Coordenação de Veículos Aéreos não Tripulados e Redes de Sensores Sem Fio para Aplicações de Monitoramento

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Outline

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Introduction

Surveillance system

- Integrated use of mobile and static sensor nodes
- Complementary features:

  Static nodes: simple (low-end), very cheap, massive deployment, basic sensing

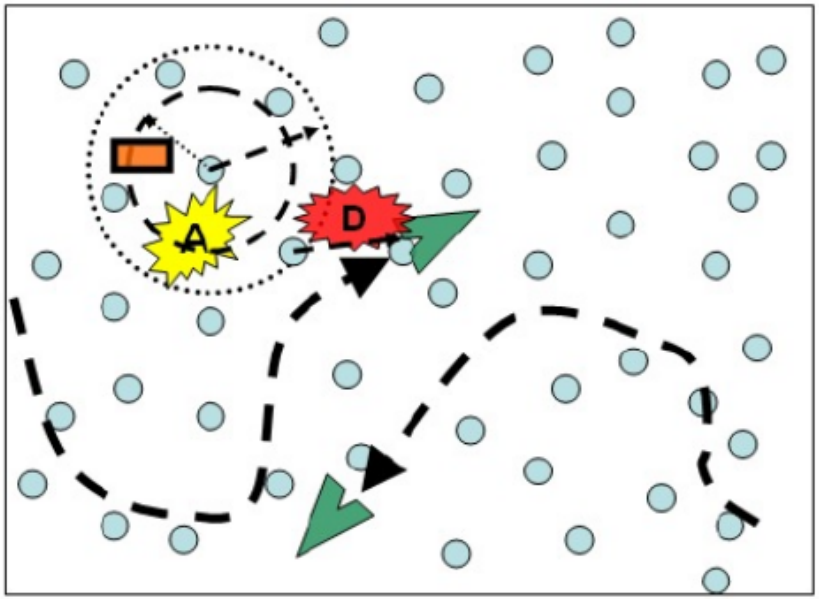
  Mobile sensors: sophisticated (high-end), expensive, advanced sensing, mobility

Introduction

Coordination

How to provide coordination among these heterogeneous nodes

- Static sensors trigger the displacement of the mobile ones
- Mobile nodes (UAVs) react and realize a more detailed detection, providing semantically rich data



This work presents a delivery method of the alarms to the mobile nodes

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Related Work

***AWARE* project (1):** Integration of ground with mobile (UAVs) for surveillance. Division of the network in hexagonal cells. Alarms forwarded to center then to destinations.

Message dissemination in multi-level WSN (2): composed by static and mobile sensors on the ground and UAVs moving in the air. Their approach is based on the epidemic routing concept. Investigate the adaptation of the forwarding decision according to neighborhood

Divide and conquer solution (3): surveillance of large areas, static sensors in selected regions, mobile sensors move around. Focus: analyze the nodes' distribution to increase coverage

Mobile sink proposals (4,5): Handle the problem of mobile sinks in WSNs

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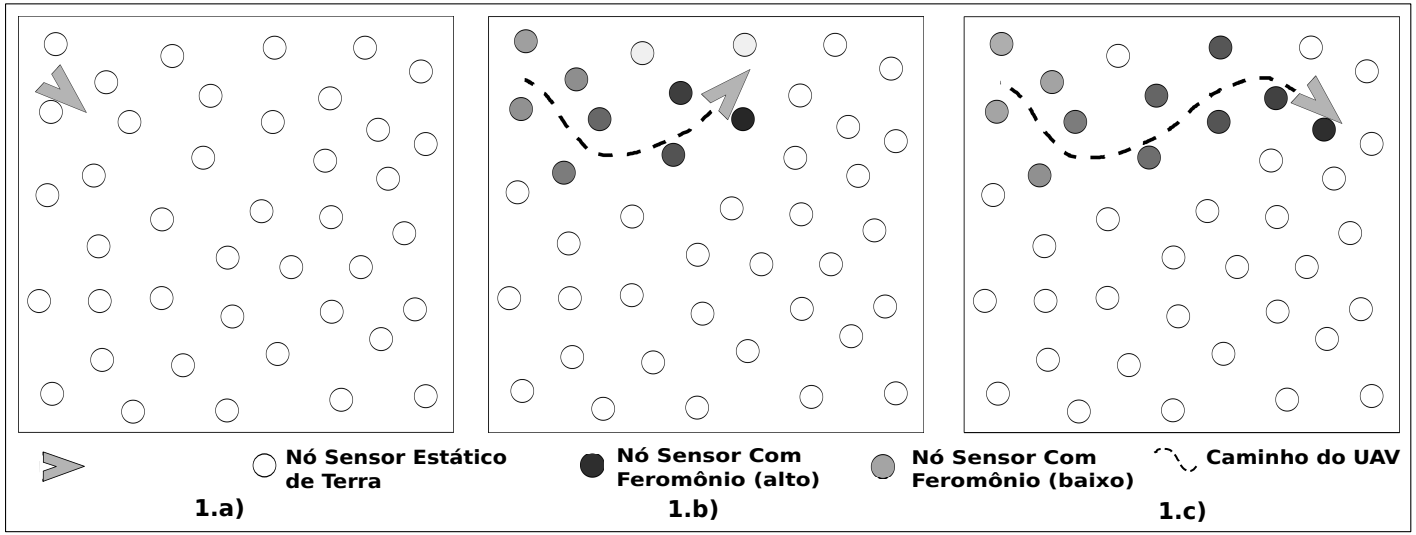
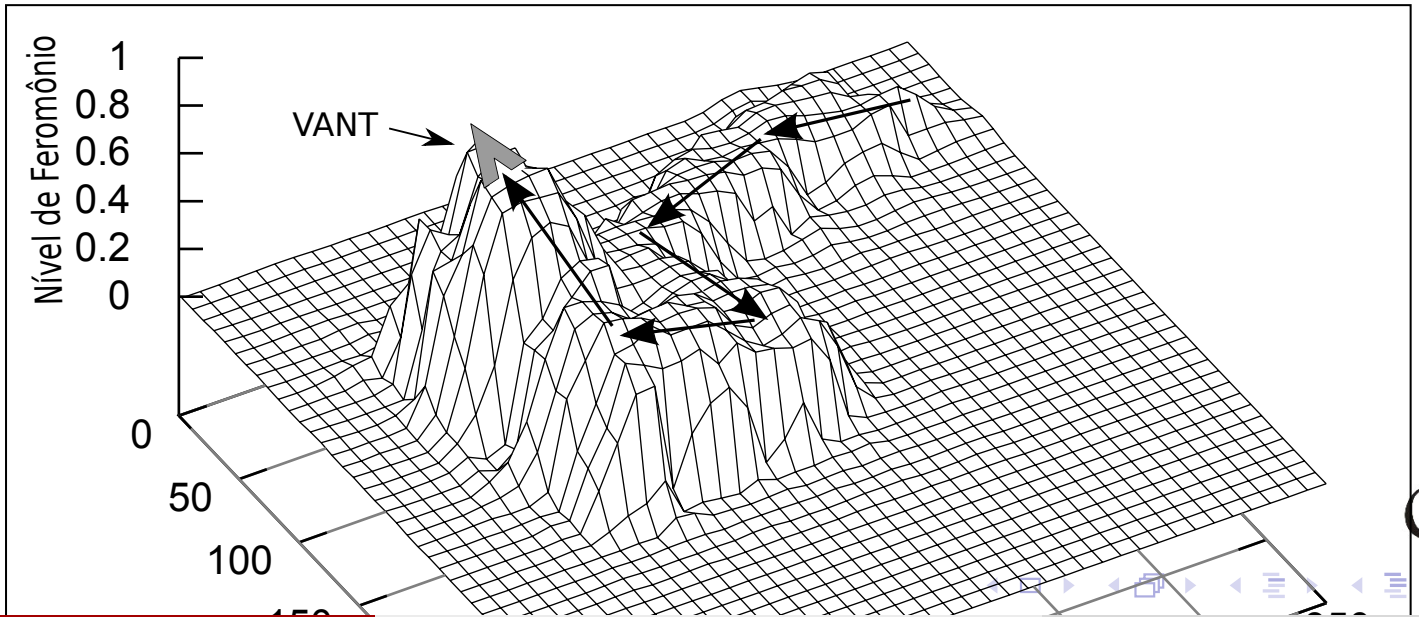
Pheromone based alarm delivery

Pheromone distribution mechanism





Pheromone based alarm delivery

Pheromone distribution mechanism

- Pheromone has spacial and temporal information (related to the beacon): "distance" from UAV and timestamp.
- Pheromone evaporates: $C_p(t+1) = C_p(t) \times r | r \in [0,1]$

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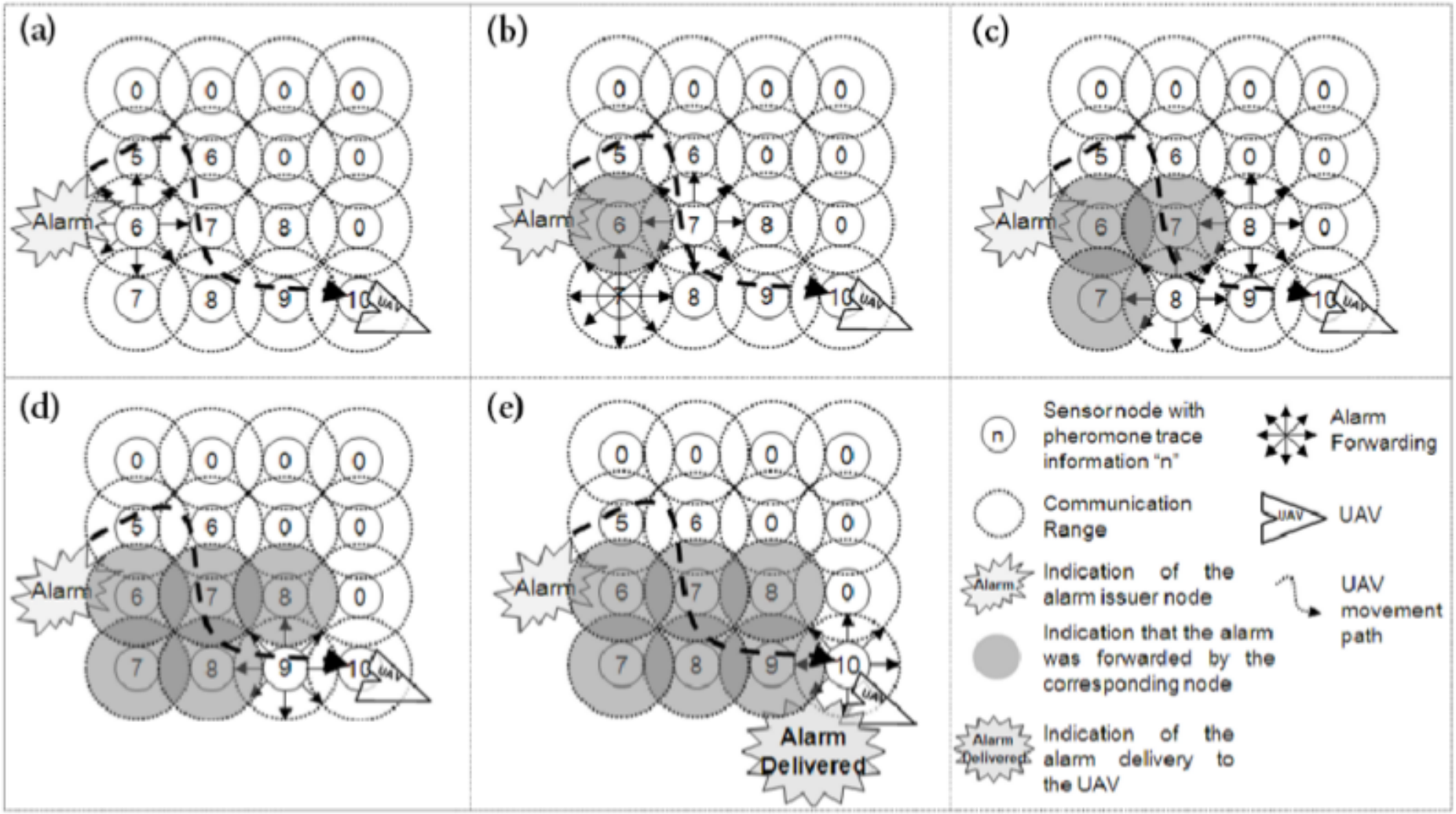
Pheromone based alarm delivery

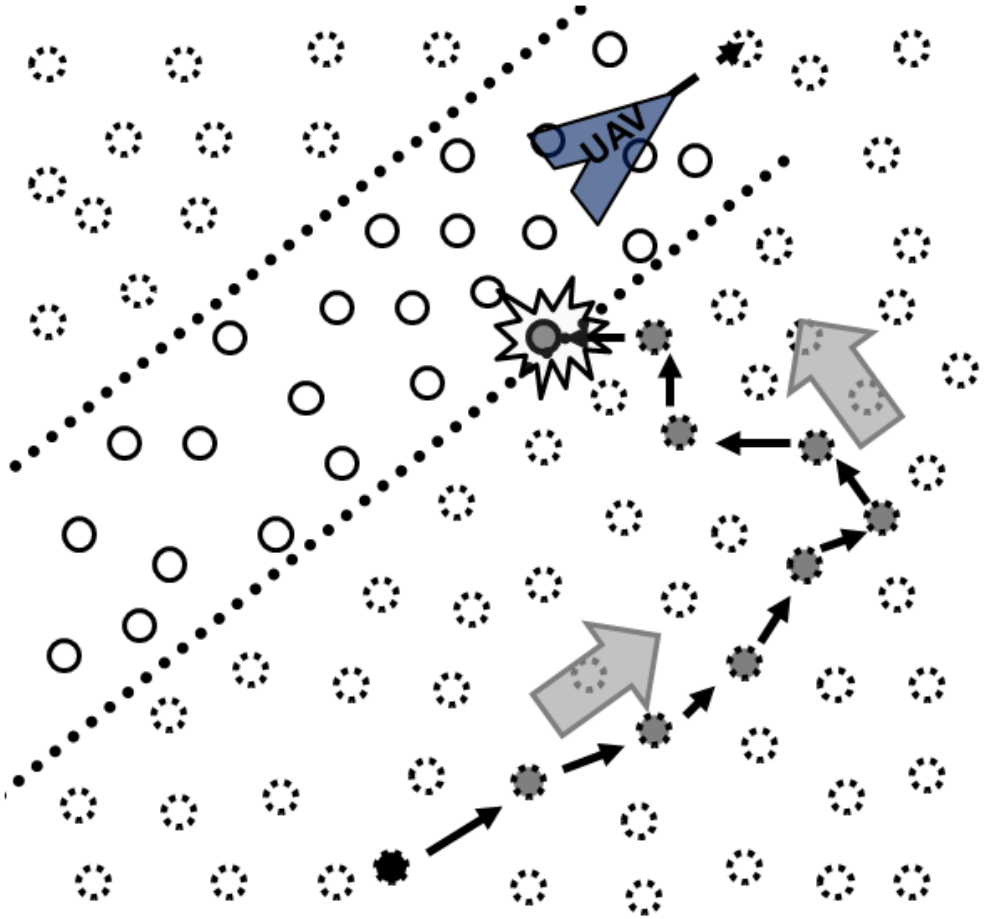
Trail following mechanism

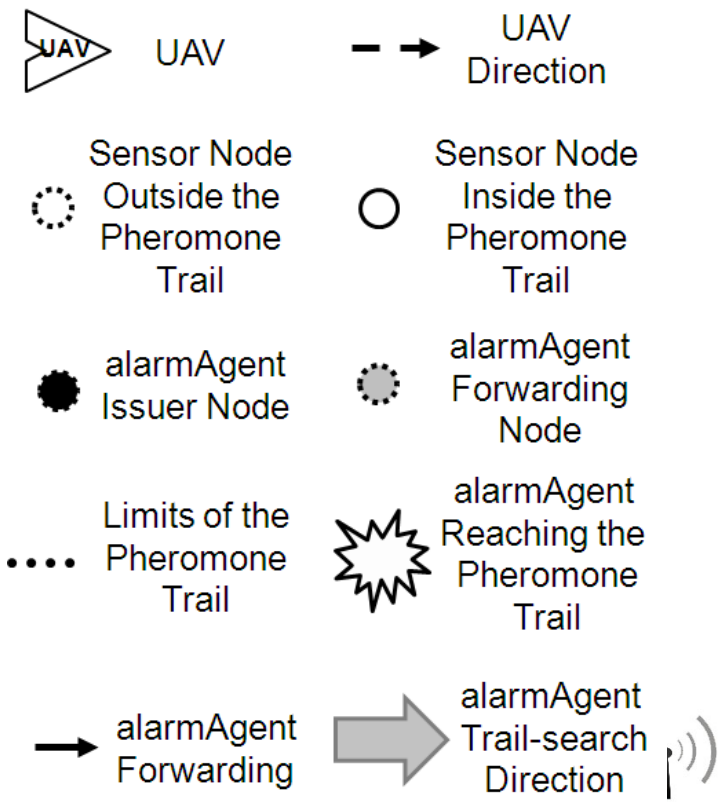


Pheromone based alarm delivery

Trail search mechanism

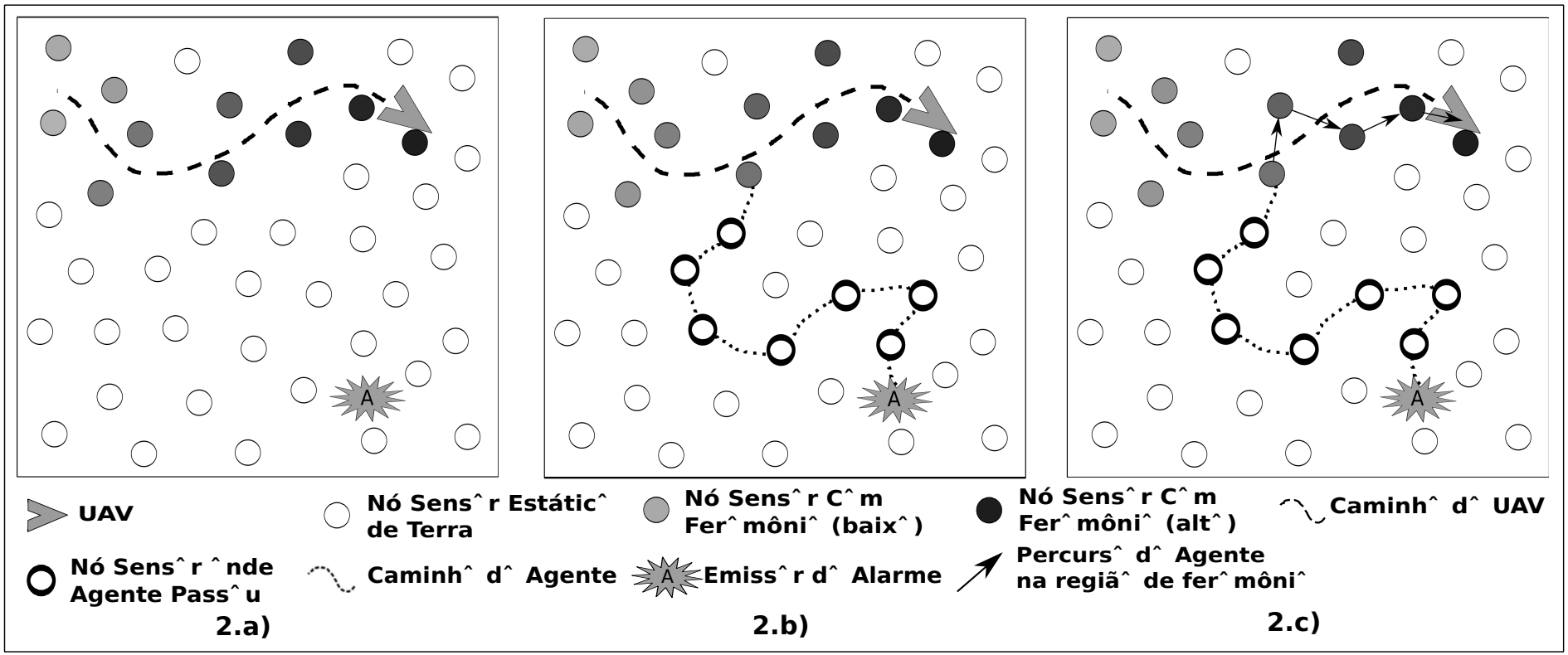
Alarm maybe issued by nodes outside trails!





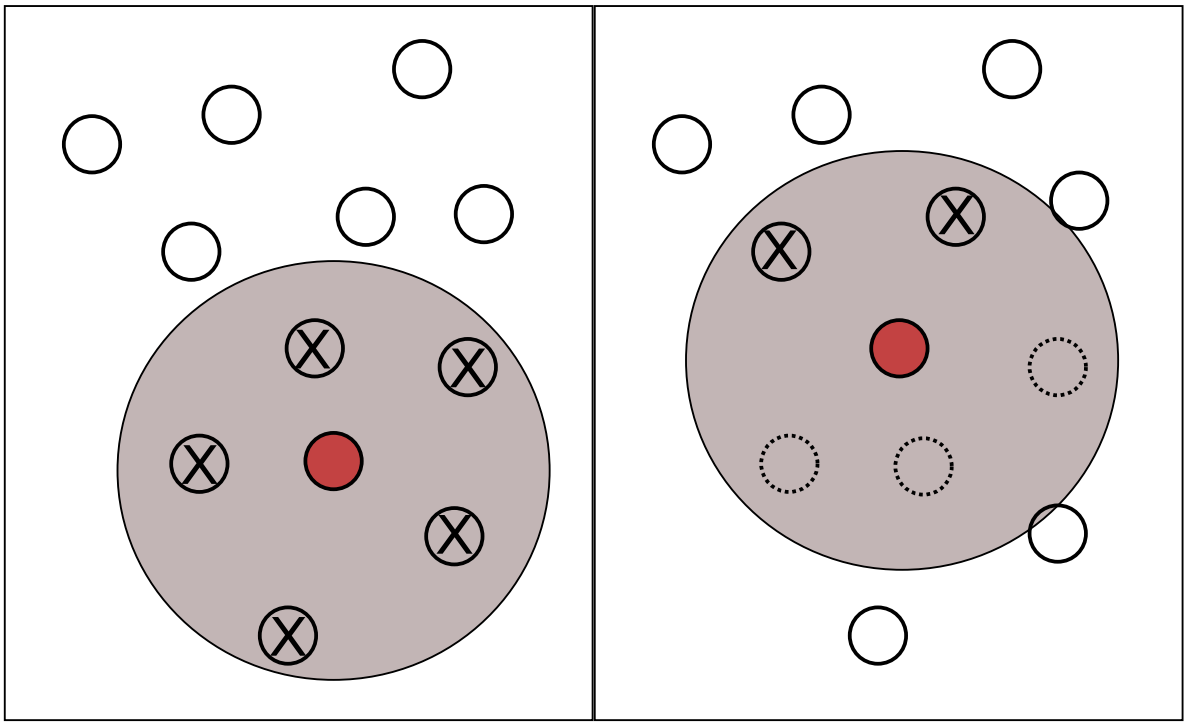
Pheromone based alarm delivery

Trail search mechanism



Pheromone based alarm delivery

Trail search mechanism



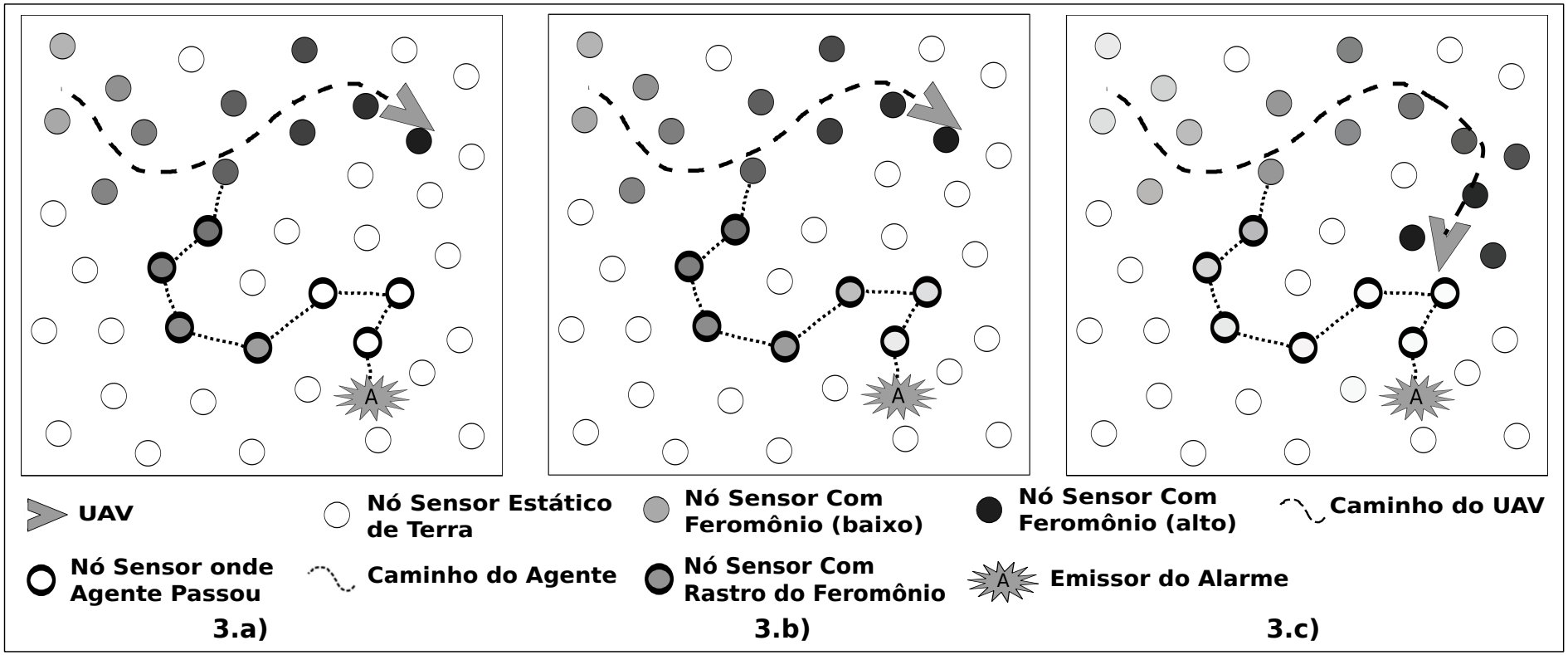
Node with agent

Candidate as next hop

Eliminated for next hop selection

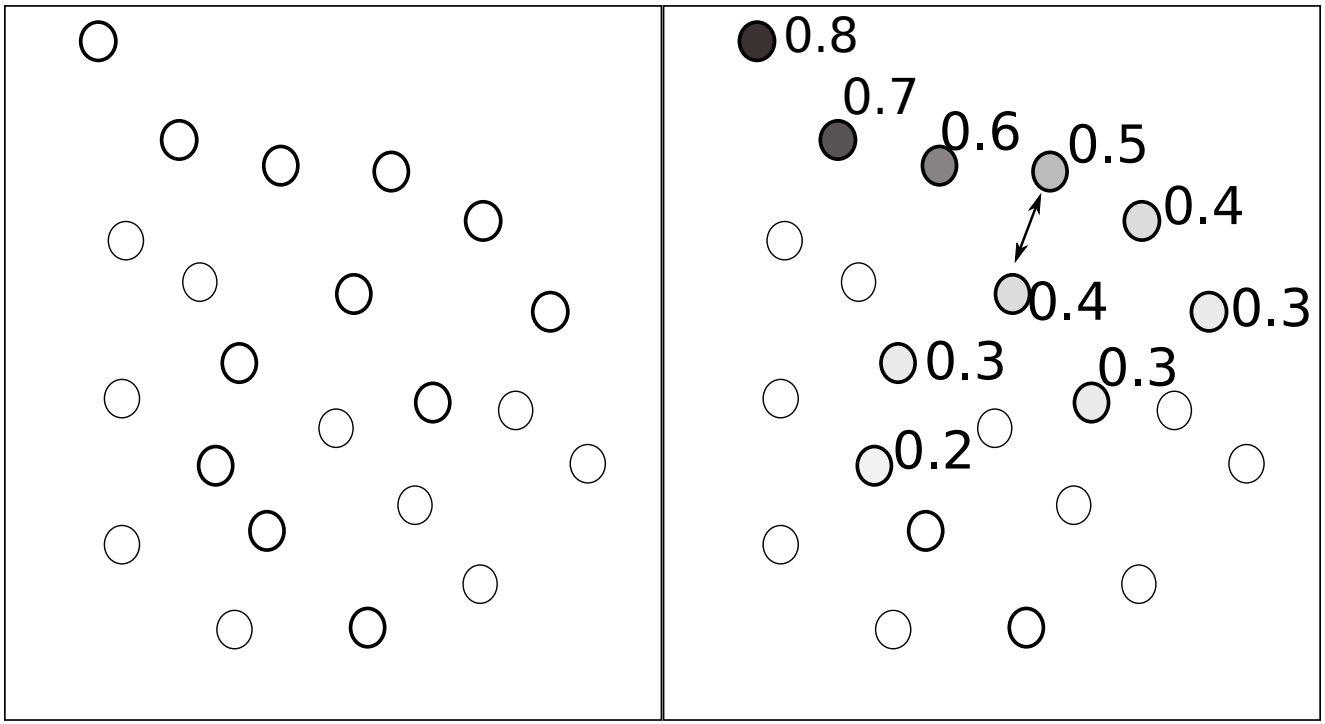
Pheromone based alarm delivery

Retro-propagation mechanism



Pheromone based alarm delivery

Retro-propagation mechanism



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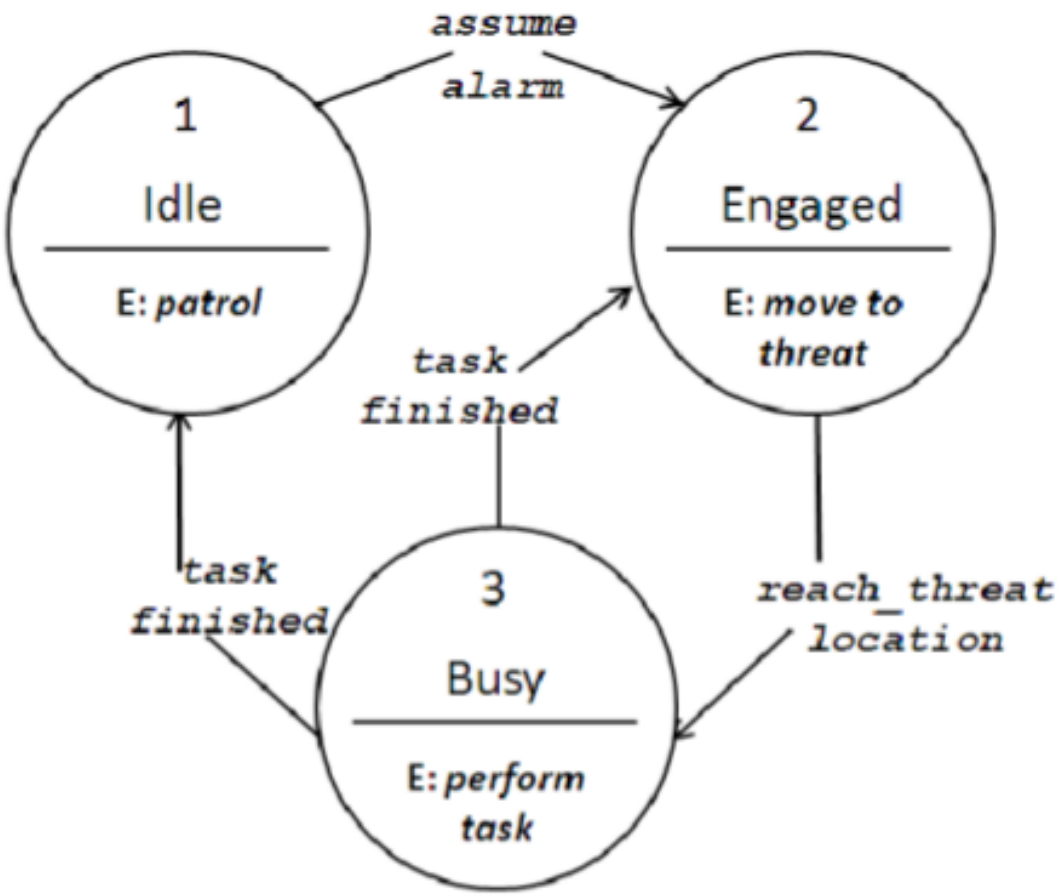
Pheromone based alarm delivery

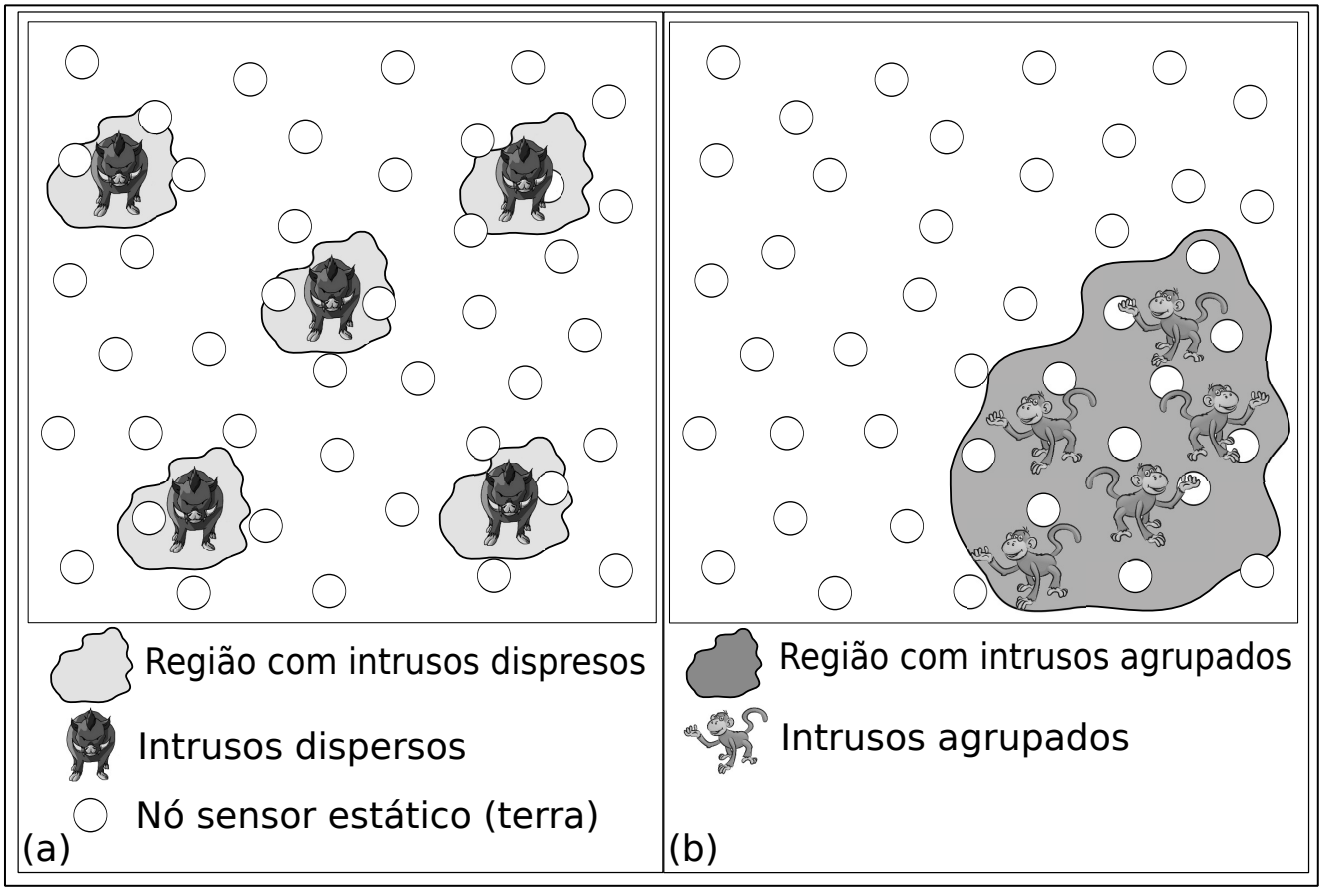
UAV Behaviour



Results

Scenarios

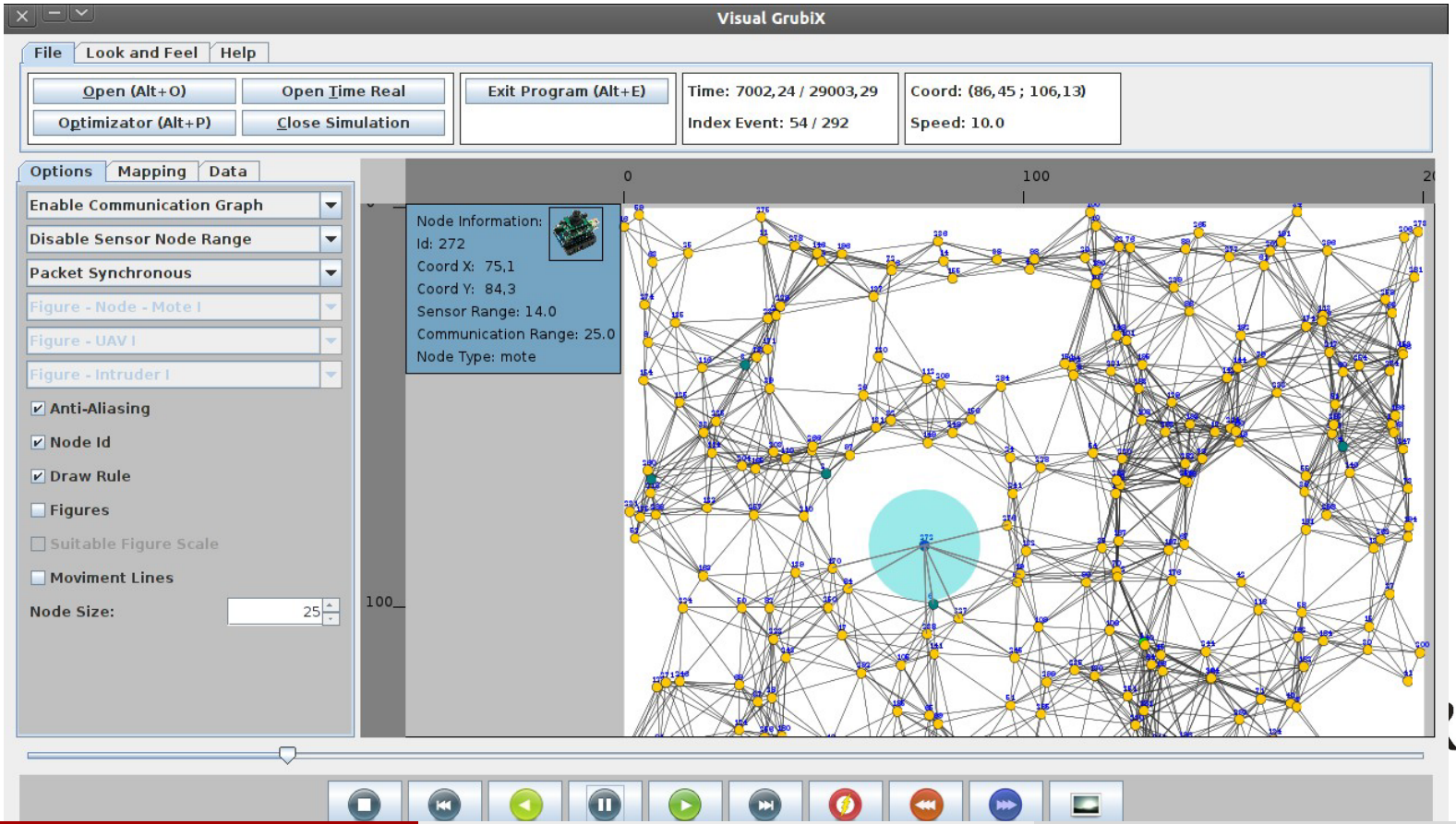
- Two types of environments:



Results

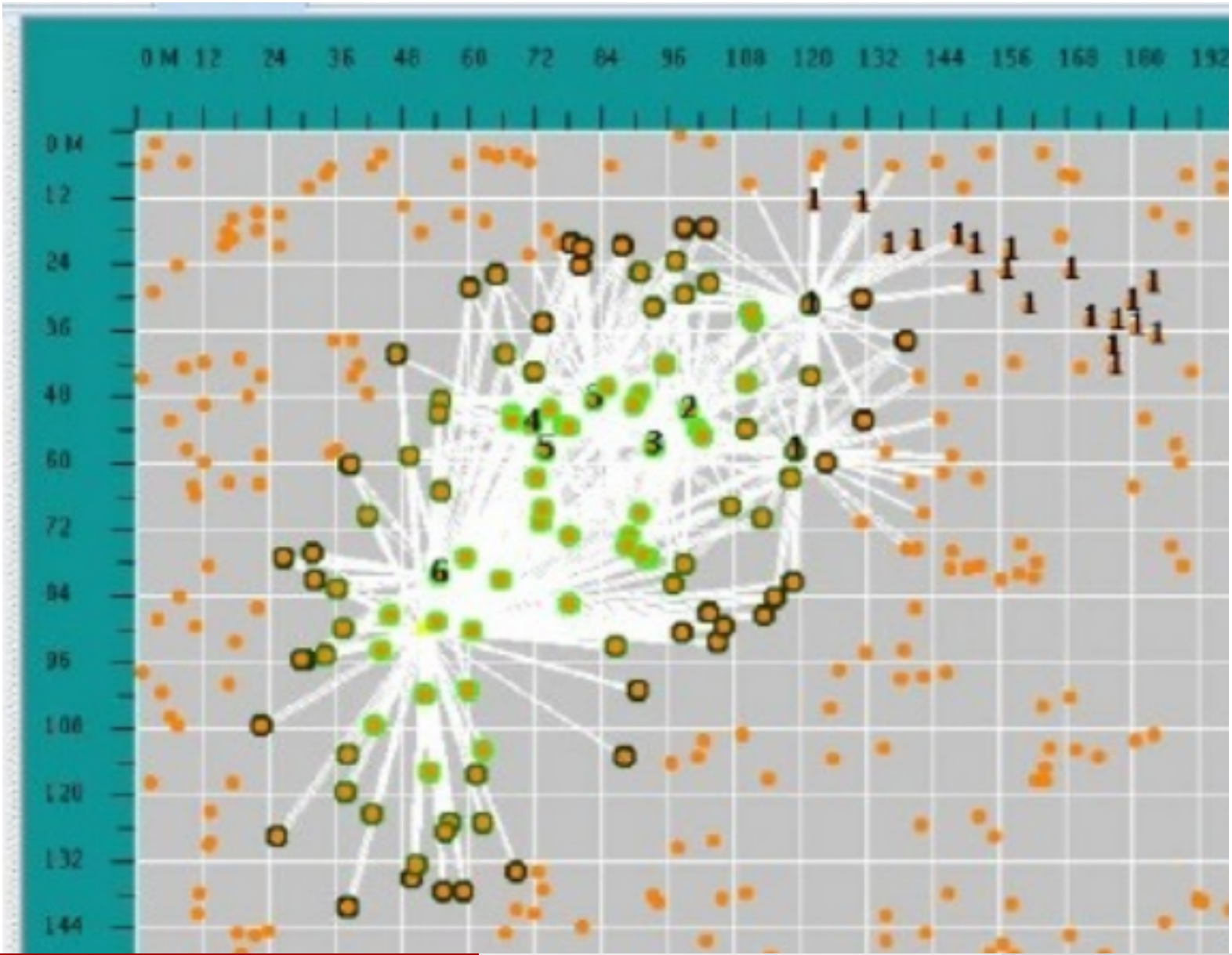
Simulation Setup

Number of Nodes	500	Deployment	Random
Monitored Area	$350m$ x $350m$	Radio Range	30m
Number of Intrusions	$\{2, 4, 6, ..., 16\}$	Environment	ID, IA
Number of nodes	500	Number of executions	50

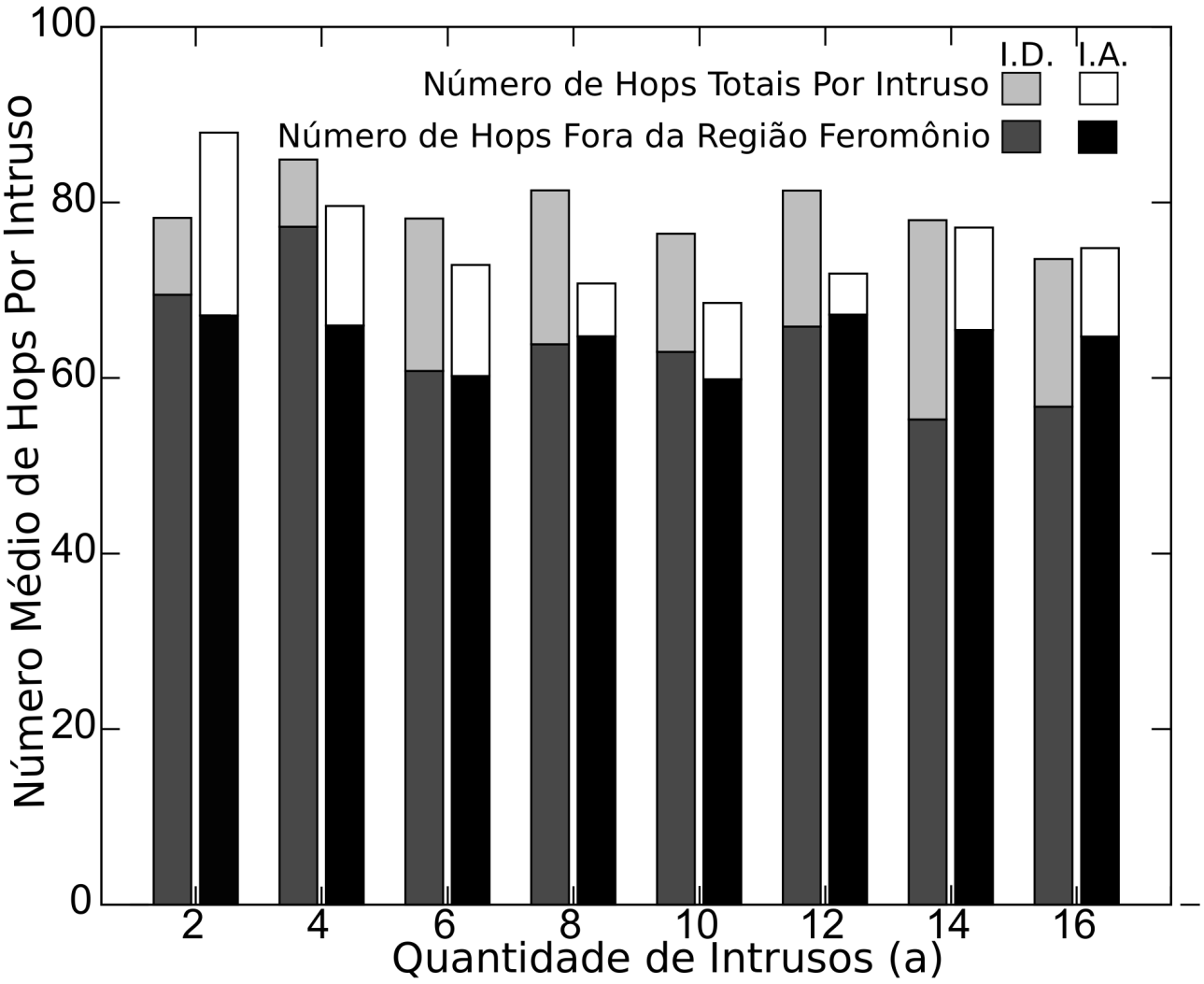


Results

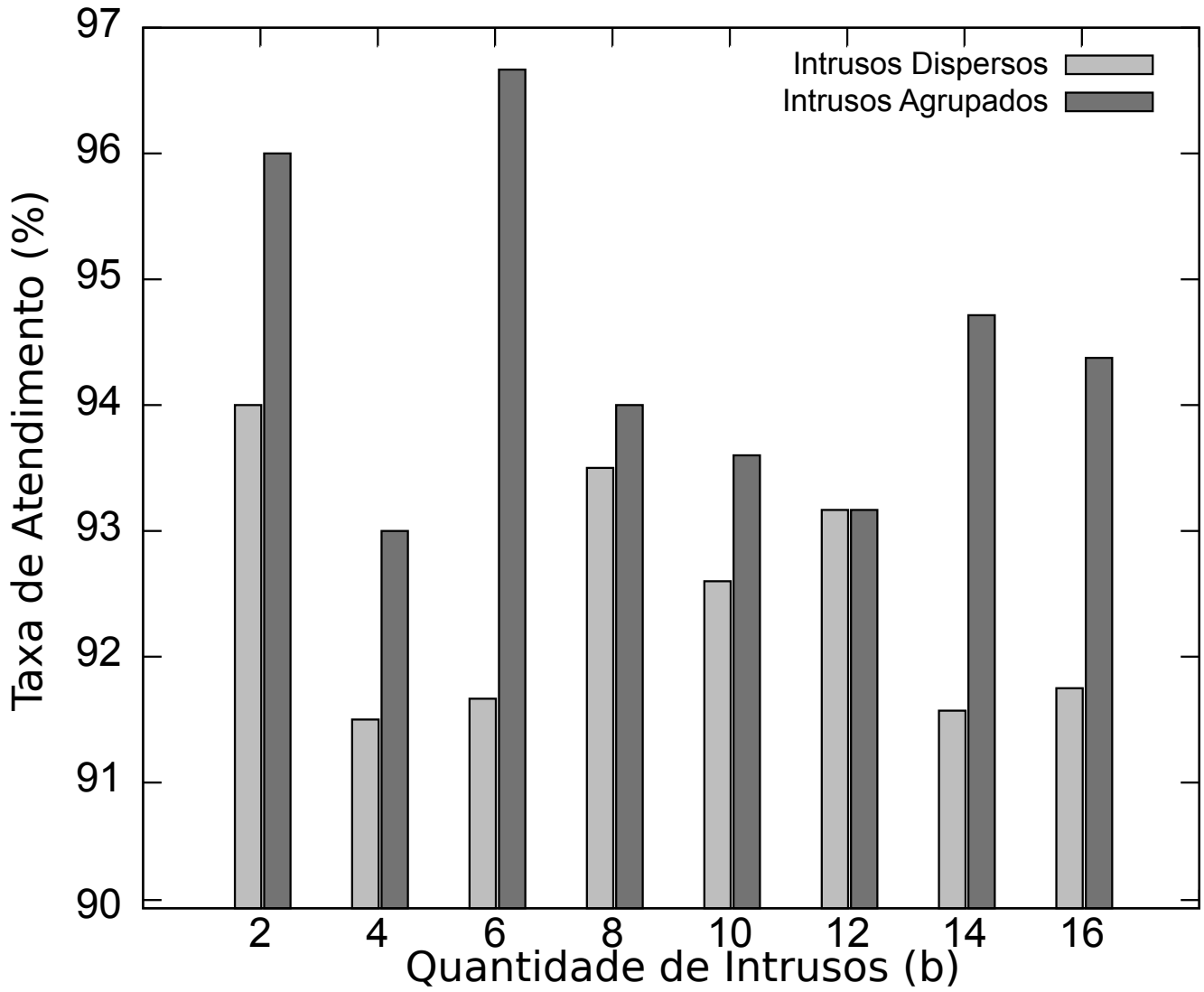
Example of run



Results


100
80
60
40
20
0
Número Médio de Hops Por Intruso
I.D.
I.A.
Número de Hops Totais Por Intruso
Número de Hops Fora da Região Feromônio
2
4
6
8
10
12
14
16
Quantidade de Intrusos (a)

Results



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Conclusions

- A technique for coordination of UAVs and WSNs for surveillance applications presented
- During its flight, the UAV distributes digital pheromone to the ground sensors
- When an event is triggered, an alarm is issued and search for the UAV
- The pheromone path is incremented using the retro-propagation method
- Experiments showed scalability in relation to the amount of intrusion
- More experiments with multiple UAVs still necessary
- Negotiation among UAVs should be developed

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References

(1) A.T. Erman, L. Hoesel, P. Havinga, "Enabling Mobility in heterogeneous Wireless Sensor Networks Cooperating with UAVs for Mission-Critical Management", *IEEE Wireless Communications*, vol. 15, n.6, pp 38-46, 2008.
(2) S.K. Tan, A. Munro, "Adaptive Probabilistic Epidemic Protocol for Wireless Sensor Networks in an Urban Environment", in *Proc. of 16th International Conference on Computer Communications and Networks*, Honolulu, Hawaii, USA, 2007, pp.1105-1110.
(3) Y. Xiao, Y. Zhang, "Surveillance and Tracking System with Collaboration of Robots, Sensor Nodes, and RFID tags", in *Proc. of 18th International Conference on Computer Communications and Networks*, San Francisco, CA, 2009, pp. 1-5.

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(5) K. Hwang, J. In, D. Eom, "Distributed Dynamic Shared Tree for Minimum Energy Data Aggregation of Multiple Mobile Sinks in Wireless Sensor Networks," in *Proc.of 3rd European Workshop on Wireless Sensor Networks*, Zurich, Switzerland, 2006, pp.132-147.

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Thanks

Thank you for your attention!

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