A prescriptive and adaptive framework for UAS SoS Testing in LVC Environment

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Outline

• PATFrame team
• PATFrame objectives & scope
• PATFrame stakeholders
• PATFrame tasks
• PATFrame features
• Next steps
Prescriptive Adaptive Test Framework

Prescriptive

Test Strategy/Test Infrastructure

Adaptive

System under test
PATFrame Objective

To provide a decision support tool encompassing a prescriptive and adaptive framework for UAS SoS Testing

- PATFrame will be implemented using a software dashboard that will enable improved decision making for the UAS T&E community
- Focused on addressing BAA topics *TTE-6 Prescribed System of Systems Environments* and *MA-6 Adaptive Architectural Frameworks*
- Three University team (MIT-USC-UTA) draws from experts in test & evaluation, decision theory, systems engineering, software architectures, robotics and modeling
Time Scale for Testing Decisions

PATFrame Scope

Test Execution (real time)

Data Collection, analysis & reprioritization

Test Planning (in SoS environment)

Test Development (i.e., design for testability)

Long Term Planning Decisions/investments

Minutes

Hours

Days

Months

Years
PATFrame Stakeholders

DoD Test Resource Management Center (TRMC)

- Army Test & Evaluation Command (ATEC)
- Air Force Operational Test and Evaluation Center (AFOTEC)
- Naval Air Systems Command (NAVAIR)

UAST Steering Group
- White Sands Developmental Test Command
- Ft. Hood Operational Test Command
- Kirtland Air Force

Transition Partners
- N-UCAS Navy

PATFrame Stakeholders

MIT
USC UTA
SoftStar
PATFrame kickoff meeting
Fort Hood, TX - Aug 2009
Task 1: Prescribed System of Systems Environment

Goal: Construct Theoretical Best “SoS” Test

Normative

Goal: Capture Actual SoS Test

Descriptive

Metric set, “best” levels

Descriptive (actual)

Actual SoS tests include metricA', metricC, etc.

Goal: Synthetic framework for SoS testing at single and multi-program level

Prescriptive

“Successful SoS Test” = f (metricA, metricB, etc.)

Metrics, state of the practice levels

Test A contribution to state of the practice

Goal: Synthetic framework for SoS testing at single and multi-program level

“success”

Limit

MetricA, MetricB, MetricC, ..., MetricN

Normative (best)

Descriptive (SoP)

Descriptive (actual)

Potential (new test A)

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Task 2: Adaptive Architectural Frameworks

- Ontology
- Causal Model
- Design Idioms for SoS
- Framework for dynamic adaptation
Features under development:

- System modeling (adaptive architectures, dependency matrices)
- Risk prediction (leading indicators, knowledge-based forecasting)
- Test planning (real options)
- Test resource estimation (parametric modeling)
- Test evaluation & adaptation (system dynamics)
Real Options as Prescriptive and Adaptive Framework for SoS Testing

- **Use case:**
  - Question: what to test? (i.e. what SoS test scenarios to prescribe?)
  - Inputs: models of autonomous/net-centric system of systems, major uncertainties
  - Outputs: enablers and types of real options for responding to uncertainties as candidate test scenarios (i.e. identification of how SoS can adapt)

**Joint/ SoS Model:**

- **Ontology**
  - Vehicle1 (Army)
  - Vehicle2 (Navy)
  - Vehicle3 (Air Force)

- **Uncertainties**
- **Mission objectives**

**Identification of Real Options:**

Objective: Maintain Vehicle1 ↔ Vehicle2 comm.
Uncertainty: proximity of vehicles 1 and 2

1. Real option to adjust comm. range using flexible range comm. systems on vehicles1, 2
2. Real option to use Vehicle3 as relay
System of System Risk Based Testing

Risk Identification
- Long life expectancy
- Multiple stakeholders
- Multiple requirements
- Number of interfaces
- Complexity of system integration
- Environment Operation

Risk Mitigation
- Operation and Usability in Environment
- Requirements Balance
- Incremental Technology Maturation
- Optimized Utilization

Synchronized Position Hold Engage Reorient Experimental Satellites (SPHERES)

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Knowledge Base Analysis Techniques

Risk & Uncertainty Analysis (leading indicators)

Process Analysis (System Dynamics)

Primary Inputs to PATFrame:
- Models of the system under test
- Model of the SoS environment
- Mission needs/goals
- Test Requirements
- Available resources and time

Primary Outputs for Test and Evaluation:
- How should my test strategy change?
- What realizable options are available?
- Which test do I run and in what order?
- When am I done Testing?

Primary Outputs for Test and Evaluation:
- Plan
- Analyze and Design
- Execute
- Evaluate

Reasoning Engine

Ontology

Knowledge Base

Analysis Techniques

Primary Outputs for Test and Evaluation:
- What realizable options are available?
- Which test do I run and in what order?
- When am I done Testing?
Next Steps

• PATFrame workshop tomorrow (10:30-4:30)
• Evolve uses cases with transition partners
• Obtain feedback on PATFrame features
• PATFrame workshop March 11 in Los Angeles (at USC)
• Continue alignment with Net-centric systems investment area