WIP: RESILIENT TARGET PURSUIT FOR MULTI-UAV SYSTEMS

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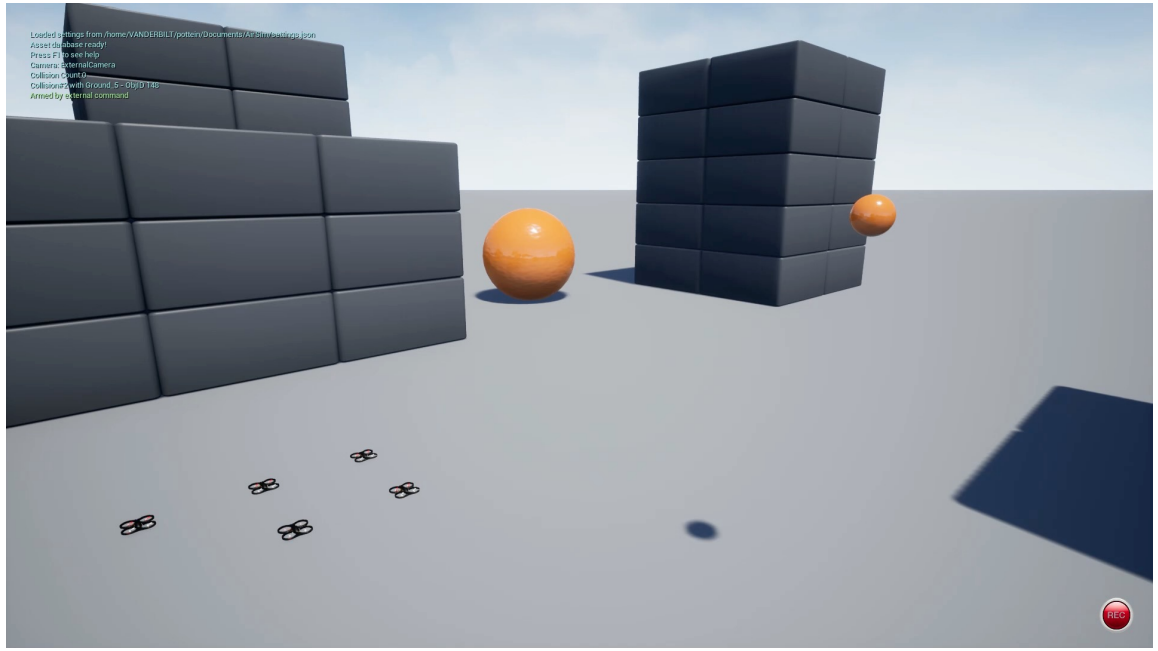
MOTIVATION

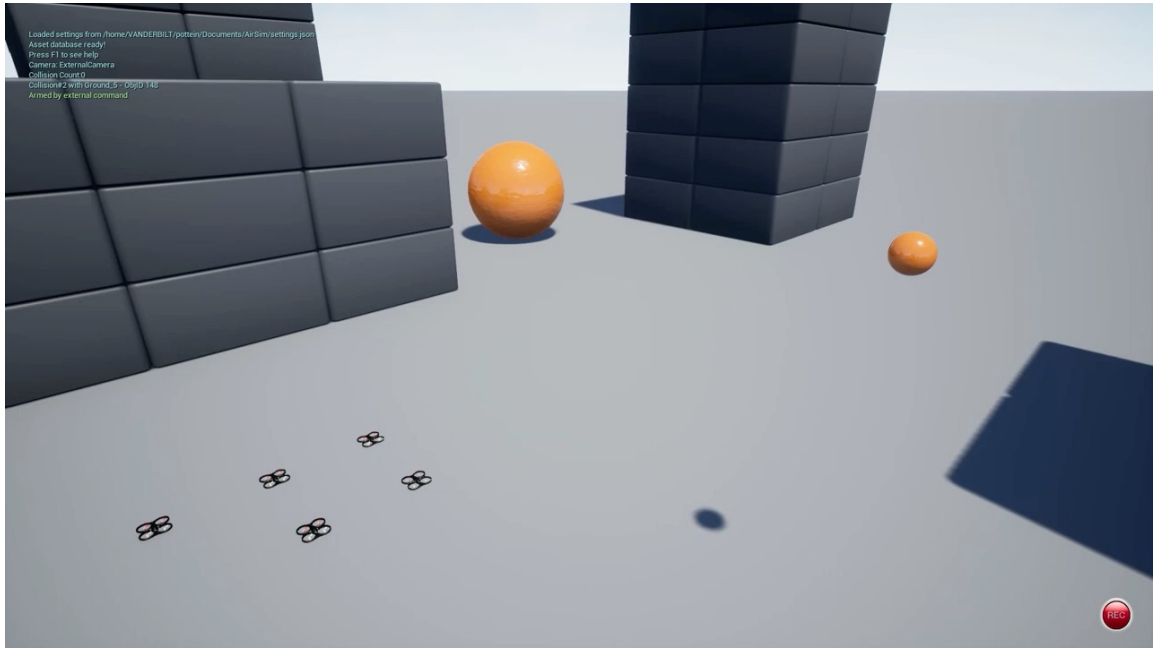
- Distributed multi-UAVs systems
  - Pursuit of target for aid/delivery of packages
- Vulnerable to Network Attacks
  - Denial of Service (DoS) Attack
  - Integrity Attack

RESILIENCE

- **DoS Attack**



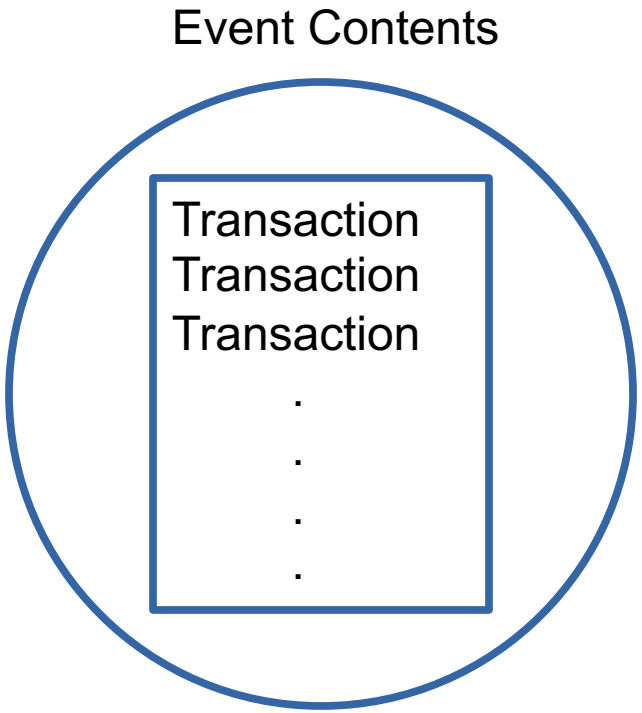
- **Integrity Attack**

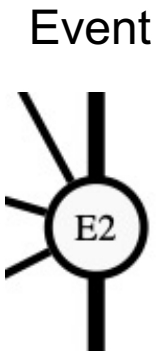


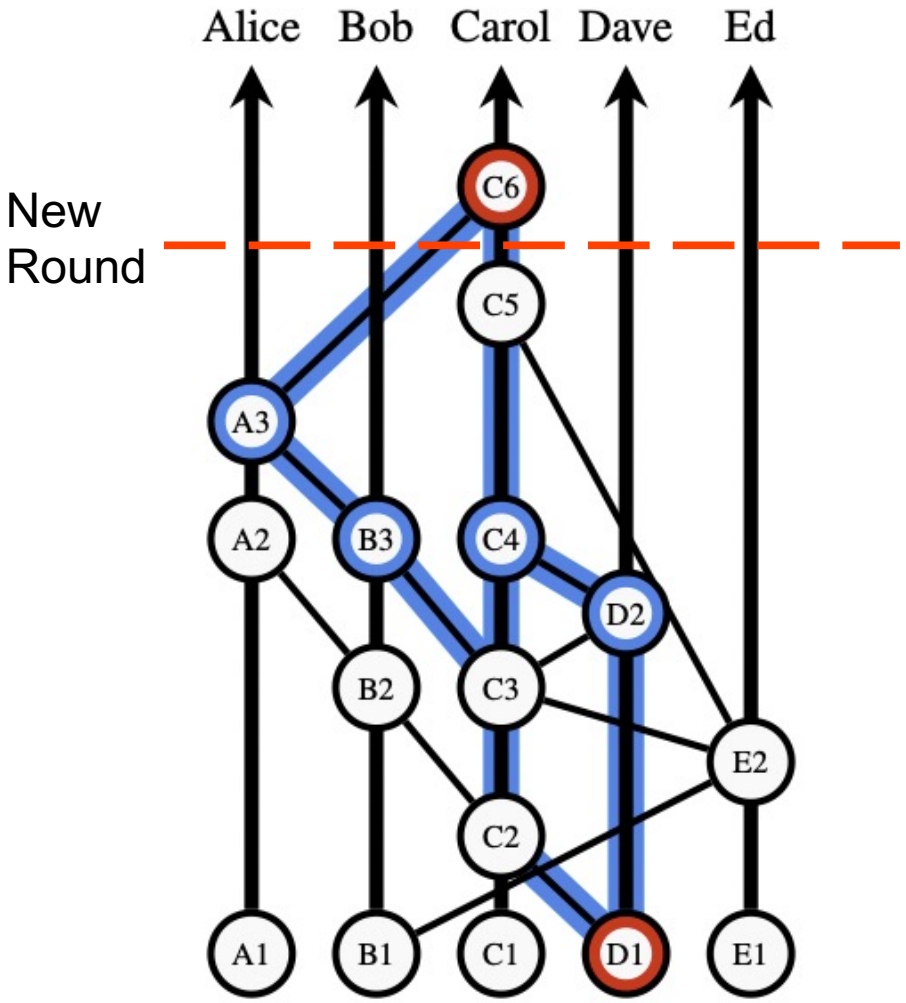
OVERVIEW

- Contribution
  - Development of a distributed target pursuit algorithm where nodes interact with only the Hashgraph for exchange of information and still maintain a global view of the system
- Integration of resilient mechanisms
  - Communication
    - Hashgraph Messaging
  - Cooperative Target Pursuit Algorithm
    - SGD using centerpoint-based aggregation

HASHGRAPH







Leeman Baard. 2016. The SWIRLDS Hashgraph Consensus Algorithm: Fair, Fast, Byzantine Fault Tolerance

HASHGRAPH

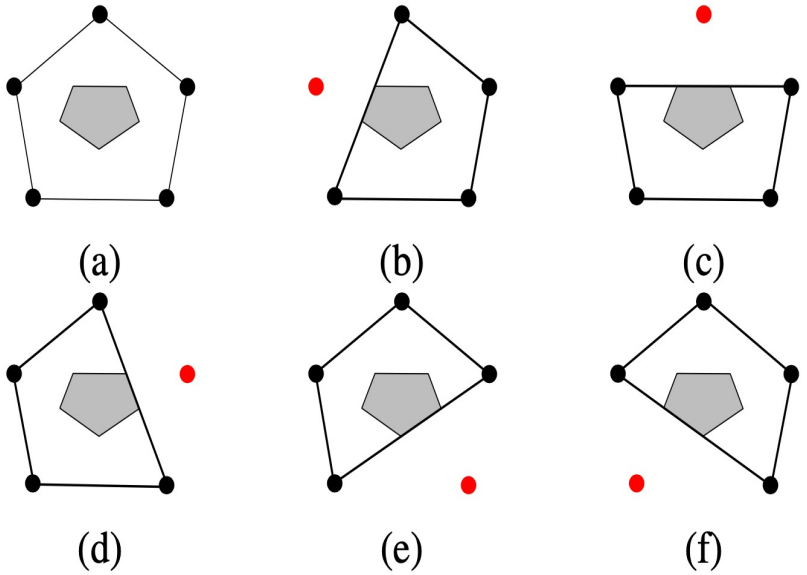
- Blockchain-like data structure used for consensus on ordering of events
- Hashgraph exceeds blockchain in efficiency and throughput
  - Only limited by bandwidth to inform other nodes of transactions
  - Nodes exchange information via a low latency gossip protocol to maintain consistency throughout each nodes' hashgraph copy
  - Virtual voting – Consensus is reached on ordering without messaging with other nodes
- Resilient against DoS attacks with up to 1/3 of participants compromised

Leeman Baard. 2016. The SWIRLDS Hashgraph Consensus Algorithm: Fair, Fast, Byzantine Fault Tolerance

CENTERPOINT

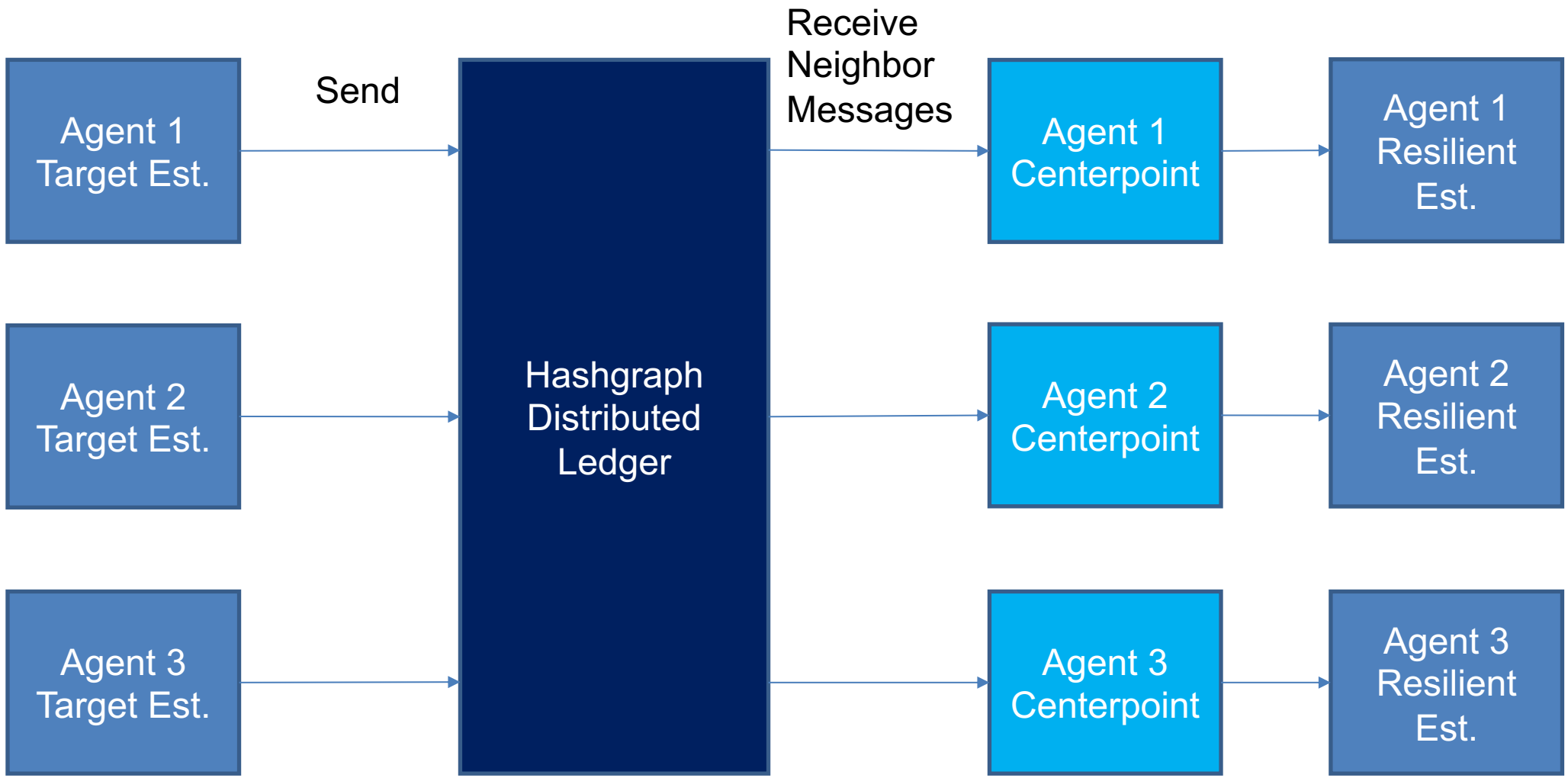
- **Resilient against adversarial/out-of-distribution points**
- **Computes a point in a "*safe*" region of normal points**
  - **"safe" region – region inside of convex hull of a set of points**
- **Limit of f adversarial points**

$$f \leq \left\lceil \frac{n_k}{d+1} \right\rceil - 1$$

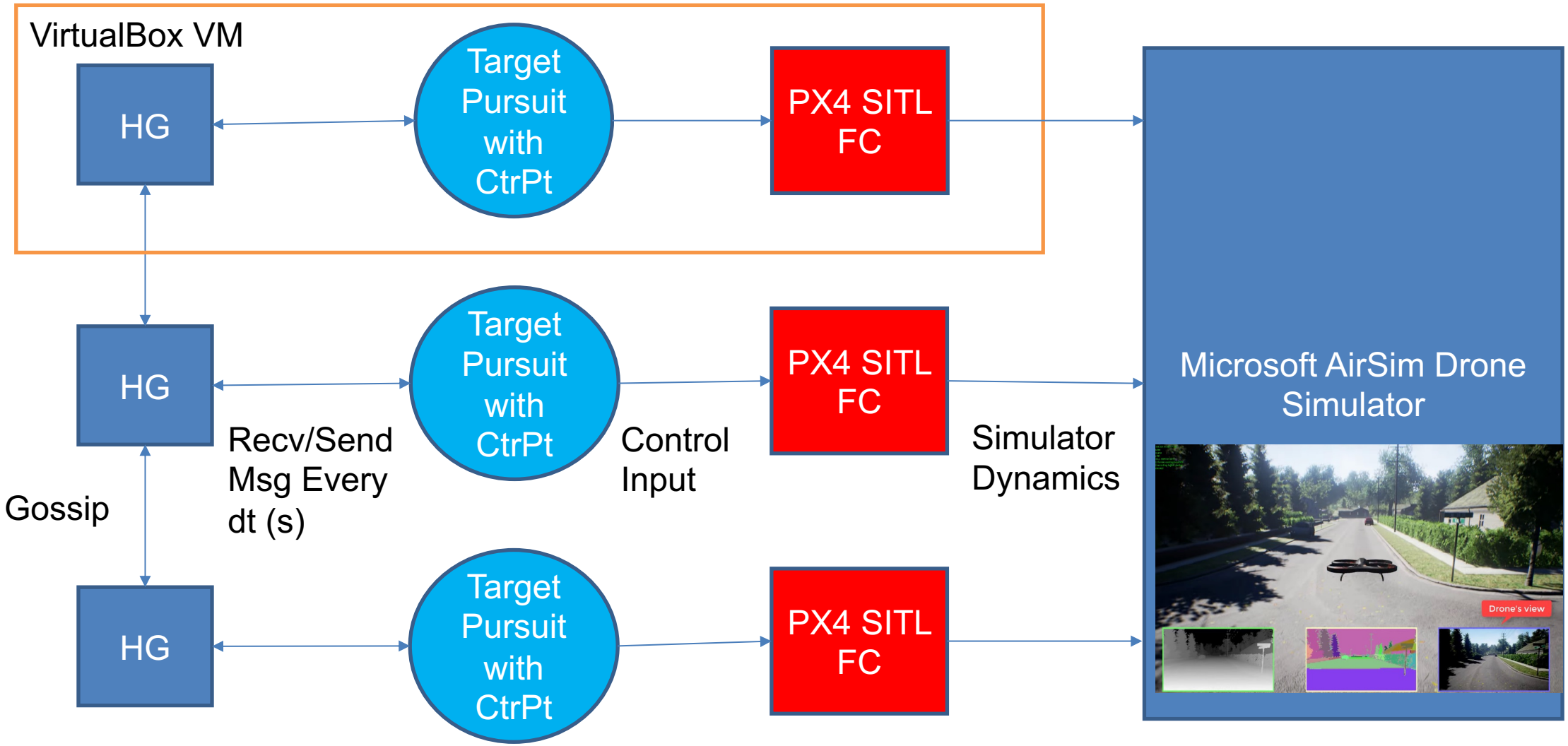


Jiani Li, Waseem Abbas, Mudassir Shabbir, and Xenofon Koutsoukos. 2020. Resilient distributed diffusion for multi-robot systems using centerpoint. Robotics: Science and Systems, Corvalis, Oregon, USA (2020)

COOPERATIVE TARGET PURSUIT (AT TIME T)

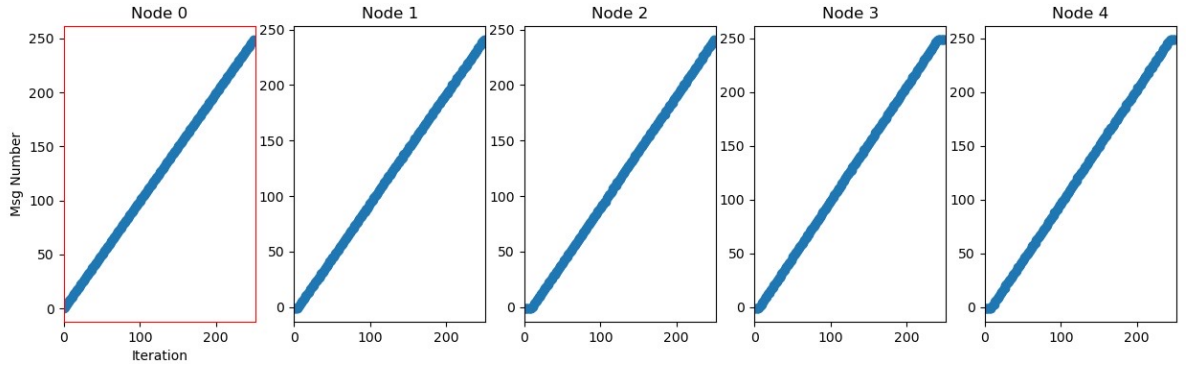


SOFTWARE ARCHITECTURE

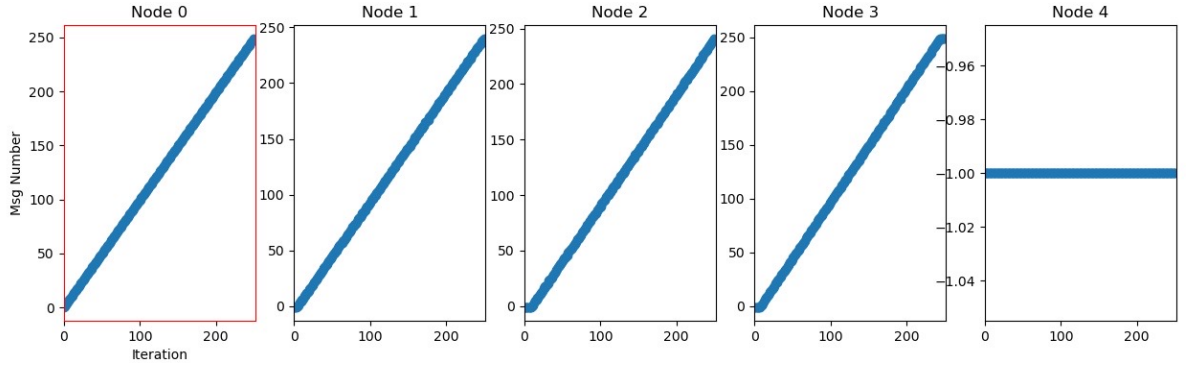


ORDERING OF RECEIVED MESSAGES (DT=0.5)

Normal Operation

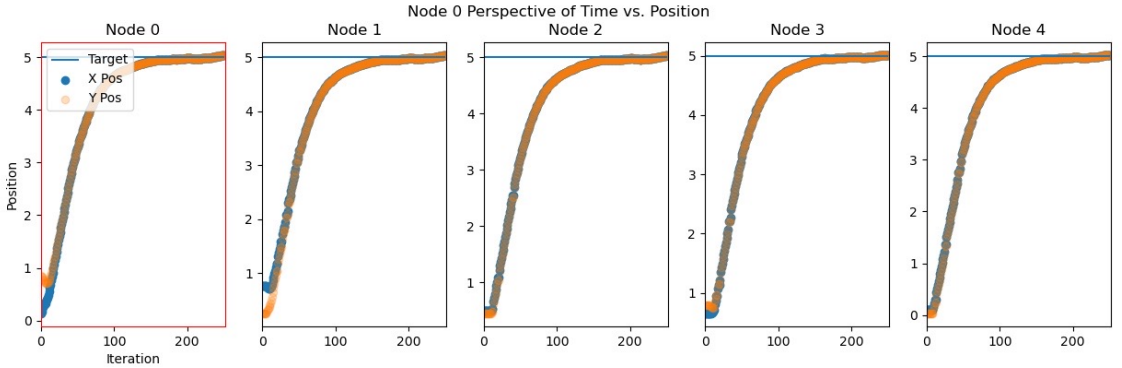


DoS Attack

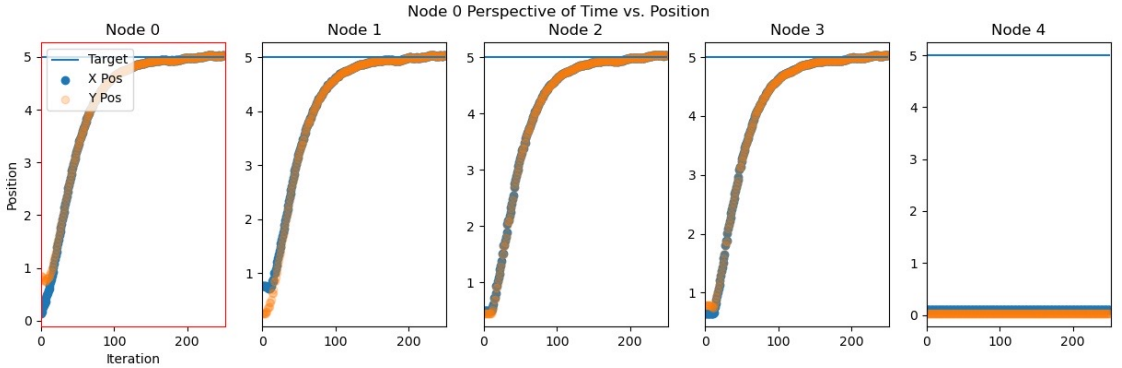


POSITIONS RECEIVED FROM NODES (DT=0.5)

Normal Operation

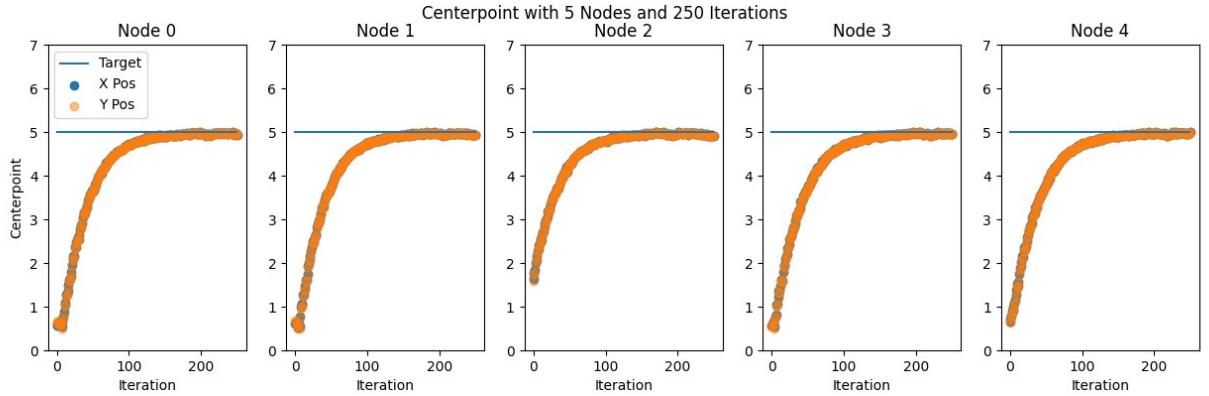


DoS Attack

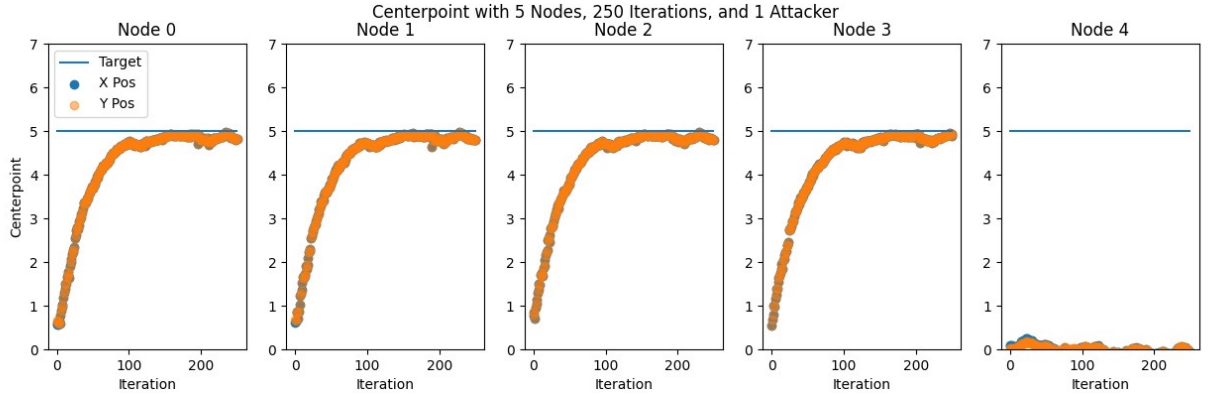


CENTERPOINT OF TARGET ESTIMATES (DT=0.5)

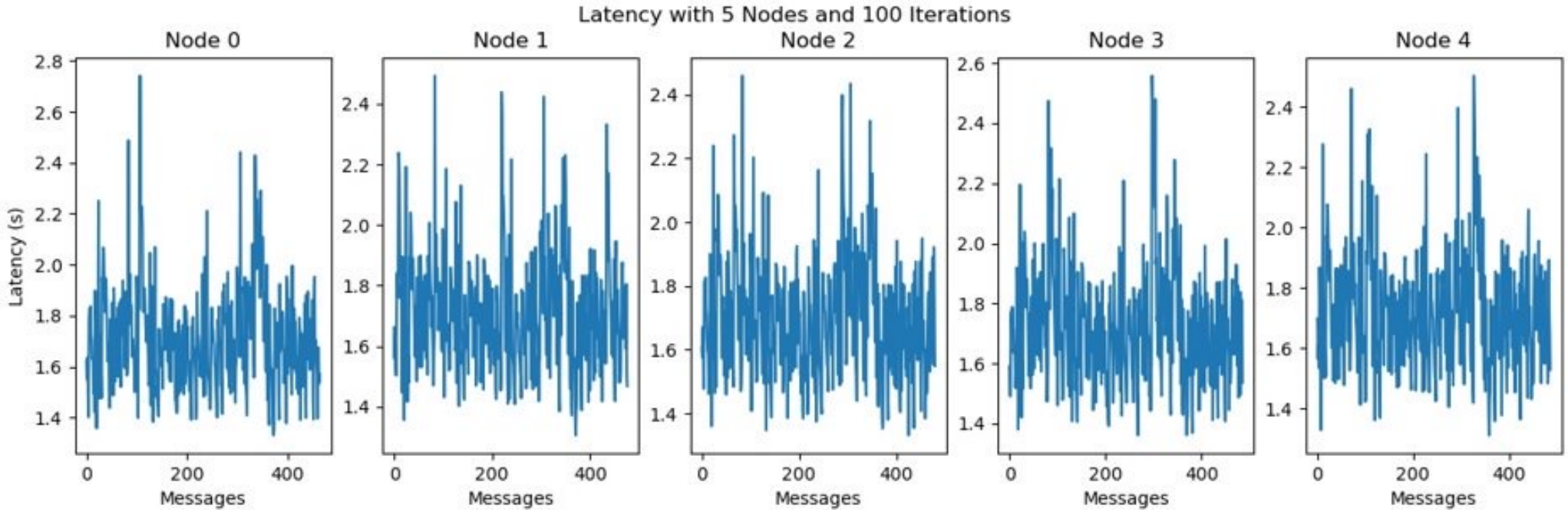
Normal Operation



Integrity Attack (Rightmost Node)



LATENCY OF RASPERRY PI CONFIGURATION

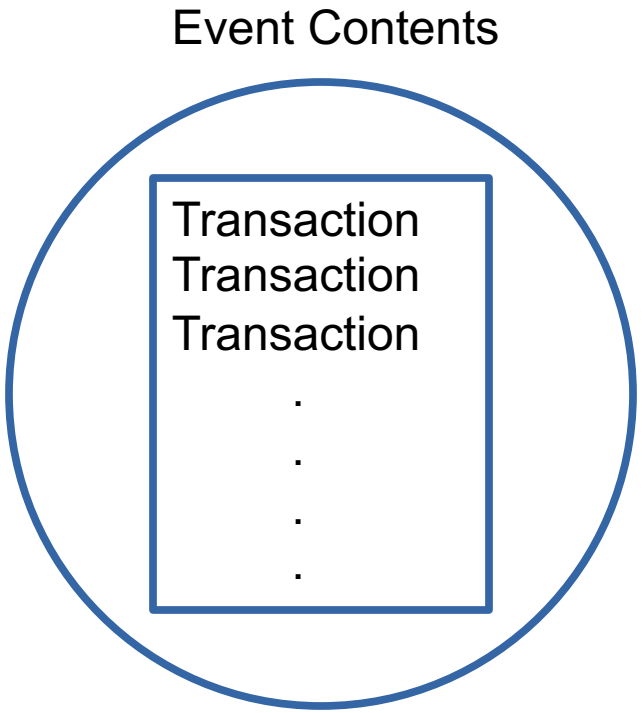


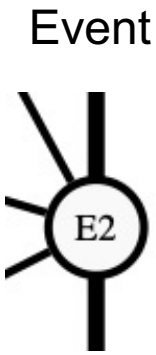
FUTURE WORK

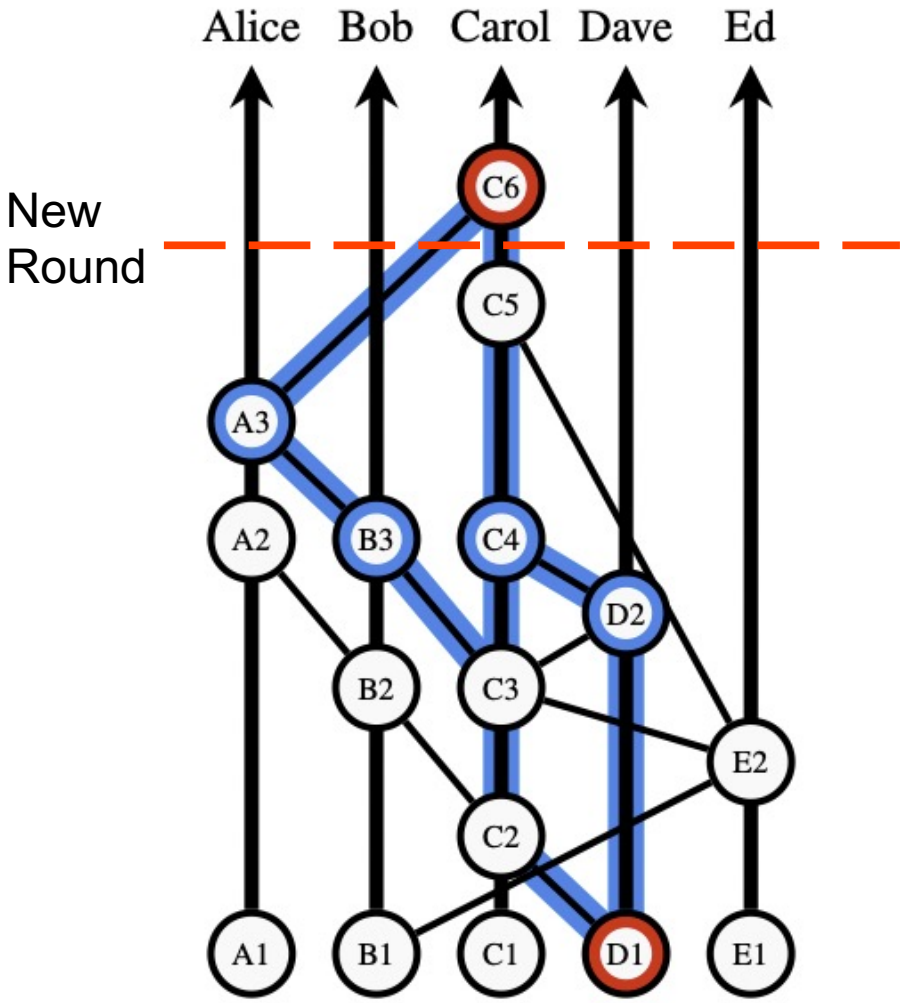
- Scalability
  - Analysis of consensus with greater number of nodes
- Latency/Throughput
  - Nodes have recent information from other nodes
- Security
  - Analysis of hashgraph/centerpoint integration in additional multi-agent scenarios

THANK YOU

HASHGRAPH







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