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"Automated Software Testing Increases Test Quality and Coverage Resulting in Improved Software Reliability."

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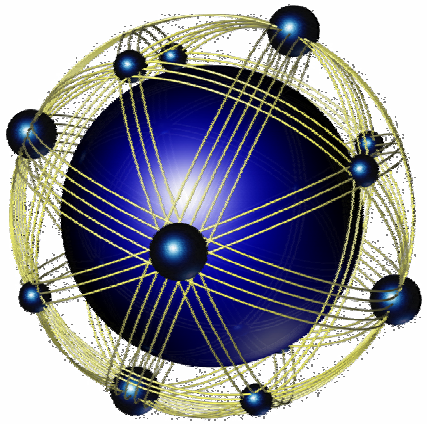
Frank Salvatore
High Performance Technologies, inc.
3159 Schrader Road
Dover NJ, 07801
(973) 442-6436 ext 249
fsalvatore@hpti.com



Outline

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Background

- Phase I SBIR Completed in FY 2004 proving feasibility.
- Phase II SBIR to Start in FY 2006
- Sponsor: US ARMY ARDEC, Fire Control Systems & Technology Division (FCSTD)
- Contractors:
  - Cognitive Concepts, LLC Prime
  - High Performance Technologies, Inc (HPTi)
  - Software Silver Bullets

Project Purpose & Goals

- Generate an integrated process which enables any SW Development organization to apply Model based Specification and Testing (MST)
- Significantly advance the state of the practice for system level MST.
  - ✓ Create large models of complex system software behaviors that closely represent expected operational behavior of a specific system.
  - ✓ Automatically generate test cases from the model.
  - ✓ Define and store test scripts associated with every stimulus in the test population.
  - ✓ Generate executable test scripts.
- Implement the required tools that will enable bringing Model Based Specification and Testing technology to market.
- Reduce Software Life Cycle Maintenance Costs.

Overview SW Reliability

- ***Software Reliability*** **- Probability of failure-free software execution in a specified operating environment.**
- ***Software Reliability Engineering*** **- Systems engineering process activities ensuring reliable software systems.**
  - ***Assessment*** **- software reliability can be assessed (measured) only when the software is executing, either in a test lab or in the field.**
  - ***Prediction*** **- prior to having executable software, assessment is done by inference via a forecast.**

SRE Challenges

- Verifying the system does what users want.
- Integrating Requirements analysis and System Software testing.
- Determining what to measure and when to measure it.
- Limiting scope and breath of testing to stay on schedule.

SRE Fundamental Principal

SRE involves:

- **Developing an operational, or usage, profile of the software system under test and**
- **Exercising random test cases from the profile to obtain a direct assessment of the reliability of a software system**

Statistical Testing in a Nutshell

Statistical Testing

- Specification represented in the form of usage models
- System tests generated directly from usage models

Markov-chain usage models

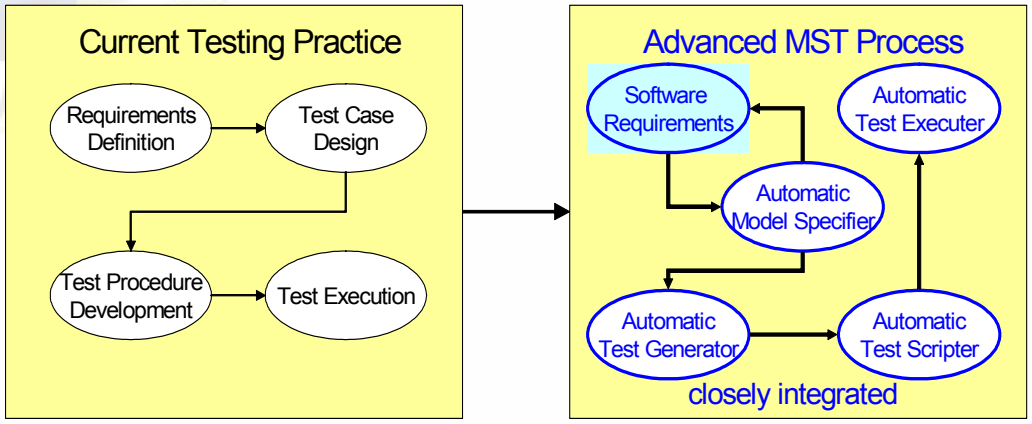
- Black box state-based models that cover every possible state of *usage* for a software system
- External behavioral representation of system
- Composed of states (conditions) and arcs (stimuli)

Software tool generates random test cases

Current State of System Software Testing

Industry practice for testing military applications uses a requirements-based approach.

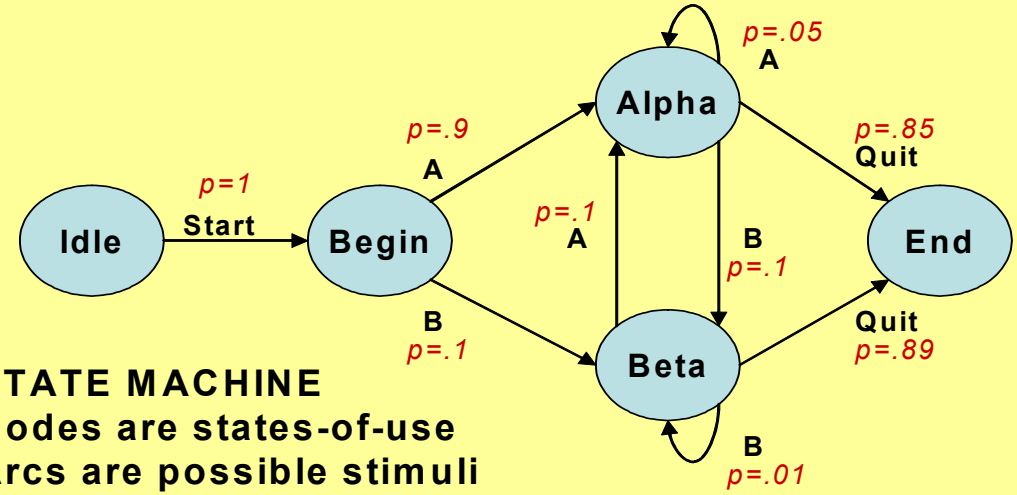
- Test cases are defined for each requirement, or shall statement.
- Test cases are designed manually or with a software tool that is independent of the requirements tool.
- Test cases are scripted manually or with a tool that is not integrated with the test design tool.
- Tests are executed manually or in some cases the tests are automated utilizing a project specific test automation tool.



An innovative approach to requirements specification and testing

MBT Structure

- MBT is a black box representation of the expected behavior of system software.
- A model-based specification is called a usage model specifying how the system is used, or behaves.



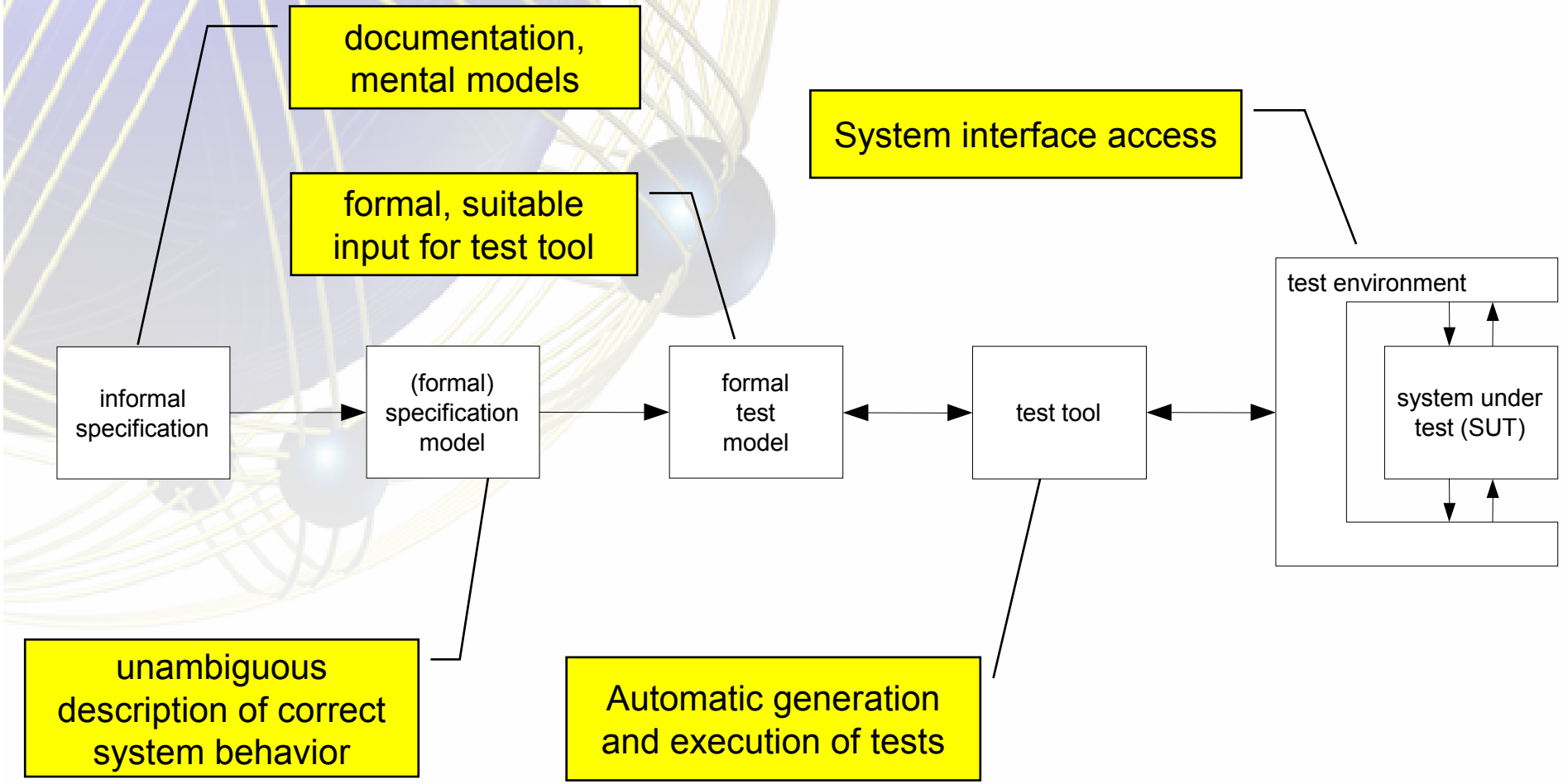
STATE MACHINE
Nodes are states-of-use
Arcs are possible stimuli
Probabilities (*p=1*) define expected usage
Test case is a path from initial to terminal state

MST Overview

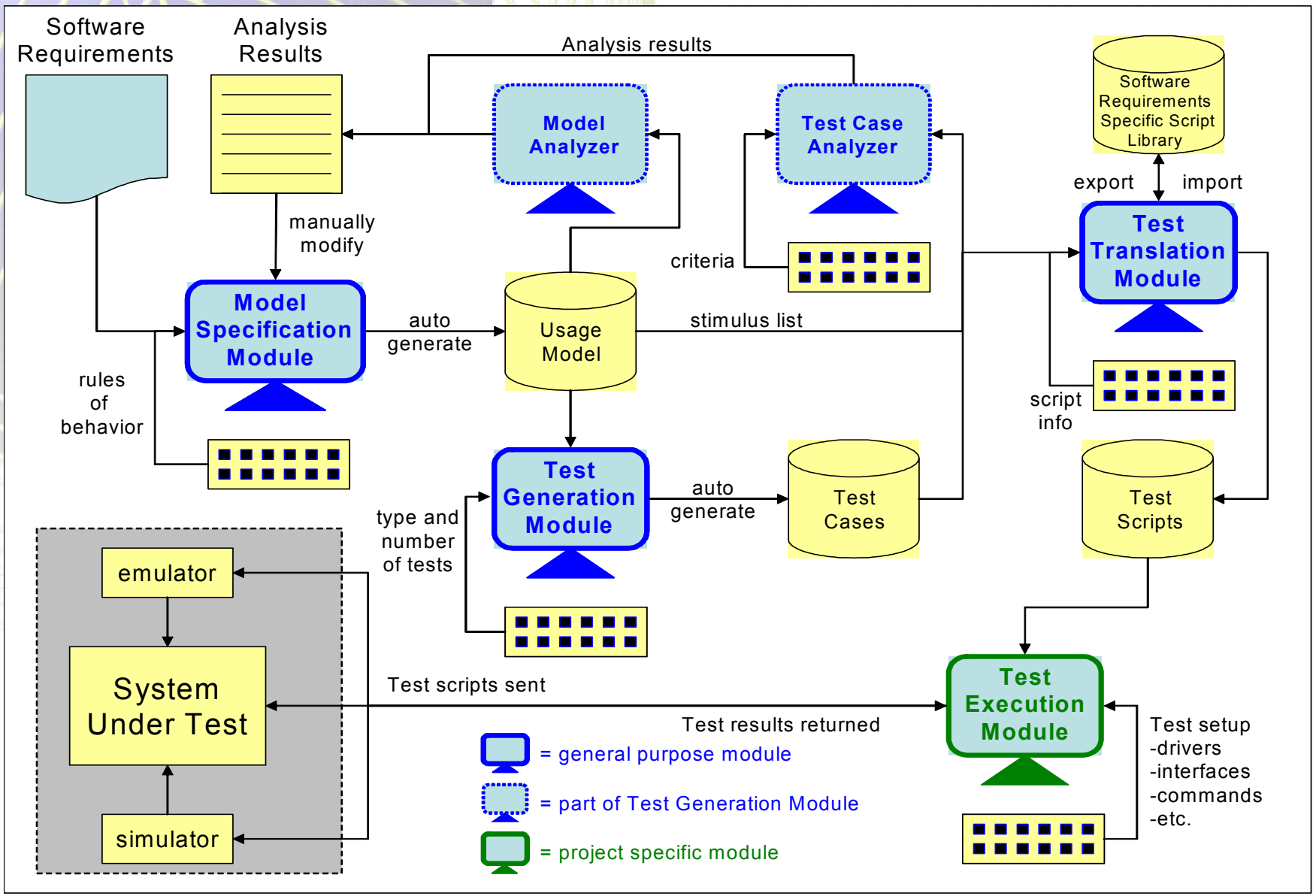
MST

- Provides a structured approach to requirements analysis and software test design.
- Ensures the system specification prescriptive and consistent to enable automatic generation of system software test cases.
- Facilitates an objective assessment of system software reliability.
- Enhanced communication between developers and testers.
- Eases the updating of test suites for changed requirements.
- Shorter schedules, lower cost, and better quality.
- A model of user behavior.
- Early exposure of ambiguities in specification and design

MBT Development Flow



Toolset Architecture



Model Specification Module

Capability:

- **Tabular entry of system requirements.**
- **Definition of the system boundary by itemizing all input stimuli and responses**
- **Specifying traceability via requirement tags.**
- **Enumeration of input stimulus sequences**
- **Automatic analysis of the completed enumeration to verify coverage and to construct the usage model.**
- **Define usage variables and associate a unique set with each state in the model.**
- **Assigning probabilities to each transition in the usage model.**
- **XML schema for storing and managing the above data**

Test Generation and Analysis Module.

Capability:

- **Provides Markov analysis of the usage model for properties useful for model validation and test planning.**
- **Enables test case generation via random walk, relative probability, and graph coverage algorithm.**
- **Enables test case management necessary for pass/fail recording and format conversion.**
- **Provides analysis of test results to compute coverage and reliability metrics**

Test Translation Module

Capability:

- **Accepts operator input to build script fragments for each system stimulus and export the result to the script library.**
- **Reads stimulus mapping information from the script fragment library that maps the stimuli used in the model to codes readable by the Test Execution Module.**
- **Determines proper code sequences to perform the test cases created by the Test Case Generator.**
- **Generates test scripts for the Test Execution Module from the fusion of script fragments**

Test Execution Module

Capability:

- **Executes target specific test scripts using hardware and software elements designed to interface with the system under test.**
- **Provides the operator an interface to observe the test steps being performed as well as enabling the operator to pause or restart testing.**
- **Logs any results generated from the testing in formats for human interpretation and for input to the Test Case Analysis and Generation Module**

Auto-Tester

Capability:

- **Perform end-to-end testing of System Software.**
- **Record scripts from a PC keyboard and play them back to the keyboard port of a PC.**
- **Translate the serial communication between the Display Unit (DU) and the AFCS Computer Unit (ACU).**
- **In order to support the Enhanced Display System (EDS), the connection to the Auto Tester would be inserted between FBCB2 and the ACU, not between the EDU and FBCB2**

Automated Test Capability

Capability:

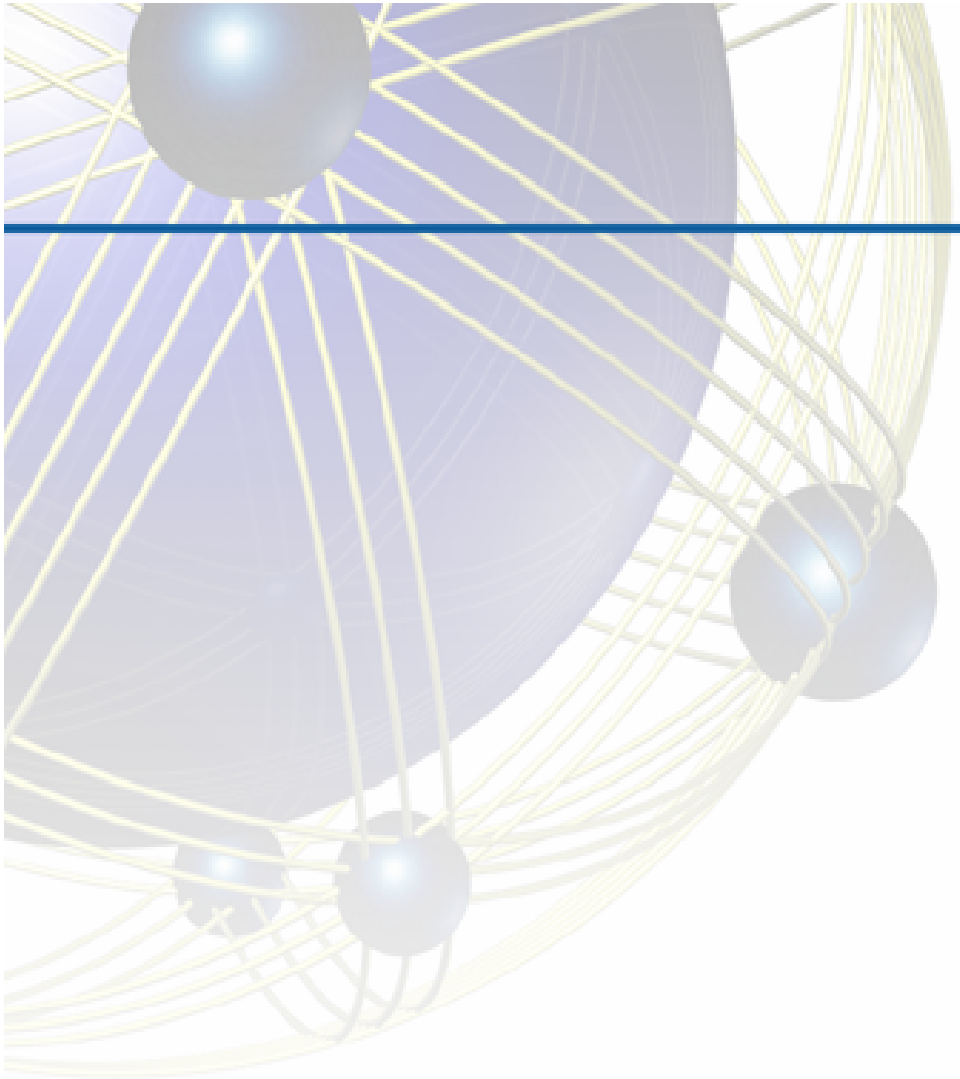
- **Supports Developmental, Integration, and Formal Qualification Testing (FQT) of a Fire Control Software System.**
- **Provides and demonstrates a means to capture test cases and procedures in a reusable form.**
- **Supports management of test artifacts, including storage, retrieval, editing, merging, and searching.**
- **Perform end-to-end testing of a Fire Control system software.**
- **Monitors and records the system's responses to stimulus, and, as necessary, emulates the appropriate response via a system interface to complete a given test case.**

Applying MST to Achieve Software Safety

- Traditional approaches include static analysis
- MST provides a robust, dynamic approach
  - ✓ Models cover all usage states, including rare ones.
  - ✓ Statistical testing ensures that potentially hazardous unknown or unforeseen events are covered in the system test suite. Static analysis alone cannot predict the consequences of highly complex behaviors.
- MST is a supplement to, not a replacement for, methods such as Fault Tree Analysis and Hazard Analysis.

Summary

- Automated Software Testing Increases Test Quality and Coverage Resulting in Improved Software Reliability.
- Project starts FY06
- Results will be provided in a final report and demonstration.
- Advance the state of the practice for system level MST.
  - Create large models of complex system software behaviors that closely represent expected operational behavior of a specific system.
  - Automatically generate test cases from the model.
  - Define and store test scripts associated with every stimulus in the test population.
  - Generate executable test scripts.
- Integrated Suite of Tools.



Questions?