Test and Evaluation in a System of Systems Environment

A Case Study of the Air Force Modeling & Simulation Training Toolkit (AFMSTT)

Edwin P. McDermott
and
Sharam Sarkani, PhD, PE
Thomas A. Mazzuchi, DSc
Notes

► This presentation is an extract of work being submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Systems Engineering at The George Washington University

► This presentation has been cleared for public release by the Electronic Systems Center, Hanscom AFB, Massachusetts

► The opinions expressed here are solely those of the principal author
Outline

► What is AFMSTT?
► Why is AFMSTT interesting relative to SoS T&E?
► What has AFMSTT done to make it work?
► Layered T&E Strategy
► Lessons learned that could be applied elsewhere
► Some fortunate circumstances
► Recommendations for further research
► Postscript
What is AFMSTT?

► The Air Force Modeling and Simulation Training Toolkit (pronounced “AFF’ mist”)
► Software program over 15 years old (written mainly in ADA & C++ > 2M SLOC)
► Significant human control/inputs/interaction (approximately ten model controllers)
► Provides a constructive air picture for battle staff training during major exercises and experimentation
AFMSTT Components

- Air Warfare Simulation (AWSIM) – sim engine
- Graphical Interface Aggregate Controller and Data Server (GIAC) – displays air picture
- C2 System Interface (CSI) – external links
- Logistics Simulation (LOGSIM) – injects realistic logistics constraints & behaviors
Why Is AFMSTT Interesting? (relative to T&E in a SoS)

► AFMSTT functions in several complicated federations and interacts with many systems not under a common governance system – the *essence* of System of Systems

► AFMSTT has been undergoing constant evolution since its inception with nearly continual modification
Joint Live Virtual Constructive (JLVC) Environment

Service Combat Simulations

Linkages to Live Systems/Forces

ASTi Radios
Voice Comms

SI MPLE
USA

BFTT
Navy
Range Integration

Virtual Simulators

AWSI M
USAF

ICE/FMS-D
USA, USMC, SOCOM

J CATS
USA, USMC, SOCOM

JSAF
Navy, IADS

SELS
Artillery

NWARS/ACE-10S/TACSI M/MDST
Sensors

C A V S I M
Apache

DVTE
USMC

V MH-53
SOCOM

V AC-130U
SOCOM

V B-52
ACC

TUAV/MUSE/AFSERS

V J STARS
J STARS

EP-3 MAST
Navy

V AC-130U
SOCOM

SSE
SOCOM

Range Integration

Linkages to Live Systems/Forces

Intelligence
What has AFMSTT Done to Make It Work?

► Constant attention to federated environment

► Integrated Test Team of Program Office (V&V), Using Command/Representative (AF Agency for Modeling and Simulation), JFCOM & Contractor along with others as required
  ▪ Developer using Agile software development
  ▪ “Test-driven development methodology”

► Intimately close-coupled and “layered” testing almost continuously
Layered Testing

► Contractor Testing
  ▪ Unit & Component QA Testing – nightly/automated
  ▪ System Integration Testing – weekly
  ▪ IA Testing (in-plant & by 46 TS) – every 30 days
  ▪ Extensive shared repertoire of test scripts and cases used to ID critical interfaces/functions (Note: These are constantly evolving/being updated!)

► Government Validation & Verification (V&V) – every 3 months done in C2 Enterprise Integration Facility @ Hanscom AFB
Layered Testing (cont)

► External Testing

- Air, Space & Cyber Constructive Environment (ASCCE) – test harness against ACE baseline
- Federation Testing (JLVC & JLCCTC) – every six months but can be done before major exercises
- Formal External IA – Air Force Communications Agency – Note: AFMSTT first legacy system to receive full ATO from AFCA!
- Event Preparation Testing – two-week “rehearsals” (bug fixing) before major events
Layered Testing
Agile Development Framework

Simulation Event, Exercise or Test Activity

CRs / DRs

Simulation Centers and Numbered AF Generate CRs and DRs

- CR/DR Clarifications
- Sprint Review Invites

UWG Prioritizes

AFAMS places CRs and DRs into DB

ESC Oversight

- CR/DR Clarifications
- Sprint Review Invites
- DR submissions
- Estimates

Warfighter Advocate Assists with CR & DR communication

- CR/DR Clarifications
- Assessments (S,M,L)
- Need-by Event/Date

Developer CCB

Exercise Support IPT Adds CR and DR Context

- CR/DR Clarifications
- Developer Questions

Development & Maintenance IPT Updates Code

Tech Leads Break Down Stories
Lessons Learned
(with potential for other systems)

► Constant awareness of SoS environment, focus on configuration control (both systems & interfaces)
► Proactive risk management of important interfaces
► Layered, incremental testing can identify most problems early, when easily fixed
► Employment of realistic test environments (fed tests)
► Pre-planned pre-event rehearsal time periods and allotted time for fixing bugs
► Closer user involvement reduces “stuff nobody really wants” which decreases test requirements
Observations

► Increased cost of testing has driven a desire for “the perfect test” and “complete knowledge”

► Complexities of SoS have made this unrealistic and unachievable! (in *both* cost & time)

► AFMSTT has gone in *exactly the opposite direction* with more testing at lower levels = SUCCESS!

► The Certification and Accreditation (C&A) and Test and Evaluation (T&E) processes need to function much more efficiently in concert/combination
Fortunate Circumstances

The AFMSTT primary mission is to function within a large federated system of systems

- Not all systems do so regularly

Small-dollar program, avoided many large formal documentation requirements

- LCMP incorporates most aspects of SEP, TEMP, etc. into widely used, concise living document

Popular User Base & linkage to Joint National Training Capability (JNTC) forces incremental delivery
Recommendations for Further Research

- Additional case studies
- Identify and investigate other large system-of-systems federations
- Work towards a set of principles for SoS T&E and develop a methodology
  - Roadmap for SoS/Net-Centric Approaches
  - Likely that a family of approaches will be needed (large/small federations, hardware/software systems)
Postscript

- DoD Exercise budget decreasing
  - Fewer dollars for major exercises
  - Fewer dollars for programs like AFMSTT
  - Modernization on Horizon – funding challenges

- Since no contract lasts forever, AFMSTT is preparing to recompete development
  - The “documentation gatekeepers” have struck!
  - AFMSTT program office now dedicating personnel to writing documents (that so far have been unnecessary)
Questions?