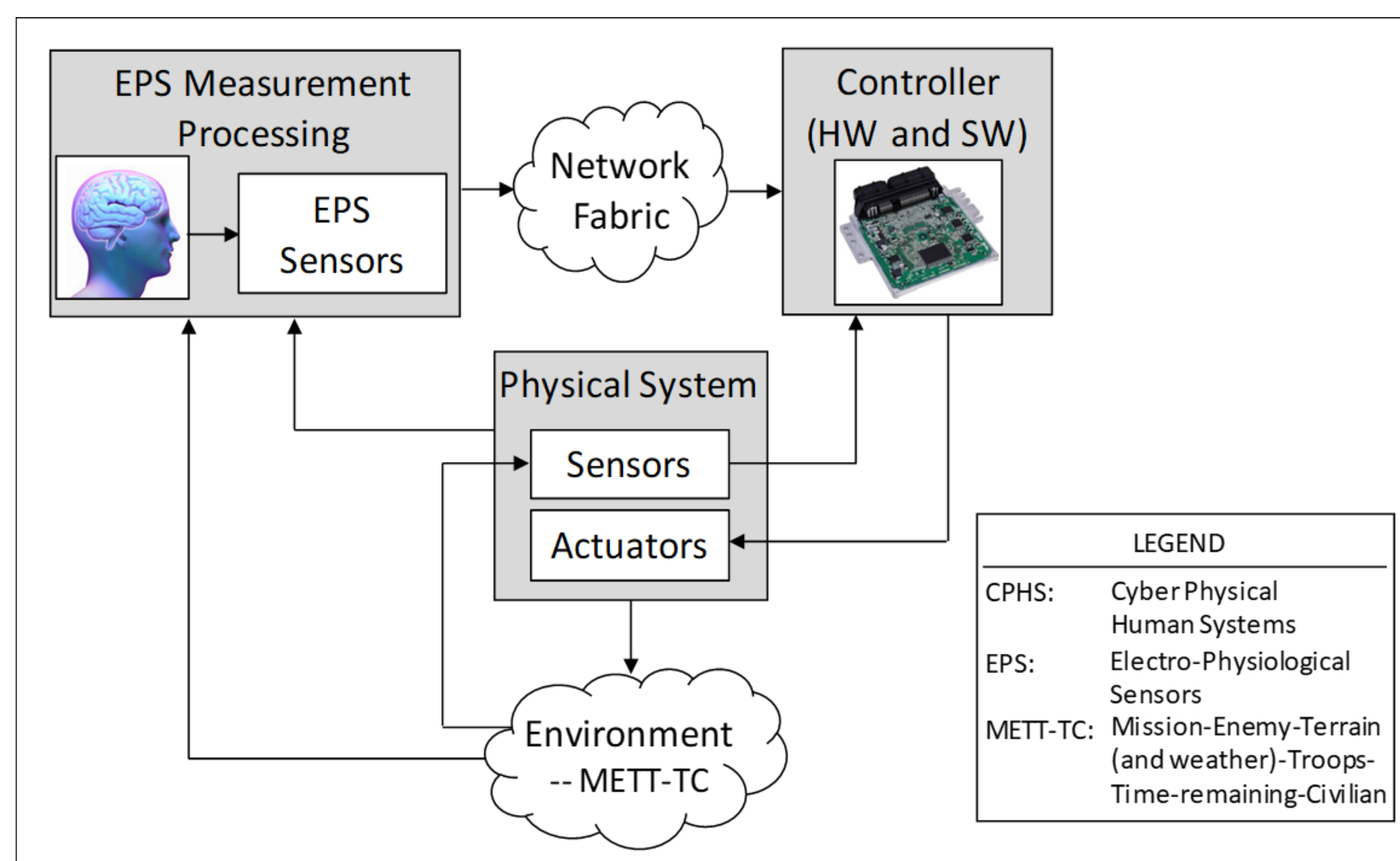


Research Task / Overview

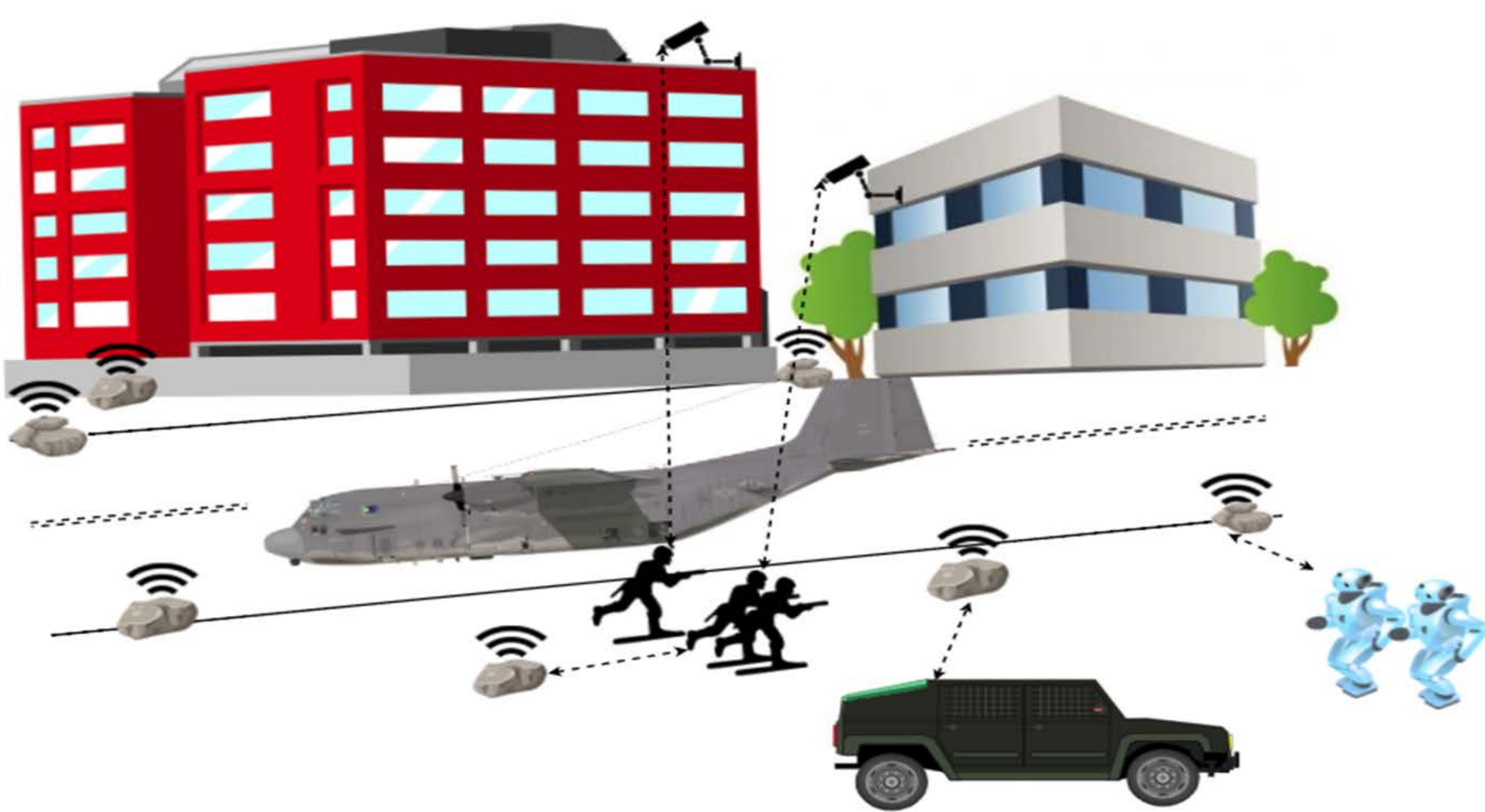
- A class of safety-critical socio-technical systems in which interactions between *physical system* and *cyber elements* that control its operation are influenced by *human agent(s)*
- Key challenges:
 - Inferring human intent – from noisy EPS
 - Incorporating strong time semantics – to ensure proper CPHS synchronization and operation
 - **Ensuring shared context – during systems operation and adaptation**
 - **Architecting Bi-Directional CPH Decision System to reduce human oversight and human error**

Data & Analysis

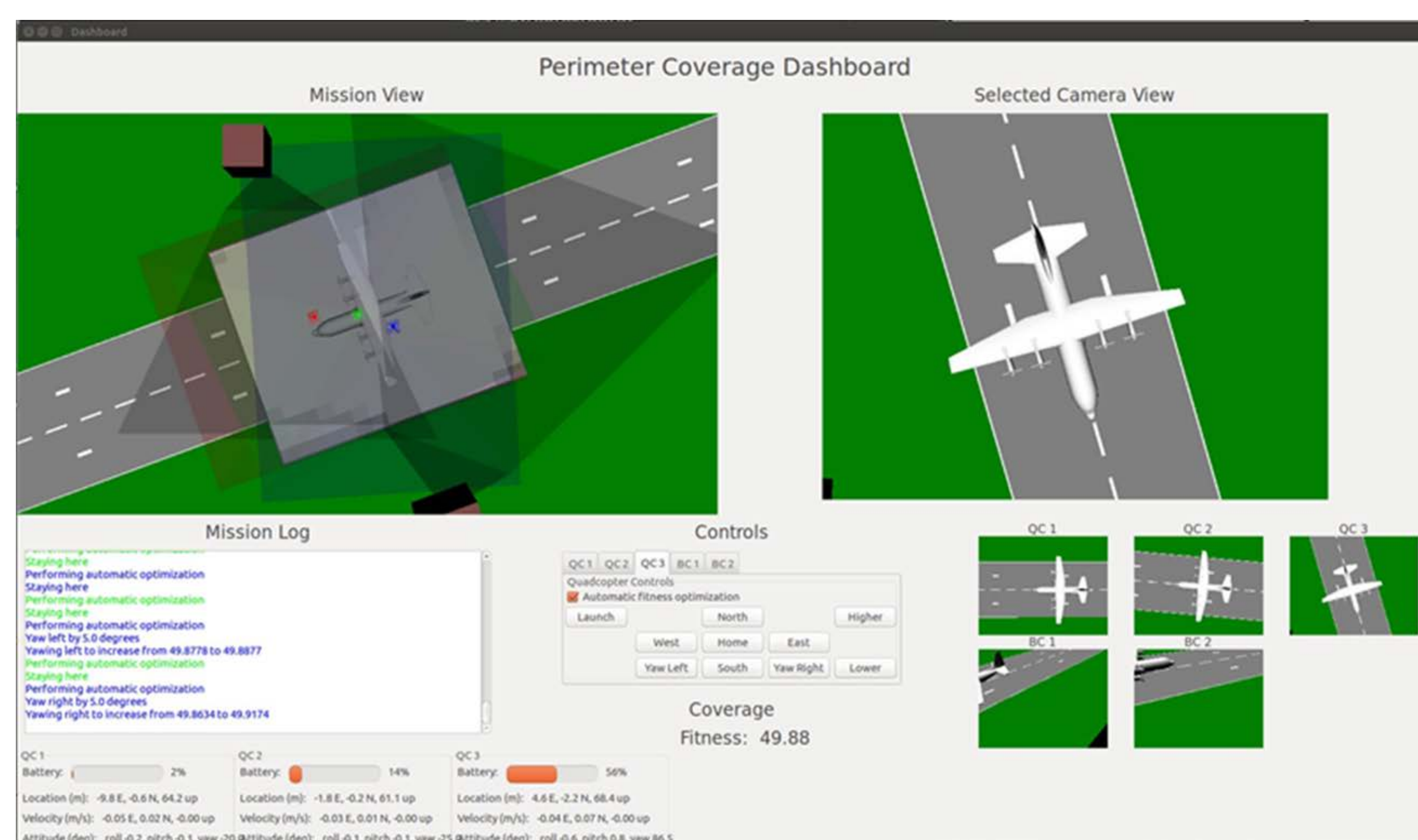
- Adaptive CPHS: System Concept



- Illustrative Example: Security of Parked C-130 Aircraft



- Dashboard Showing Optimal Location of 3 Quadcopters for Perimeter Security



Goals & Objectives

How to formulate and assess collaborative risk in distributed systems?

- Trade upside potential with penalty for failure
- Evaluate metric based on Selten's Weighted Average Log Measure of risk dominance

How can a collaborative risk metric be operationalized to evaluate a joint program?

- Develop scenario narrative based on NPOESS
- Assess collaborative risk using historical data

Methodology

- Key requirements
 - Reduce human oversight slips)
 - Minimize human error (mistakes)
- Implications – need decision support to ensure:
 - Shared context is maintained during adaptive execution
 - Human is not cognitively overloaded
 - Human is not asked to monitor infrequent events
 - Human and CPS are assigned tasks they do well
 - Neither is assigned tasks they do poorly
- Adaptive Bi-Directional CPH Decision System
 - Context ontology and context change criteria
 - Dashboard based on above to maximize SA
 - Classify tasks into: both poor at, both good at, human better than CPS, CPS better than human, better together than either alone
 - Allocate tasks based on above and provide decision support based on shared context (human task priorities and preferences) and above classification
 - Exploit machine learning (supervised, unsupervised, reinforcement) as appropriate

Future Research

- Finalize ontology to facilitate integration of cyber, physical and human elements
- Employ ontology to refine adaptive CPHS architecture and increase functionality of Prototype and Experimentation Testbed
- Incorporate components to address key technical challenges
- Explore machine learning opportunities for problem domain
- Continue developing simulation dashboard and incorporate additional dashboard functionalities
- Specify use cases to develop adaptive CPHS functionality
- Expand user interface functionality

References

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