P5-26: Networked and Secure Systems

Mission-Critical Computing
NSF CENTER FOR SPACE, HIGH-PERFORMANCE, AND RESILIENT COMPUTING (SHREC)

SHREC Annual Workshop (SAW25-26)

University of Pittsburgh · BYU Brigham Young University · Virginia Tech · UF University of Florida

January 13-14, 2026

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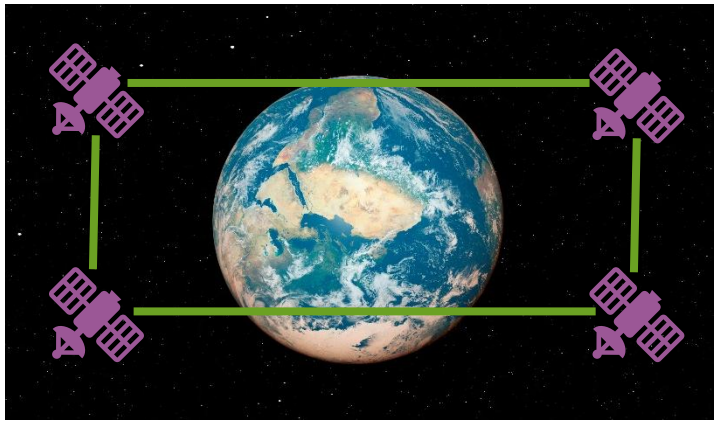
Number of requested memberships ≥ 2

Goals, Motivations, & Challenges



Goals

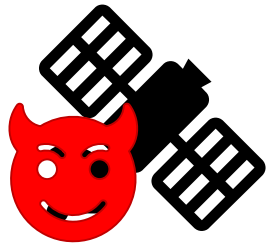
- Develop **trust** assessment framework for constellations
- Leverage predictable topology for **routing** packets through network
- Create **secure** routing algorithm for constellations by integrating trust into routing

Motivations

- **Dependence** on space-based systems for critical applications
- Constellations are growing in **size** and **complexity**
- Increasing connectivity leads to increasing **attack surface**
- Lower **computational overhead** and **latency** for satellite networks

Challenges

- Computational complexity of simulating **large-scale** satellite constellations
- Satellites must be **resilient** to many different types of attacks
- **Distributed** trust systems have access to limited amounts of information



Task 1: Trust Assessment

Task leader: Quincy Bayer

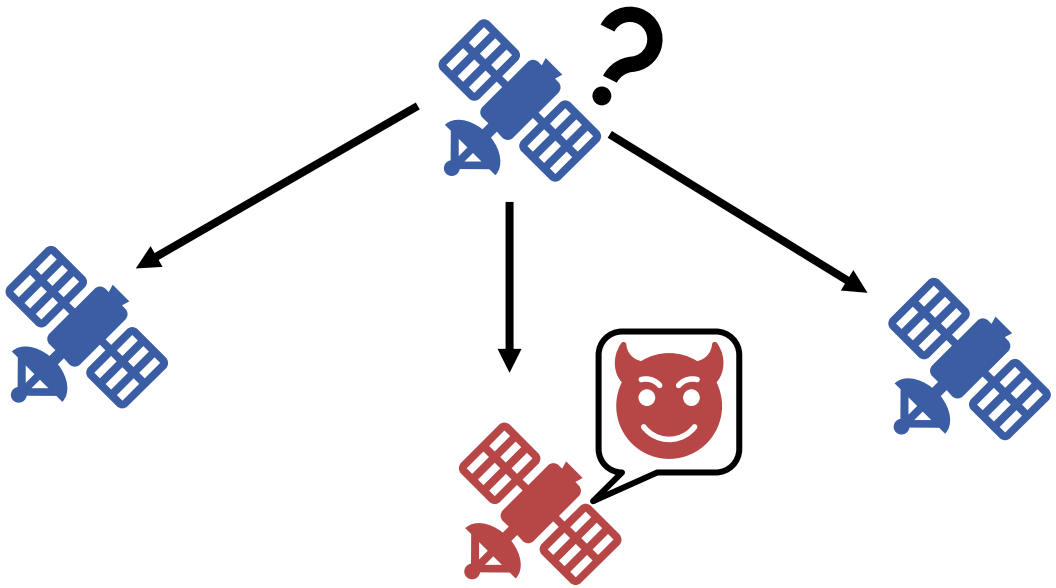
T1: Background

Satellites Reliability

- Environment and context affect performance
  - **Radiation**
  - **Battery** depletion
  - Traffic
- **Cyberattacks affect network performance**
  - Kinetic
  - Black Hole
  - Flooding
  - etc…

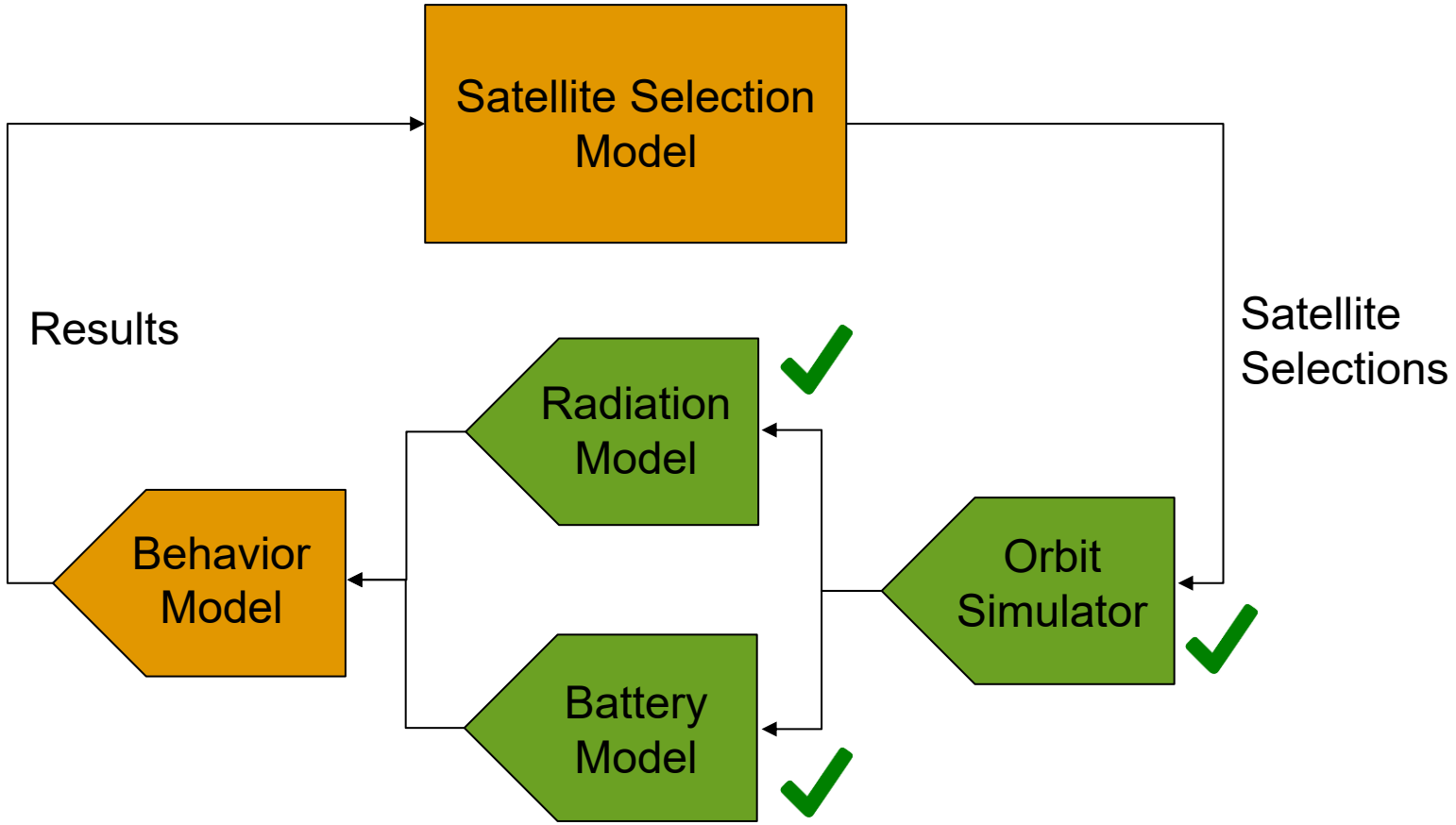
Trust Algorithms

- Trust algorithms can determine which satellites are more **reliable** for **distributed tasks**



T1: Satellite Selection Architecture

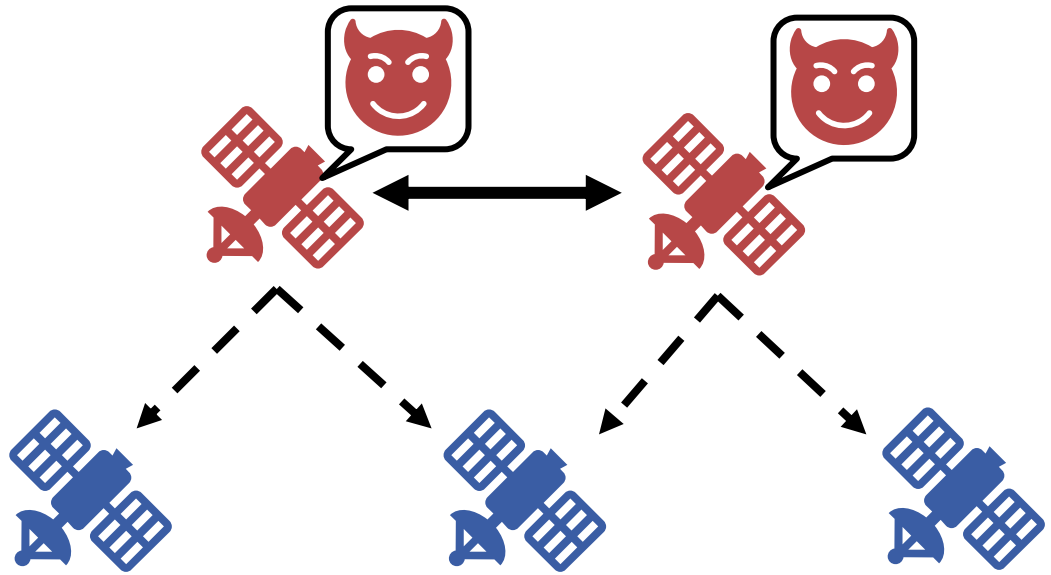
- Satellite selection model is based on **reinforcement learning**
- Train model to choose satellites for collaborative tasks such as routing



T1: Future Steps

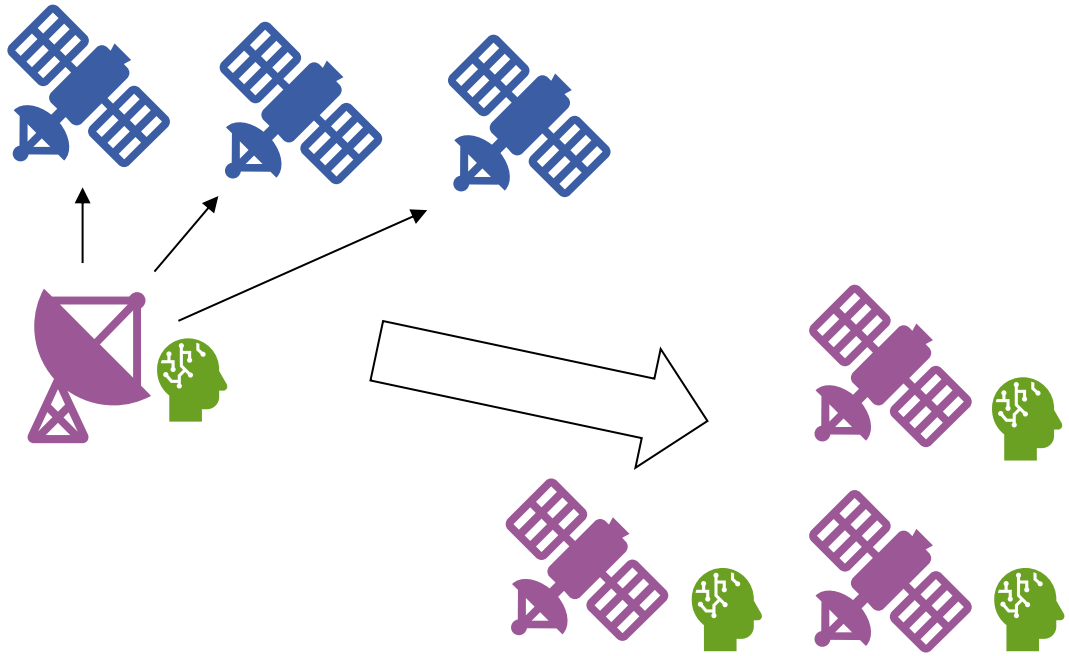
Attacks and Verification

- Account for **coordinated attacks**
- Verification methods such as **attestation**



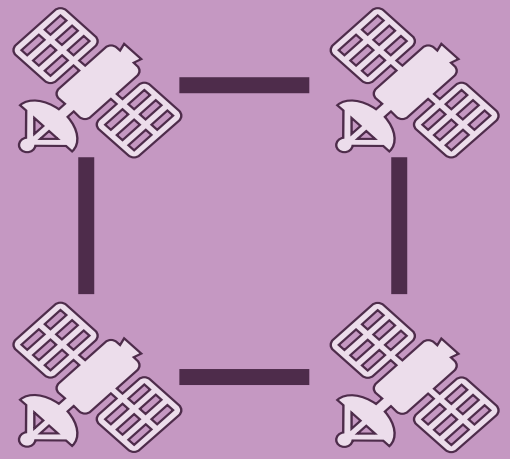
Distributed Trust Assessment

- More **resilient** against temporary drops in communication



Task 2: Constellation Routing

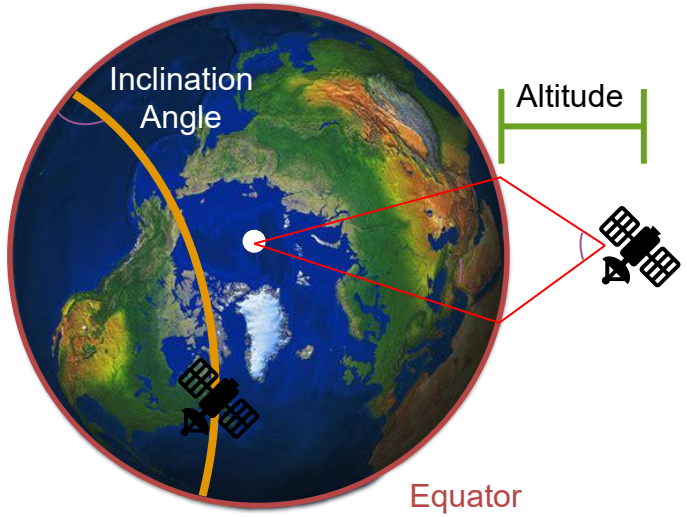
Task leader: Robert Esswein



T2: Satellite Constellation Routing

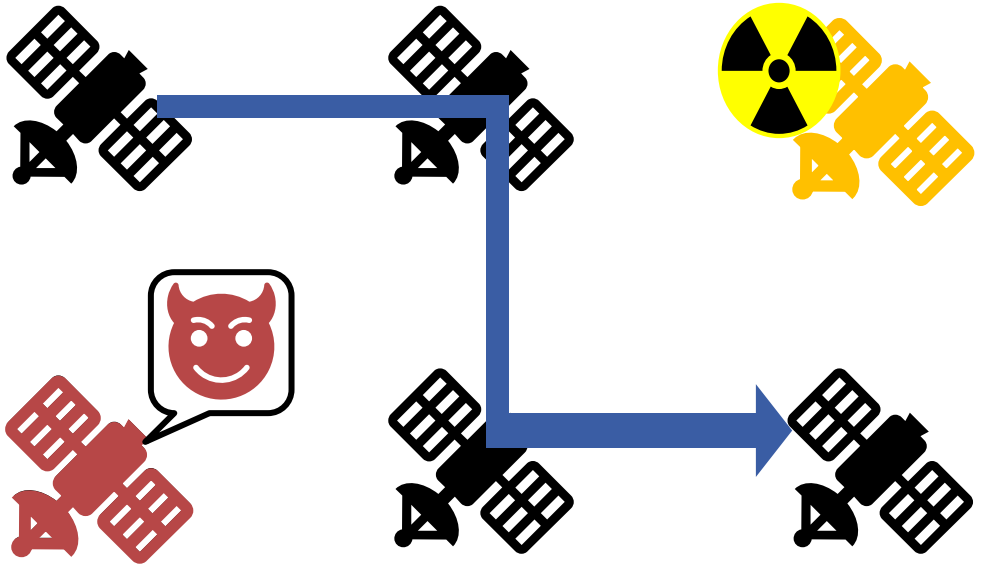
Routing Algorithms

- Utilize **predictable** topology to improve routing
- Measure effects of constellation **configuration** on routing



Trust-Based Routing

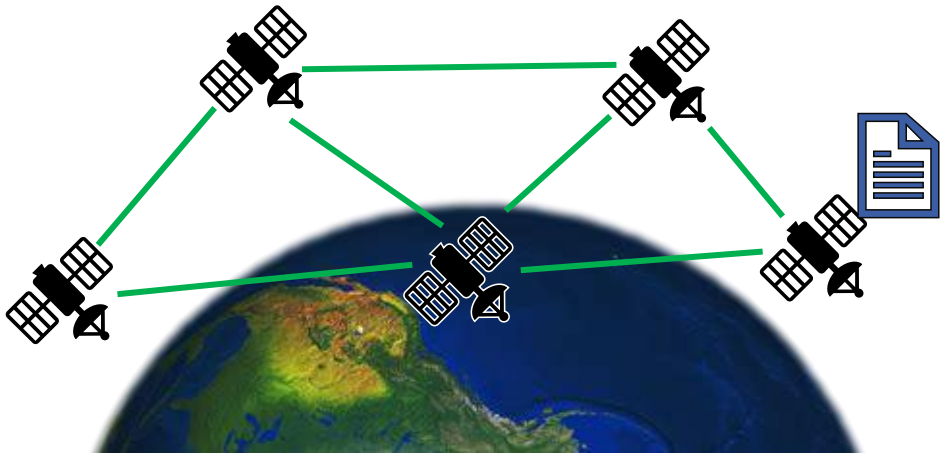
- Utilize **trust assessment** as input to routing algorithm
- Route through **trusted** links



T2: Next Steps – Routing Algorithms

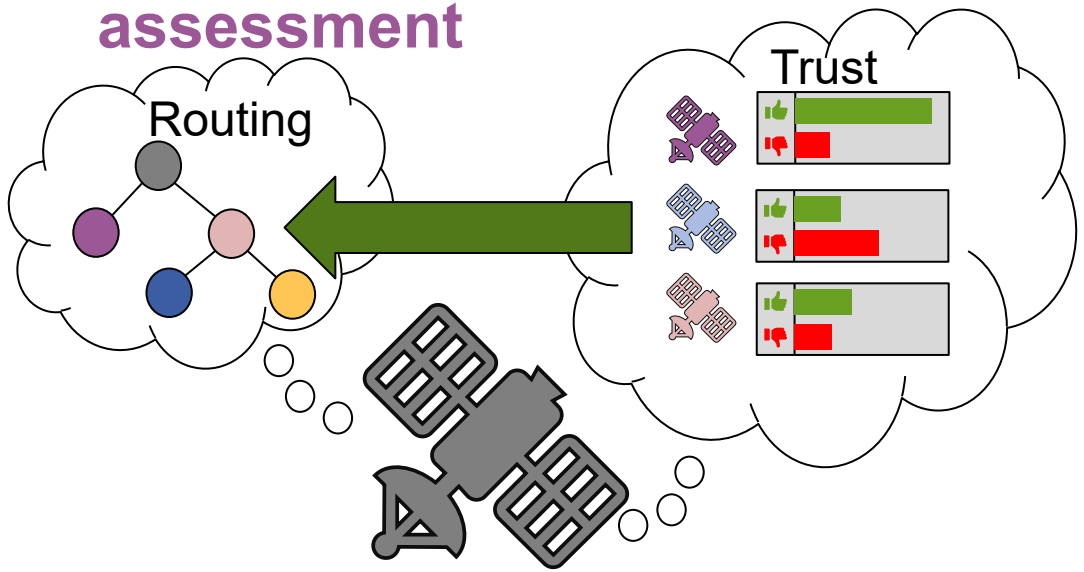
Offline Algorithm

- Leverage offline **shortest path** routing algorithm
- Minimize online computations for **low latency**



Trust Based Routing

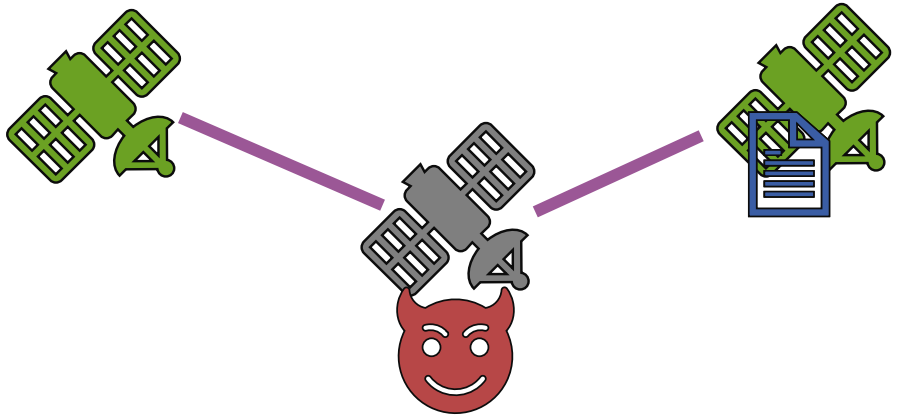
- Continue development of satellite network **simulator**
- Add support for **trust assessment**



T2: Next Steps – Constellation Simulation

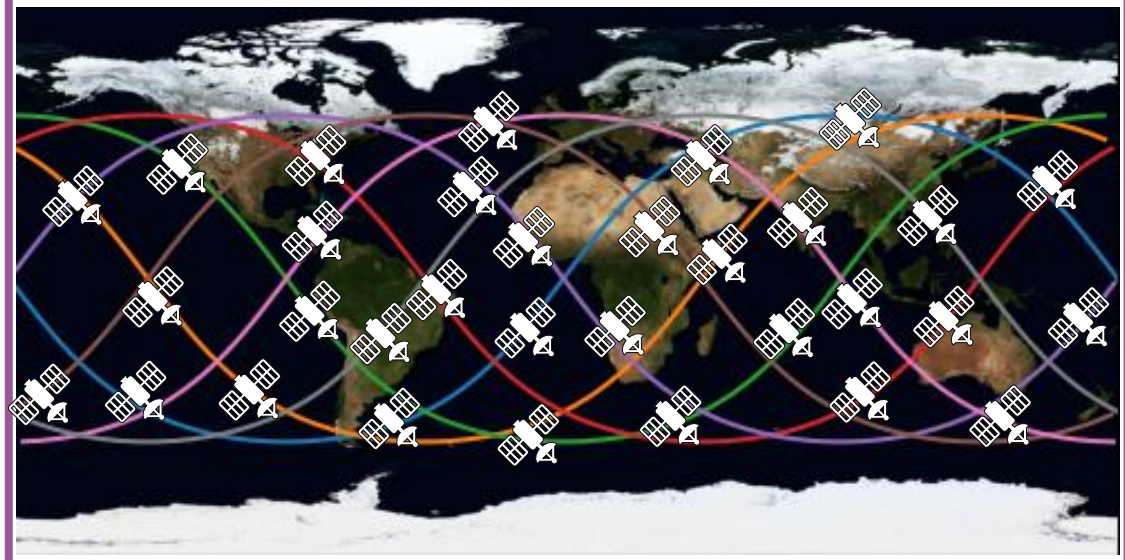
Network Simulation

- Instantiate **routing algorithms**, **traffic models**, etc.
- Integrate **trust assessment**
- Assess **queuing delay** and **link contention** in satellite networks



Simulator Scalability

- Support **larger** constellations
- Minimize effects of scale on runtime using **parallelization**



Milestones, Deliverables, Budget

MILESTONES

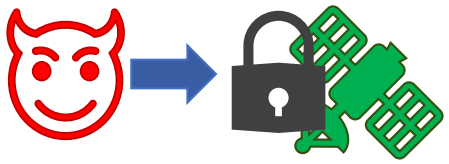
- SMW26 (06/26): Showcase preliminary results on all project tasks
- SAW26-27 (01/27): Completion of all project tasks

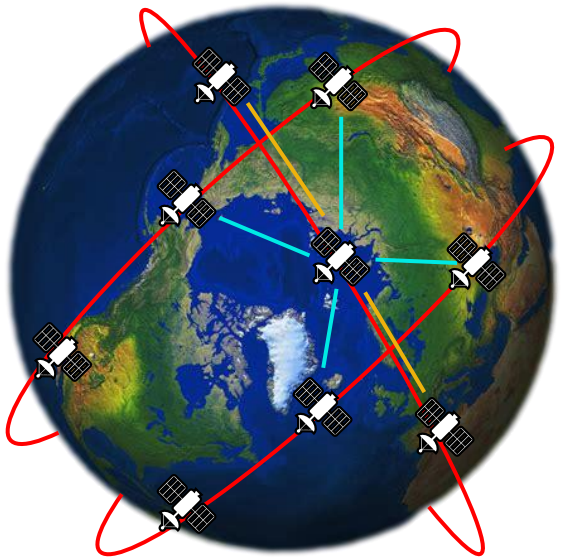
DELIVERABLES

- Monthly progress reports from all projects
- Midyear and end-of-year full reports from all projects
- 2 conference and/or journal publications

BUDGET

- Minimum recommended: Two (2) memberships
  (100 Votes)

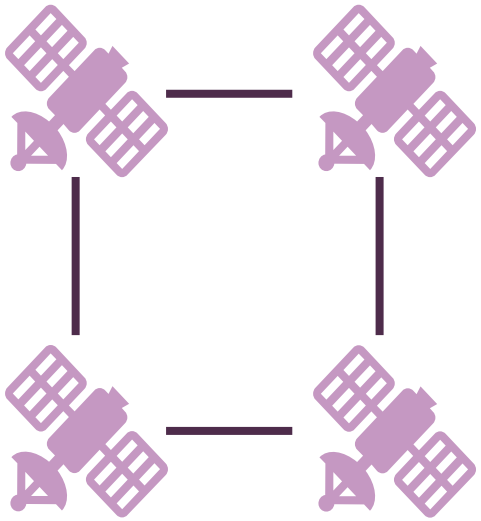




Conclusions & Member Benefits

Conclusions

- Develop a trust algorithm that relies on behavioral and environmental indicators to perform trust assessment
- Test responses to coordinated attacks and verification methodologies
- Create trust-based routing algorithm utilizing stored routing tables
- Continue to develop network simulator for varying traffic conditions and constellation parameters and configurations



Member Benefits

- Direct influence over processors and frameworks studied
- Direct influence over apps and datasets studied
- Direct benefit from new methods, data, code, models, and insights from metrics, benchmarks, and emulations