Bringing the cloud to the soldier: challenges and opportunities

Kevin Huggins, Anne-Laure Jousselme, Dominic Larkin, Nicolas Léchevin, Patrick Maupin

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Agenda

- Problem/Objective
- Background
- System Architecture
- Vulnerability Recognition
- Future work

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Problem

- Currently, dismounted soldiers have access to an abundance of cyber resources while in the forward operating base (FOB).
- Once they leave FOB, though, access to cyber resources is limited.

[http://en.wikipedia.org/wiki/File:Flickr_-_The_U.S._Army_-_Security_patrol.jpg]

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Objective

[http://en.wikipedia.org/wiki/File:Afghanistan__American_Soldiers_FOB_Baylough.jpg]

Develop a capability to enables soldiers to have access to all their cyber resources while on dismounted missions

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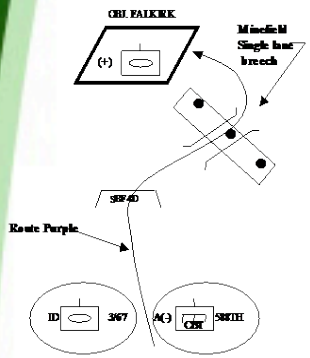
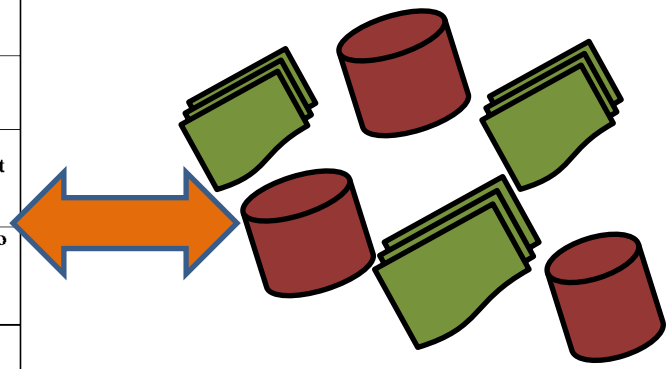
FVI components

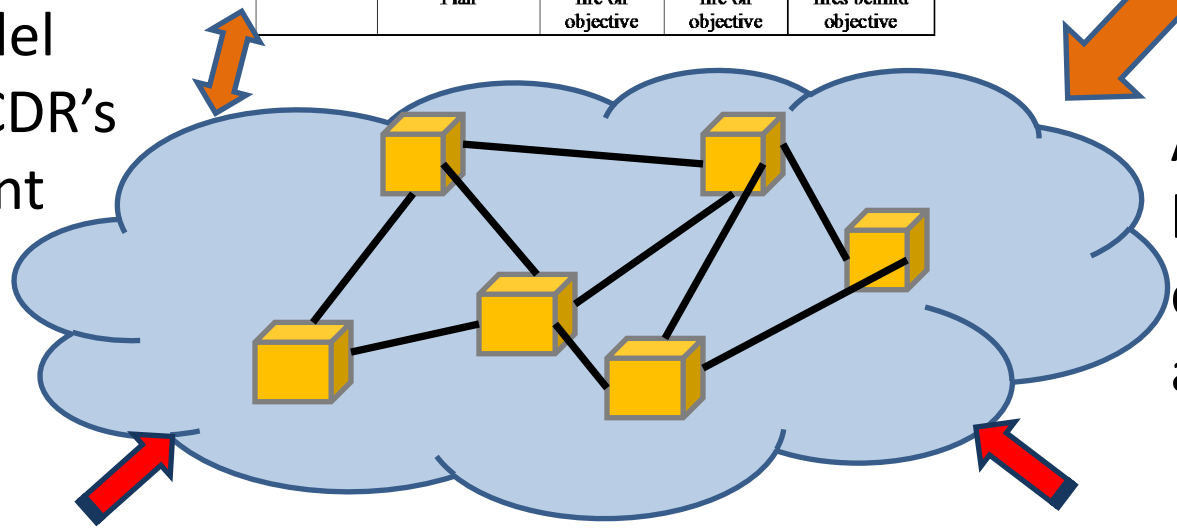
Discrete valuing of information



Phase / Unit	Phase I (move to LOD)	PhaseII (SBF4D)	Phase III (Breech)	Phase IV (Seize obj)
D/3/67 Armor	Occupy positions along LOD	Move to SBF4D	Suppressive fire on objective	Pass through minefield to seize obj
A/3/67 Armor	Occupy positions to feint attack on right flank	Execute feint attack on right flank	Execute feint attack on right flank	Execute feint attack on right flank
B/3/67 Armor	Occupy positions as battalion reserve	Be prepared to assume main attack	Be prepared to assume main attack	Be prepared to assume main attack
A(-)/588th Engineers	Occupy positions behind D/3/67	Move forward behind D/3/67	Execute single-lane minefield breech	Suppressive fire on objective from SBF4D
Artillery	Execute Fire Plan	Suppressive fire on objective	Suppressive fire on objective	On order shift fires behind objective



Computable model of CDR's intent



Adaptive, cloud-based communications architecture

Need to Share extension to Bell-Lapadula

Formal result

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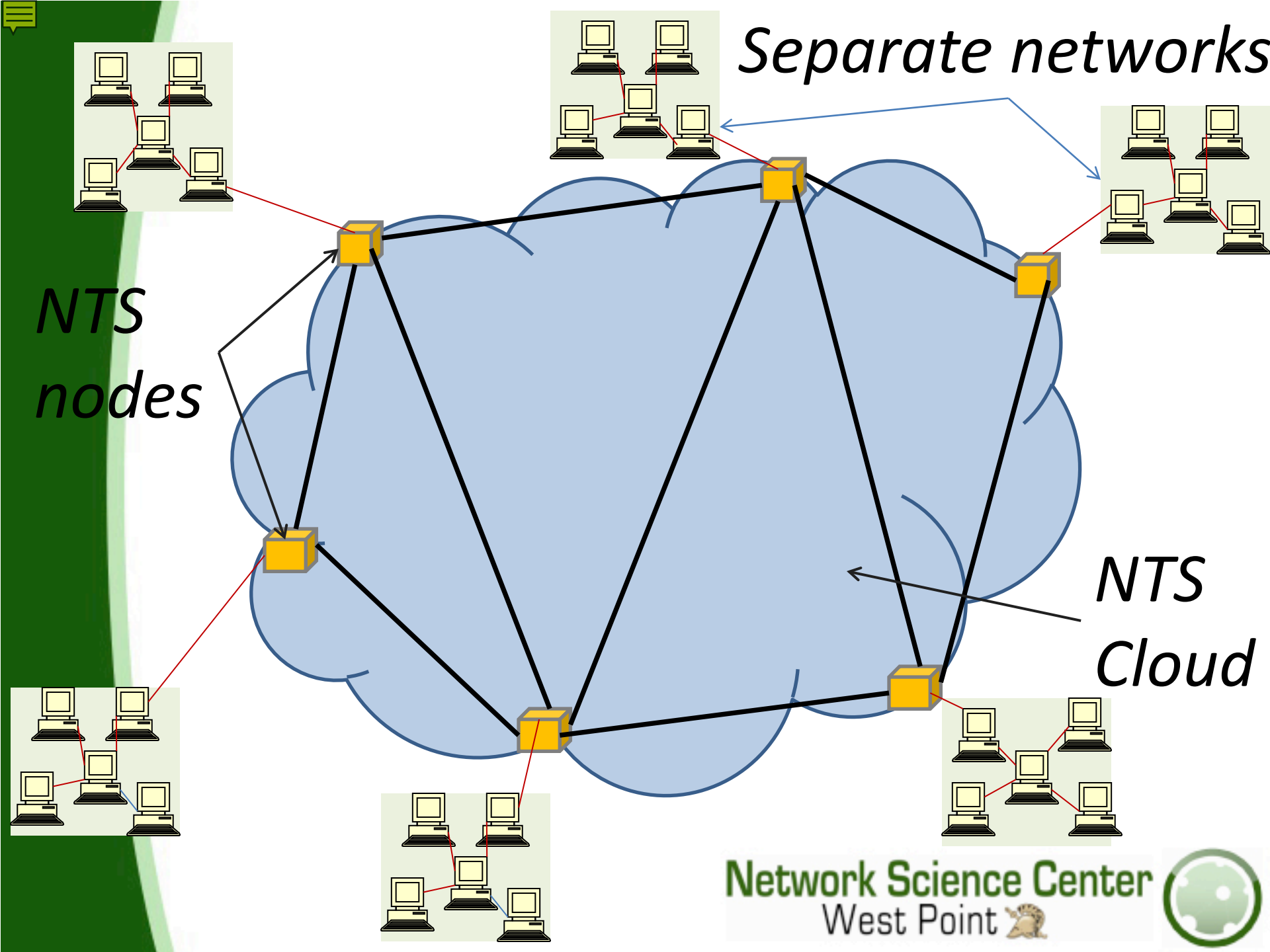
Separate networks
NTS nodes
NTS Cloud
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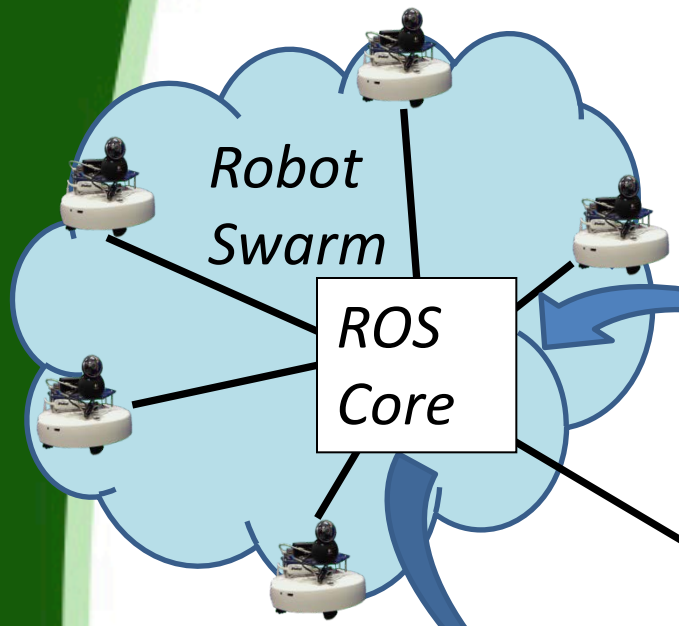
FVI Swarm Architecture



Android publishes swarm control commands

After finding the target the swarm publishes target information

The Android sends information to an FVI Node

Network Edge Device

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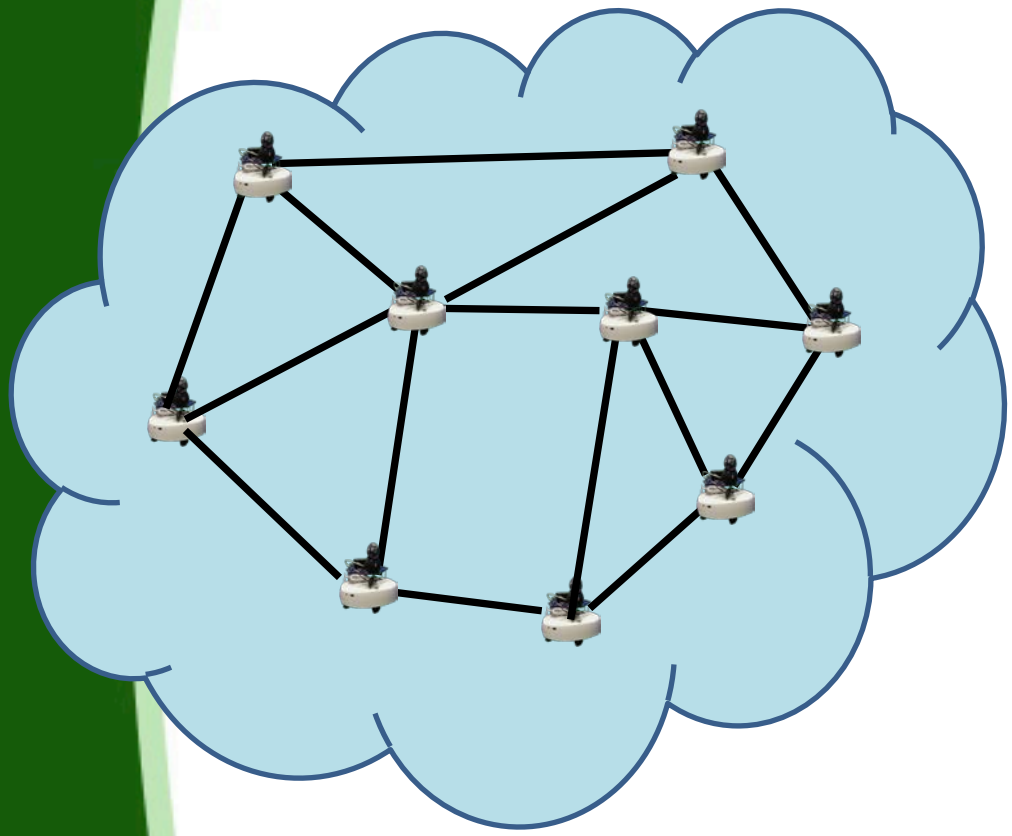
Mobile, Tactical Cloud Concept



- Instead of acting as an edge device on the NTS communications cloud, computing robots become the cloud
- Implement cloud functionality to on-board processors
- How can we make an infantry soldier more effective with a cloud at his disposal?

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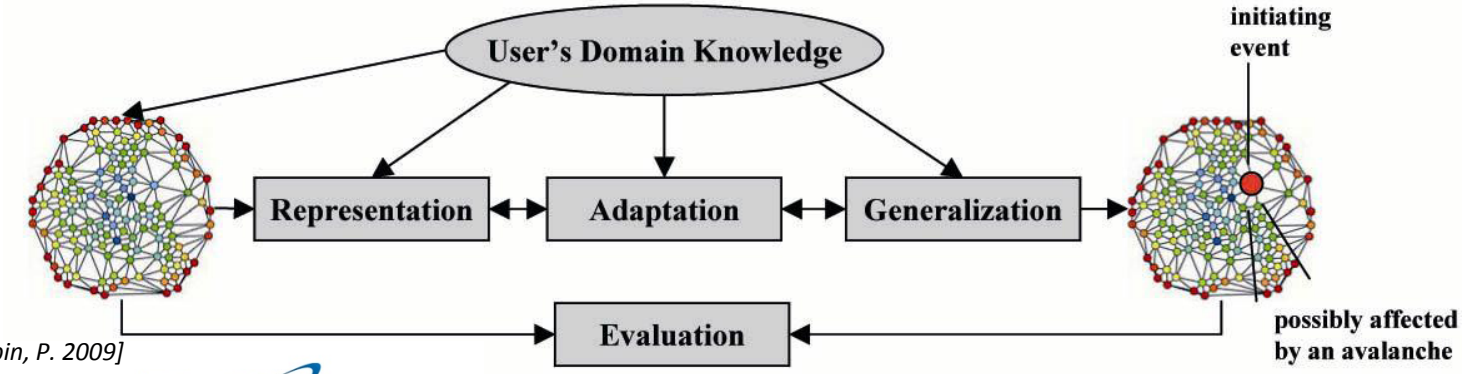
PREVU (*DRDC project*)

***P**rediction and **RE**cognition of **VU**lnerabilities in Very Large Socio-Technical Complex Networks*

i. Extract the local and global structural characteristics of evolving complex networks
ii. Deliver on-demand feature selection models to select the most efficient characteristics
iii. Model the relationship between the local and global structural characteristics with past failures and catastrophic events
iv. Detect on-line initiating and triggering events that could lead to the catastrophic failure sequences



[Maupin, P. 2009]

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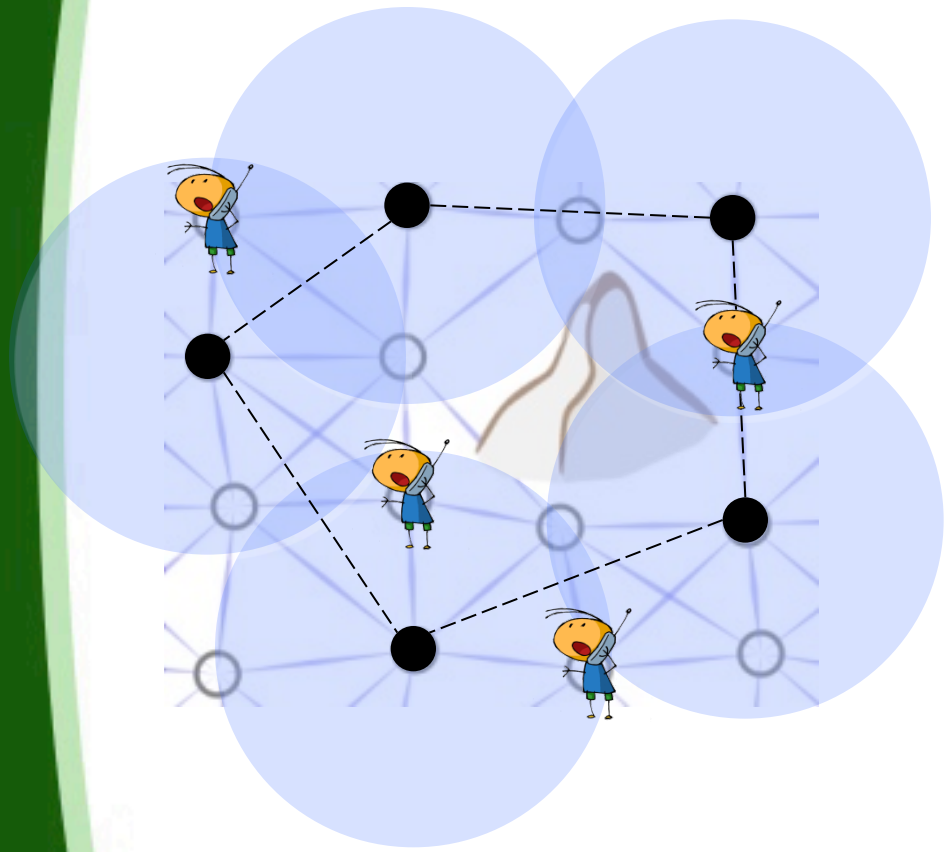
System Architecture



Robots need to:

1. Maintain clients' coverage
2. Maintain connectivity in the mobile communications architecture

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System Architecture

- *Set of robots* — $R=\{r_1, \ldots, r_N\}$
- *Set of clients* — $C=\{c_1, \ldots, c_M\}$
- *Set of communication links* — $E=\{e_1, \ldots, e_K\}$
- ***Communications graph*** — $G_c=(R, E)$
- *Set of possible positions* — $P=\{p_1, \ldots, p_L\}$
- *Set of possible paths* — $Q=\{q_1, \ldots, q_J\}$
- ***Navigation graph (discrete environment)*** — $G_N=(P, Q)$

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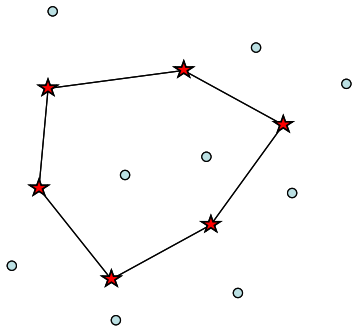
Detecting vulnerable nodes

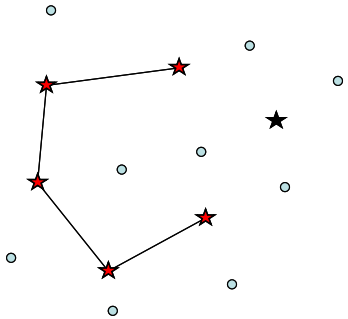
- **Vulnerability**: an instance of the network's state that may evolve in time until it affects the network's functions and the completion of its goals.
- **Causes of weakness**:
  - A robot's failure (loss of a node)
  - A loss of a link (caused by a client's move, or an obstacle to the communication link)
- **Cascading event**: Loss of network connectivity, beyond the robustness of the adaptive motion strategy.

Time-evolving of robot network



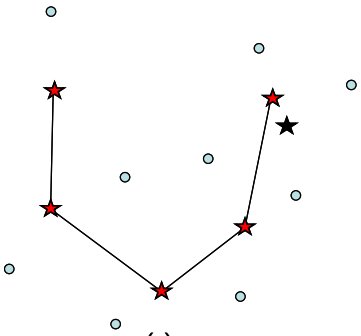
(a)

Initial optimal robot deployment.



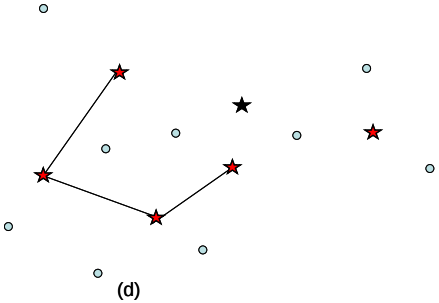
(b)

The destruction of a robot entails the loss of two communication links.

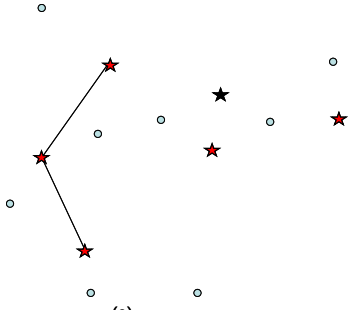


(c)

Robots are deployed adaptively to ensure optimal coverage of the area despite the loss of a robot; one link is recovered.



(d)



(e)

The environment evolves in time and in space; Since coverage is prioritized, robots adaptive deployment results in a communication graph with two active links.

Client

Robot

Disabled robot

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Future Work

- Develop robot movement strategy
- Vulnerability response

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Questions

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