CAREER: Towards Secure Large-Scale Networked Systems: Resilient Distributed Algorithms for Coordination in Networks under Cyber Attacks

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Challenge

- Information gathered in large-scale cyber-physical networks is dispersed throughout network

- Agents in network need to coordinate in order to share information and achieve globally optimal objectives

- CPS can be attacked by adversaries, compromising vulnerable agents and causing them to behave maliciously

- How to enable resilient distributed coordination, learning, and decision-making?

Scientific Impact

- Understanding of fundamental limitations of achievable performance in presence of adversaries

- "Plug-and-play" algorithms for large variety of distributed coordination, learning, and decision-making tasks

- New design principles for large-scale cyber-physical systems in a variety of application domains

Solution: Create resilient algorithms for distributed optimization, learning, and state estimation

Contributions to date:

- Identified fundamental limitations on achievable performance for a variety of distributed coordination objectives under adversarial behavior

- Created algorithms for distributed optimization, state estimation, hypothesis testing, reinforcement learning with provable performance guarantees, even under a large number of adversaries

- Algorithms are scalable and do not require nodes to know global information (such as network topology)

Example Application: Resilient Robotic Teams

Compromised Node
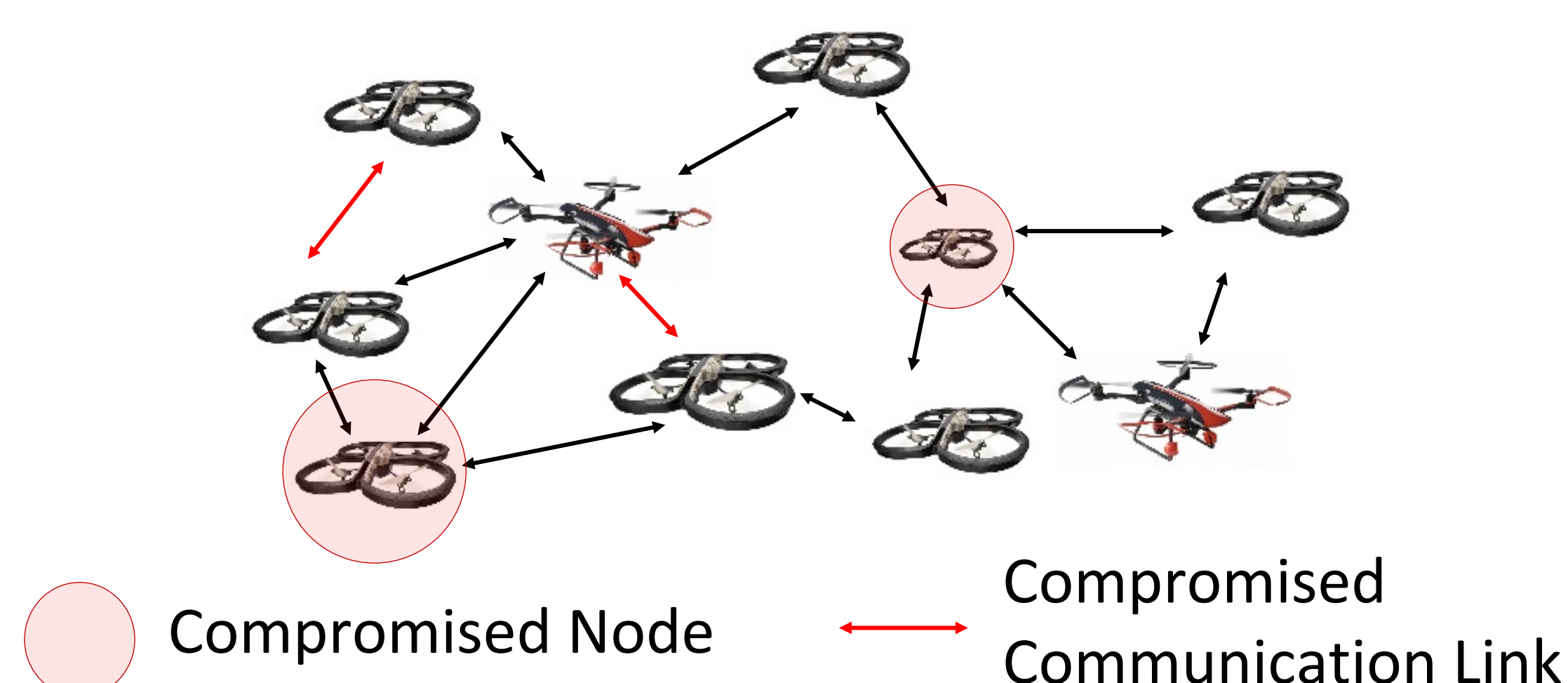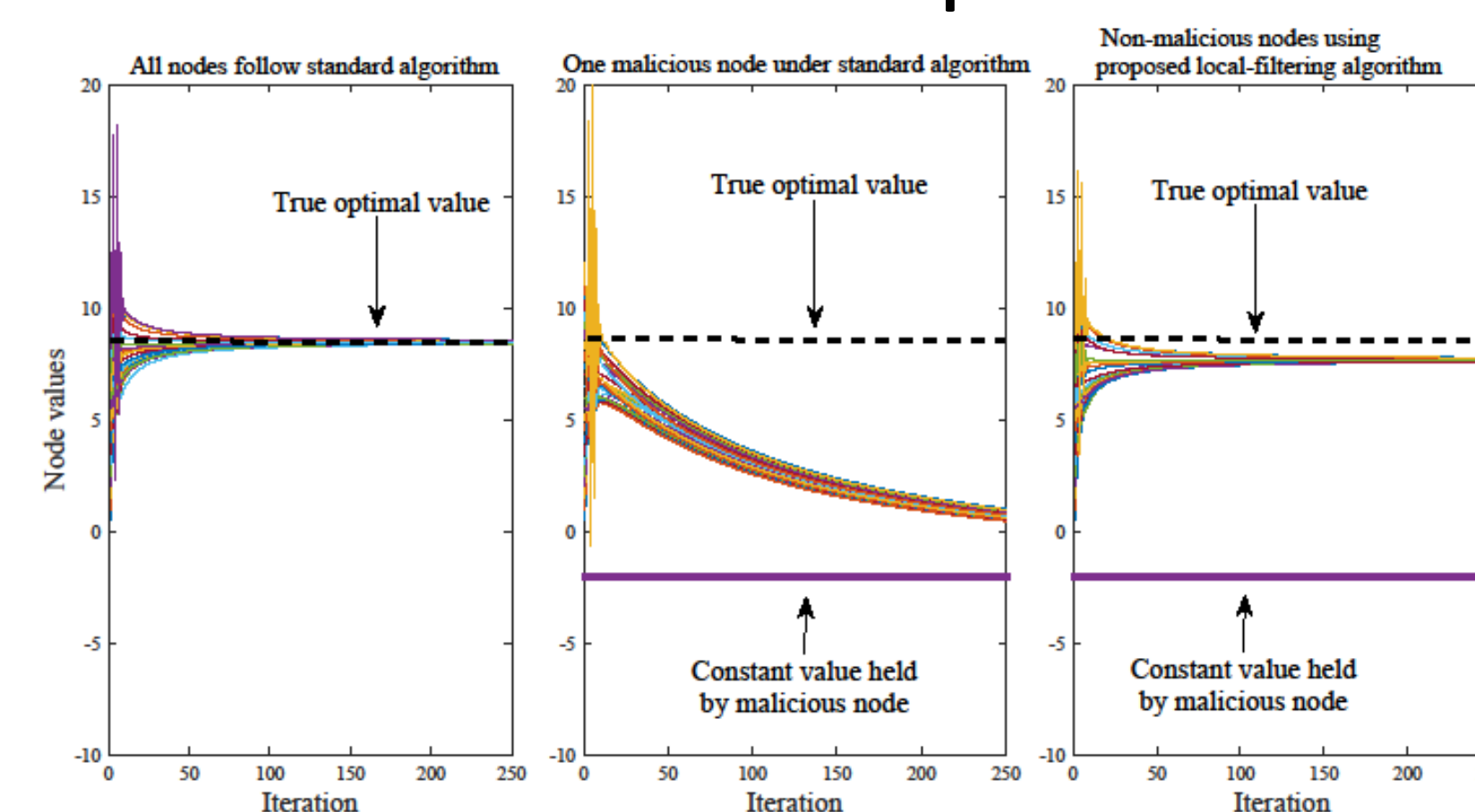
Compromised Communication Link

Illustration of our Algorithms for Resilient Distributed Optimization

Broader Impact

- Resilient cyber-physical systems and critical infrastructure enabled by the project will mitigate economic and safety consequences of cyber attacks

- Students trained in the science of resilient system design

- Easy-to-use and widely accessible web-based swarm simulator currently under development