DARTSim: An Exemplar for Evaluation and Comparison of Self-Adaptation Approaches for Smart Cyber-Physical Systems

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Self-Adaptation for Smart Cyber-Physical Systems

Self-adaptation capabilities are used to allow cyber-physical systems to operate in dynamic and uncertain environments.

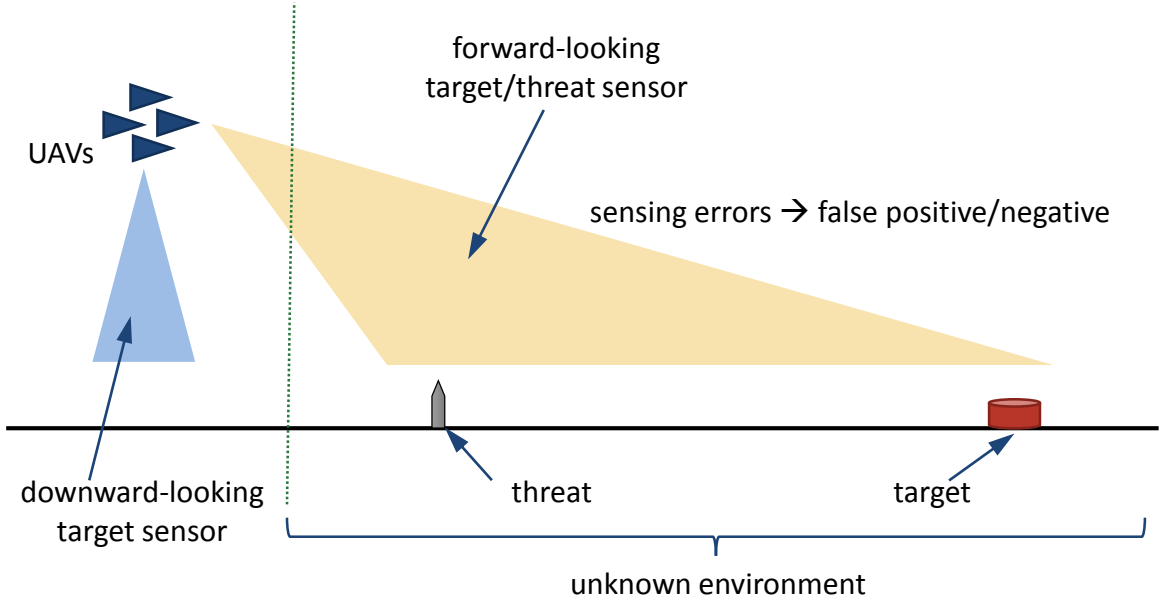
Self-adaptation for sCPS face particular challenges:

- environment monitoring subject to sensing errors
  - e.g., noisy sensors
- adaptation actions that take time
  - e.g., due to physical movement, sensors that recalibrate on power-up
- dire consequences for not adapting in a timely manner
  - e.g., physical damage to system or third party
- incomparable objectives that cannot be conflated into a single utility metric
  - e.g., avoiding an accident vs. providing good service

DARTSim

Simulated autonomous team of unmanned aerial vehicles (UAVs)

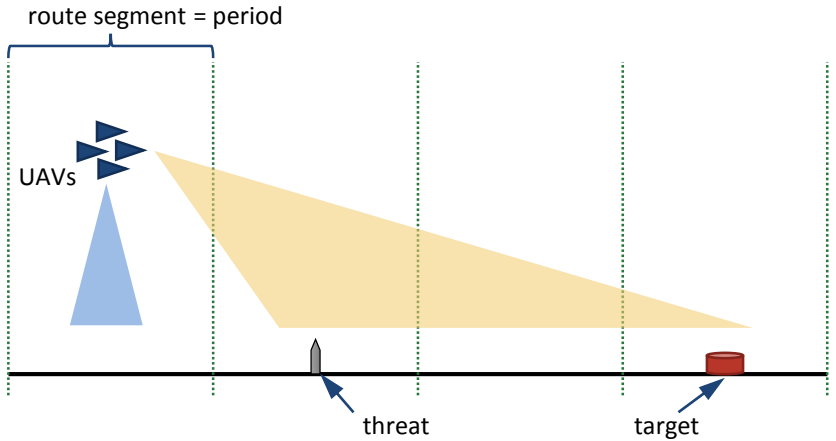
Reconnaissance mission in hostile and unknown environment: *fly predefined route to detect targets on the ground while avoiding threats*



*DART = Distributed Adaptive Real-Time

Adaptation Tactics

Tactic Code	Description	Latency
IncAlt	Climb one altitude level	1 period*
DecAlt	Descend one altitude level	1 period*
IncAlt2	Climb two altitude levels	1 period*
DecAlt2	Descend two altitude levels	1 period*
GoTight	Change to tight formation	immediate
GoLoose	Change to loose formation	immediate
EcmOn	Turn ECM on	immediate
EcmOff	Turn ECM off	immediate



*default latency, configurable

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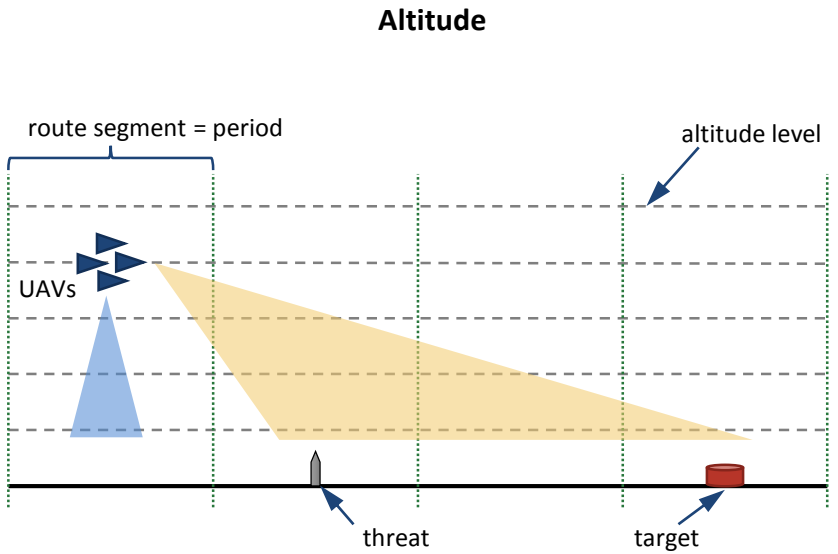

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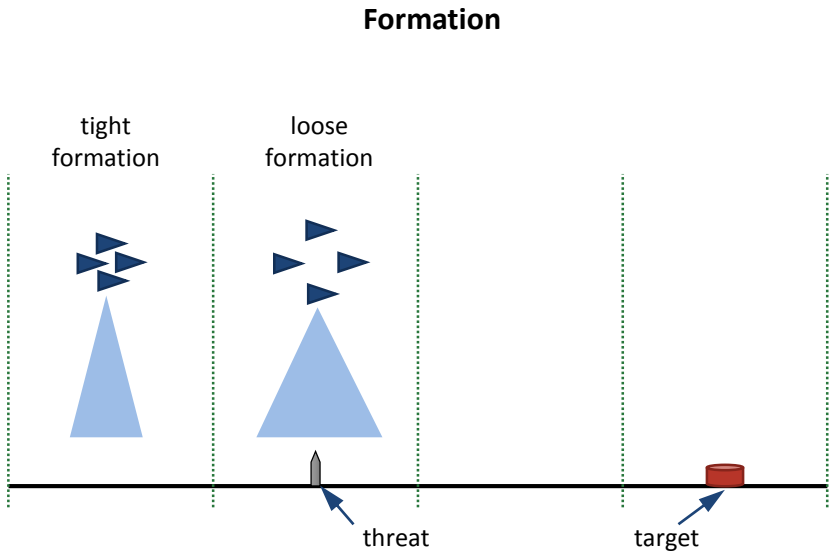

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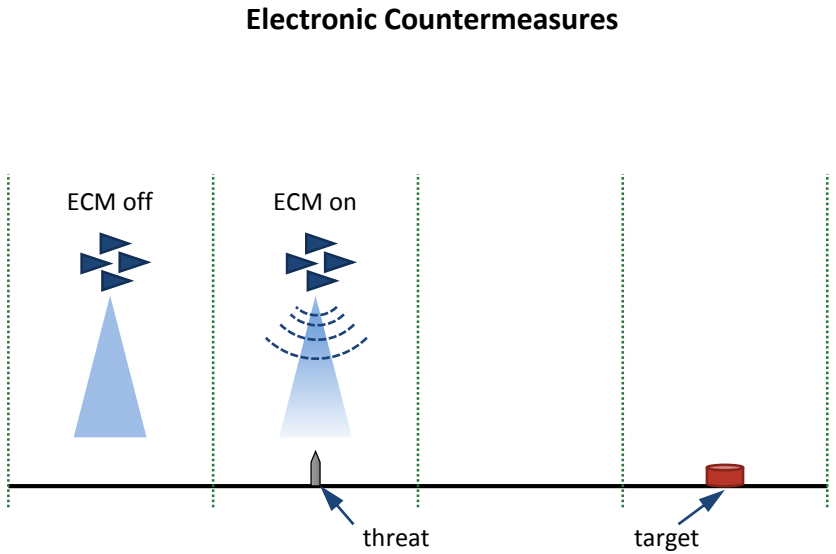

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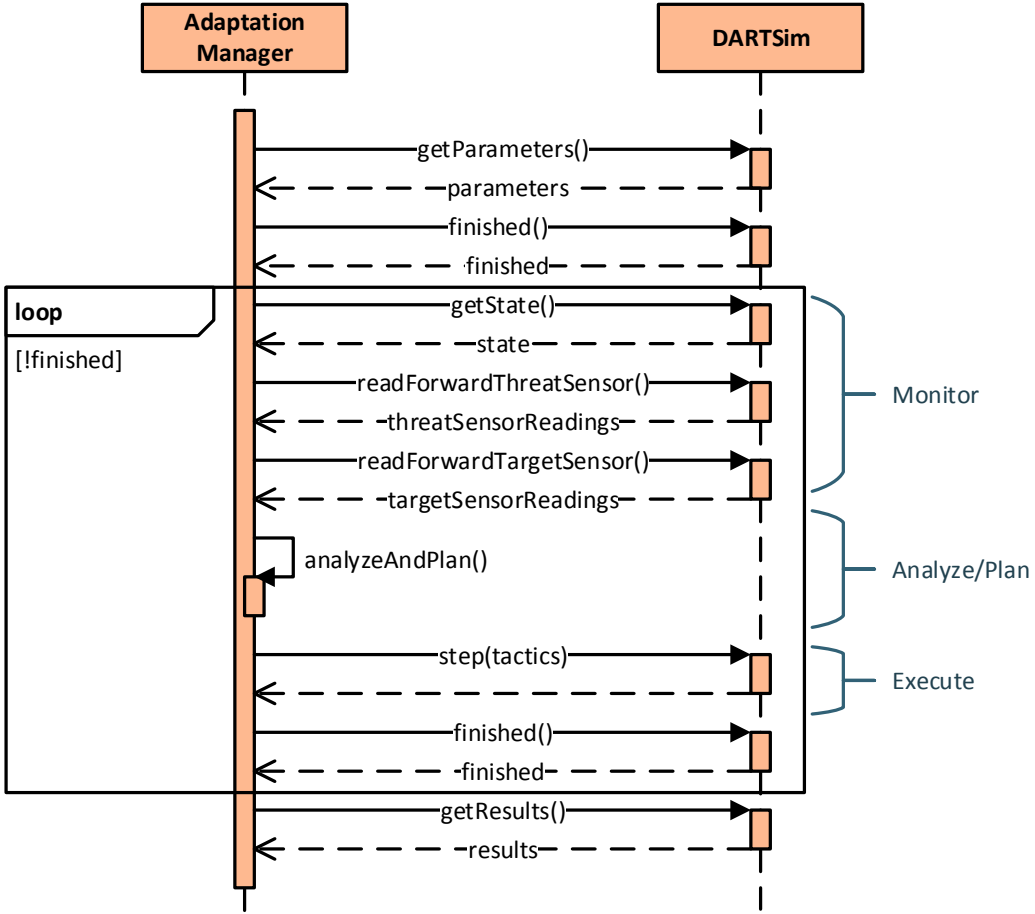

Interfacing with DARTSim

Two options:

- DARTSim as separate process
  - TCP-based interface
  - JSON-encoded parameters and responses
  - Java client library implementing this interface included
    - Simple integration with adaptation managers in Java
    - Reference implementation

- DARTSim as a library
  - linked with adaptation manager
  - simple method calls from C++
  - no inter-process communication overhead

Demonstration

Get DARTSim

Docker image:

https://hub.docker.com/r/gabrielmoreno/dartsim

Source code:

https://github.com/cps-sei/dartsim