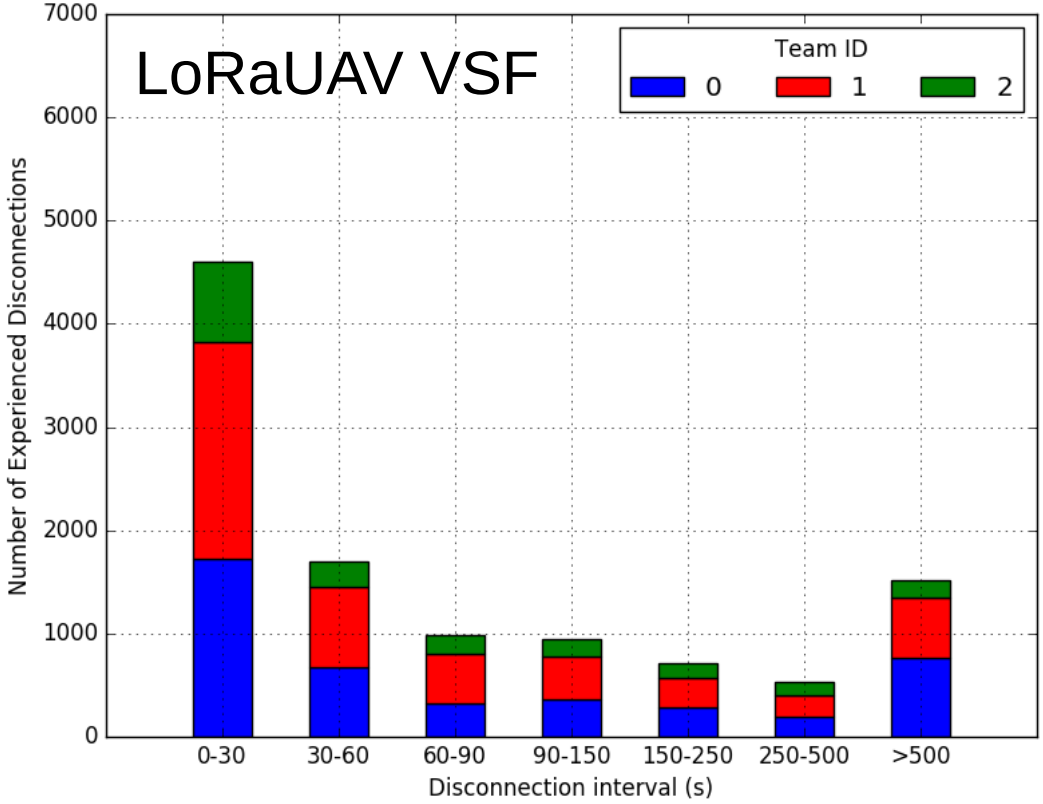


Impact of CRM and MP on PRR

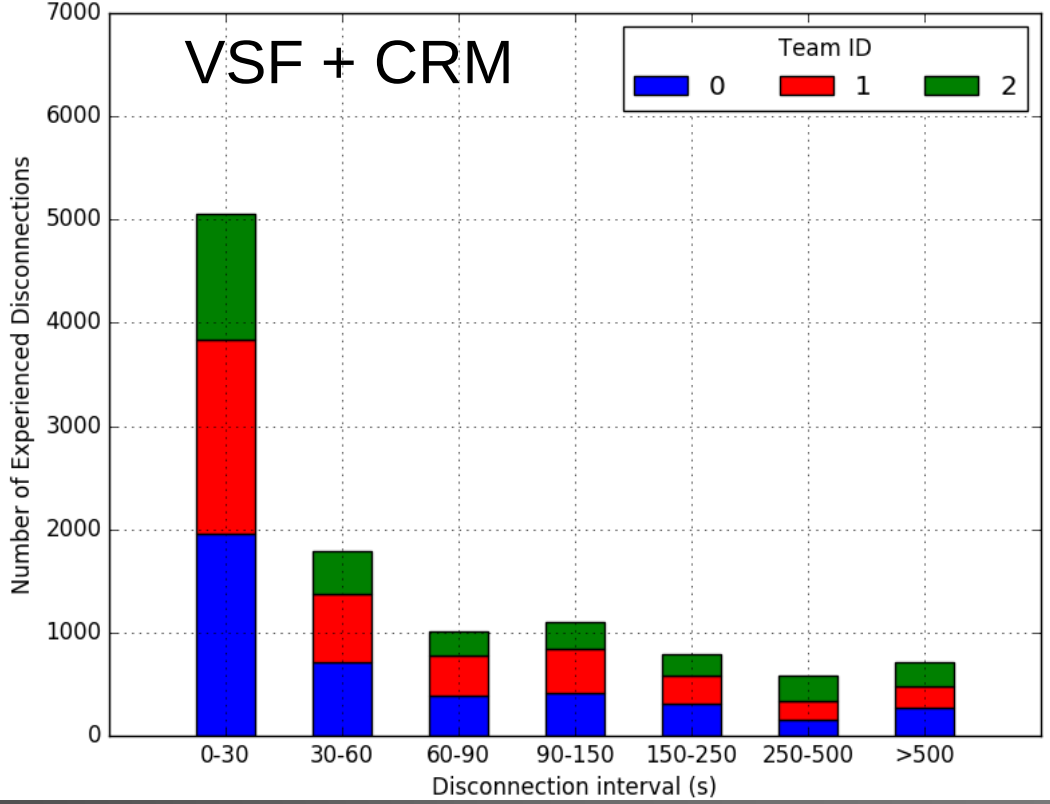
3 Teams of 20 GNs (2000x2000 m^2)



Disconnections Analysis (1)



Disconnections Analysis (2)



Conclusions and Future Work

- **The developed VSF layer**
  - Effectively pursues ground nodes coverage
  - Slightly outperform DF algorithm in PRR
- **The addition of CRM and MP**
  - Significantly increases the average PRR
  - Reduces isolation of Ground Nodes

Future developments

- More realistic mobility model of drones
- Hybrid centralized-distributed approach
- K_p optimization routine