RT-180: Extending Flexible Contracts for Mission Assurance and Reliability Assessment

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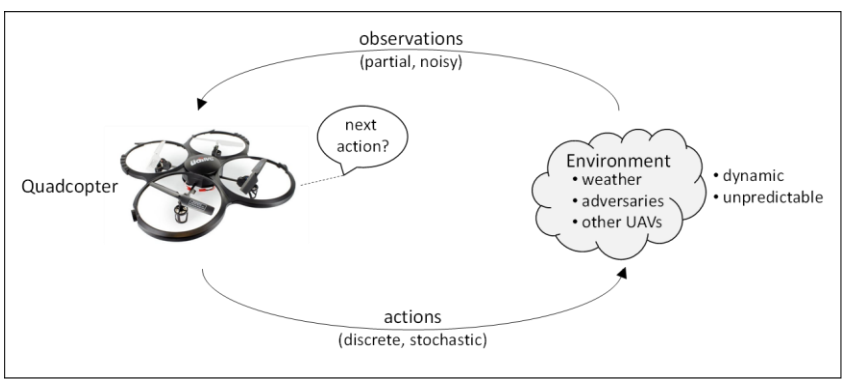
Research Task / Overview

- Advance resilience contract methodology for closed-loop mission assurance.

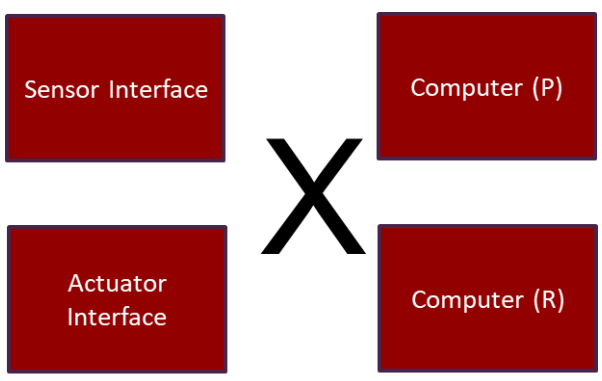


Goals & Objectives

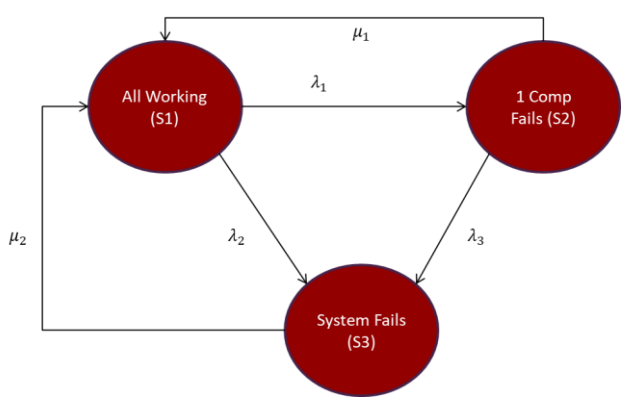
- Develop a probabilistic formal system model that enables incremental update of mission assurance assessment based on incoming sensor data
- Exploit combination of deterministic and probabilistic modeling, and reinforcement learning to strike an effective balance between flexibility and verifiability

Data & Analysis

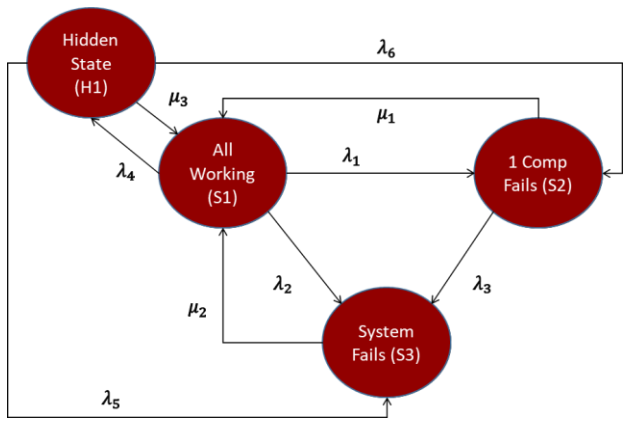
- Exemplar Problem:
  - A simple system comprising prime (P) and redundant (R) computers cross-strapped to sensor & actuator interfaces:



  - An initial Markov Model for a repairable system derived from invariant contracts might look like this:

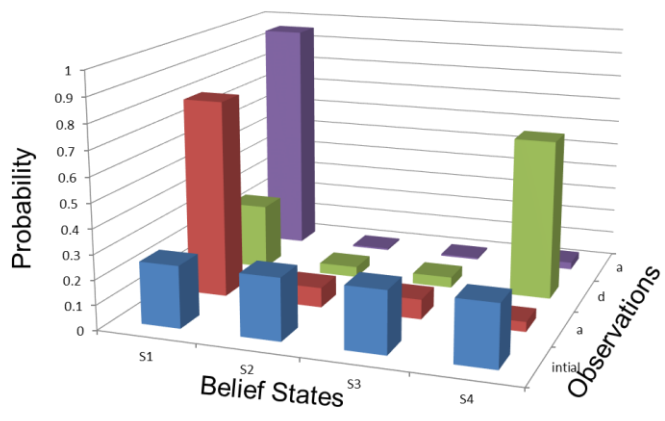


  - There can be many possible states between failed and working for computers, sensors and actuators, but we might not know what these are – for simplicity, we add a single hidden state, H1 and continue analysis:



Methodology

- Model system using a combination of:
  - Traditional contracts
  - Flexible contracts
  - POMDP
- Control flow model
- Swarm control architecture
- Iterative Bayesian belief update



Future Research

- Explore use of heuristics to dynamically modify POMDP policy
  - strictly formal/formulaic methods are insufficient to cope with real world complexity
- Pursue staged implementation
  - MDP on simple problem, POMDP on simple problem, in situ MA assessment on complex problem

Contacts/References

- Madni, A.M., Sievers, M., “A closed loop Approach to Mission Assurance Based on Flexible Contracts”, submitted to INCOSE IS 2018