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

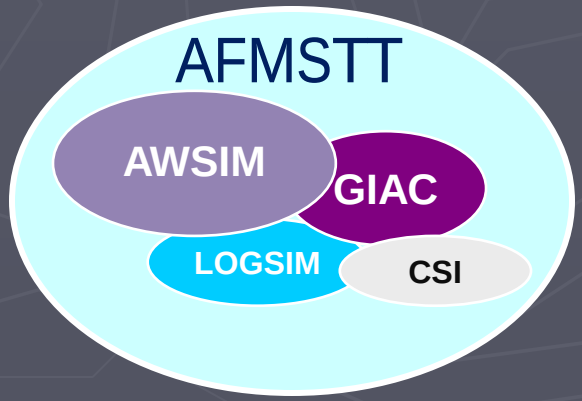
- What is AFMSTT?
- Why is AFMSTT interesting relative to SoS T&E?
- What has AFMSTT done to make it work?
- Layered T&E Strategy
- Lessons learned that could be applied elsewhere
- Some fortunate circumstances
- Recommendations for further research
- Postscript

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

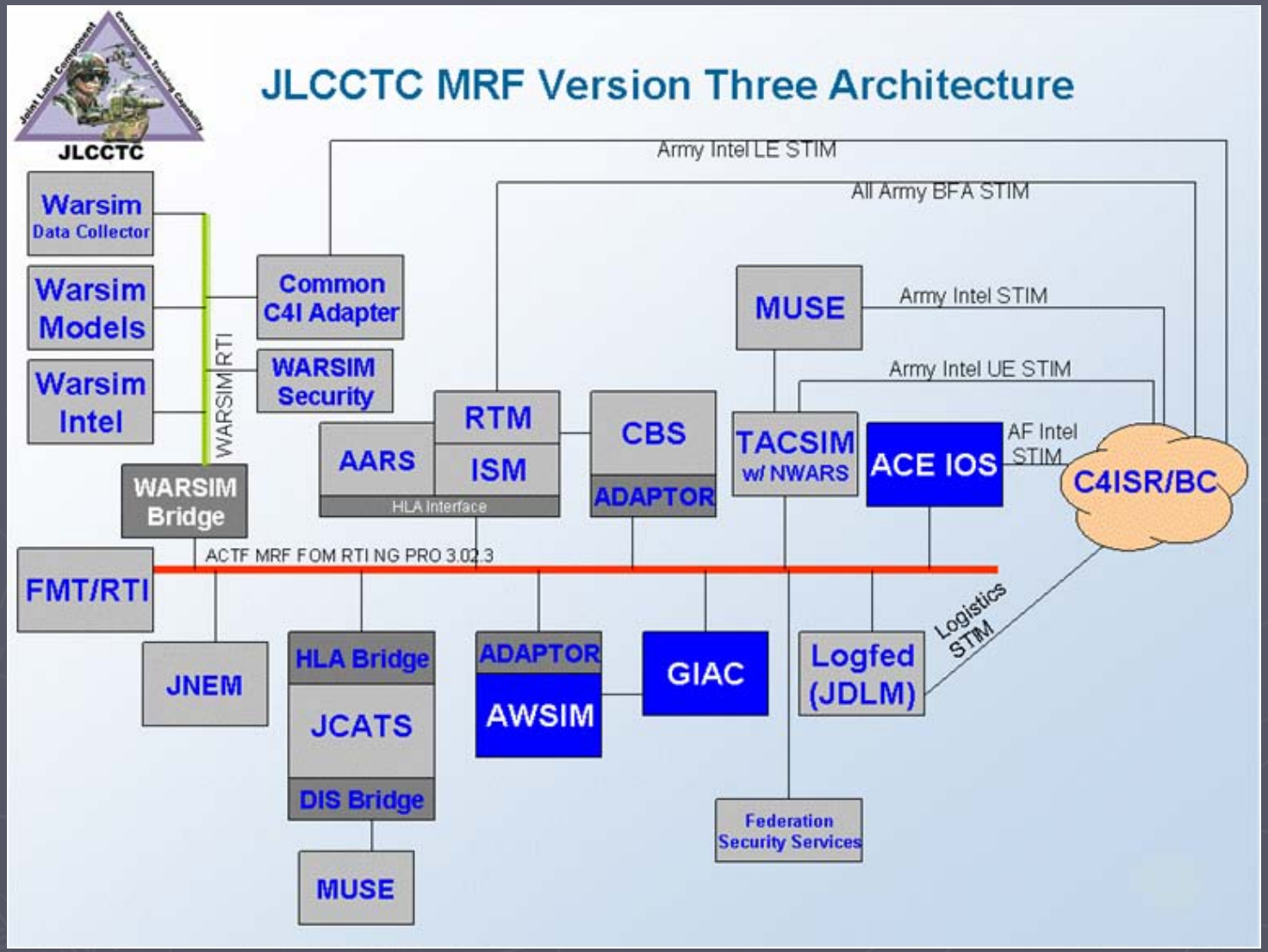
AFMSTT Components

- 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



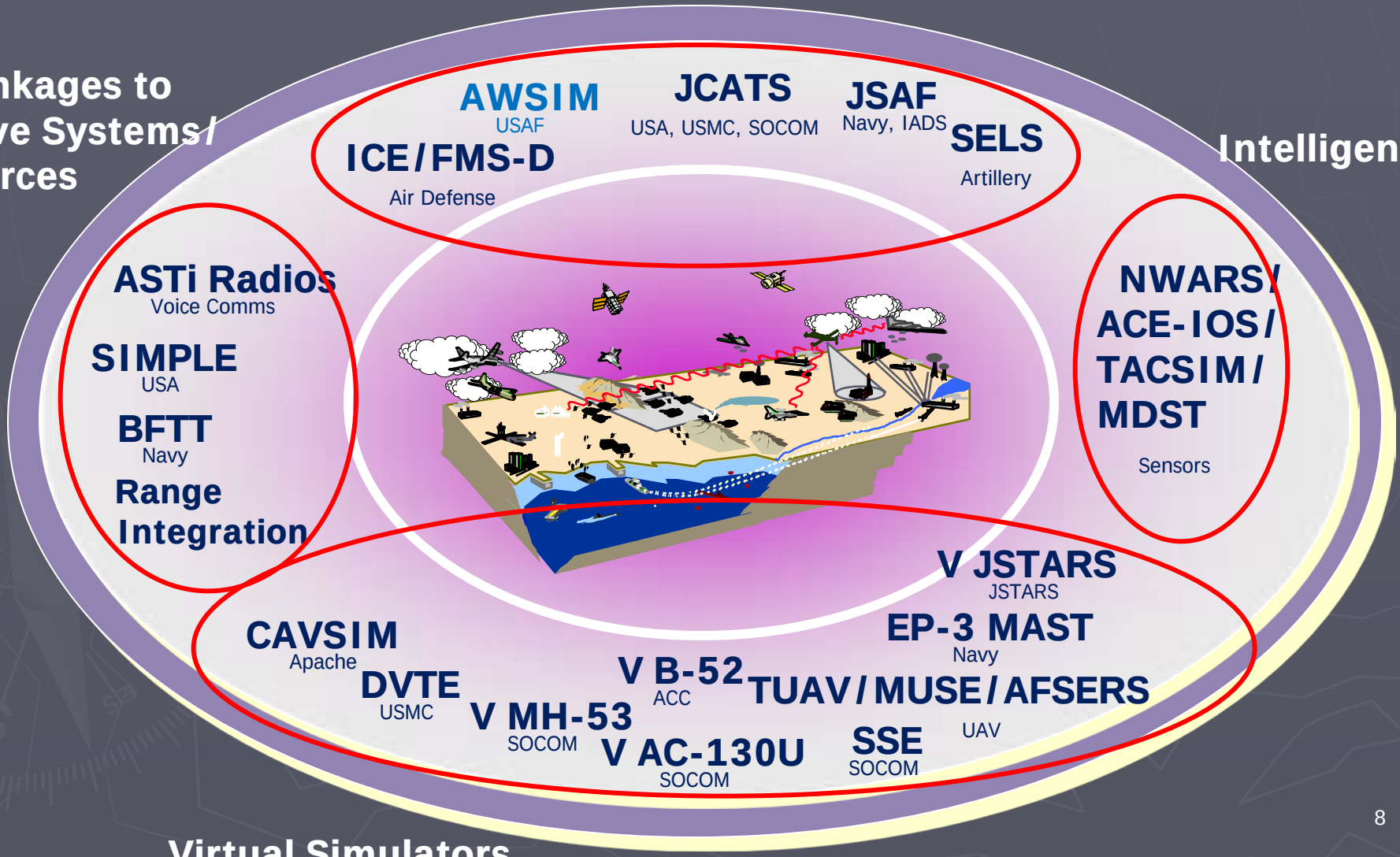
Why Is AFMSTT Interesting? (relative to T&E in a SoS)

- 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



From *Common Standards, Products, Architectures and/or Repositories (CSPAR) Baseline Document*, Version 1.0, 16 Oct 06, US Army PEO Simulation, Training & Instrumentation

Joint Live Virtual Constructive (JLVC) Environment



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

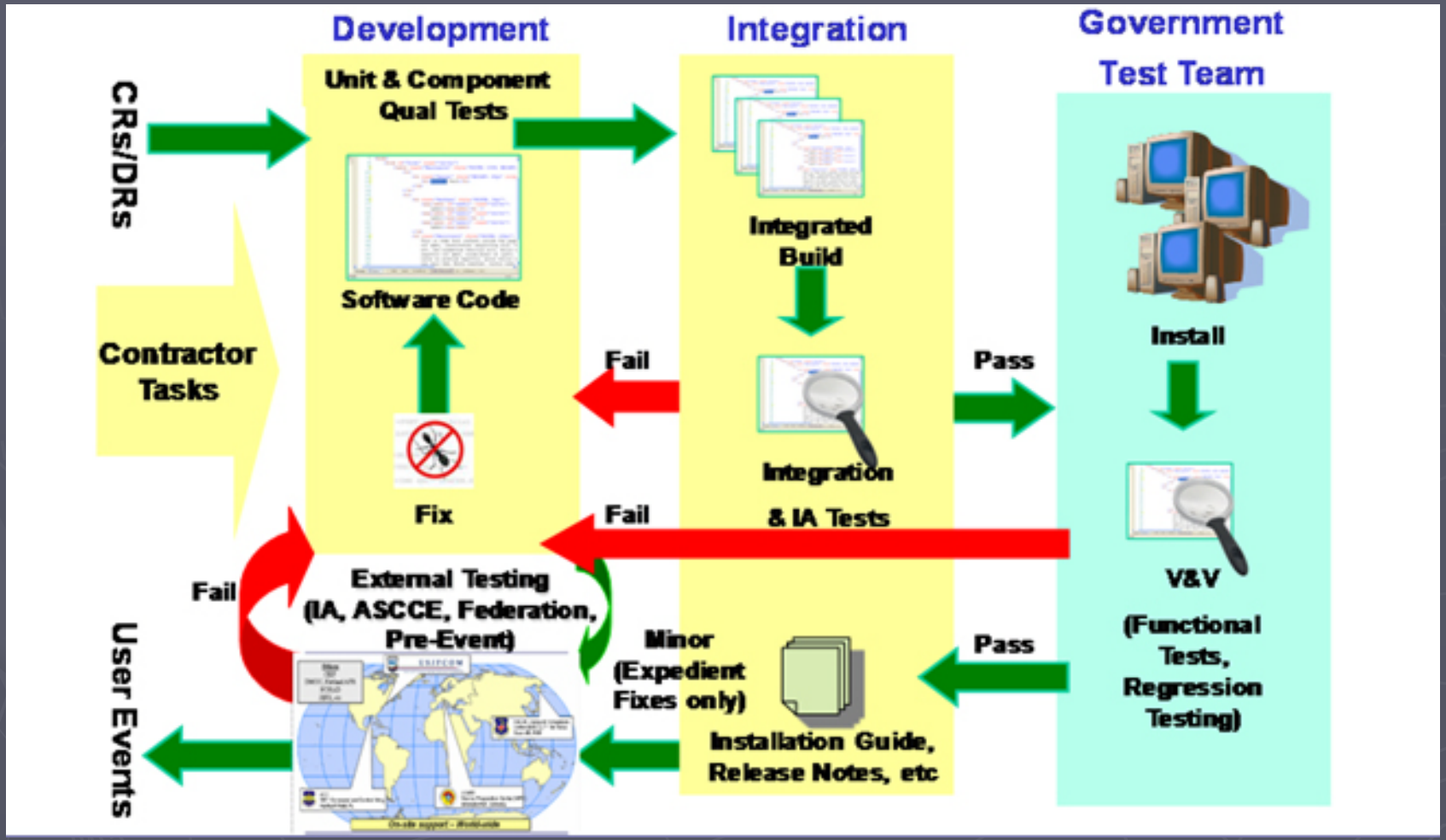
Layered Testing

- 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

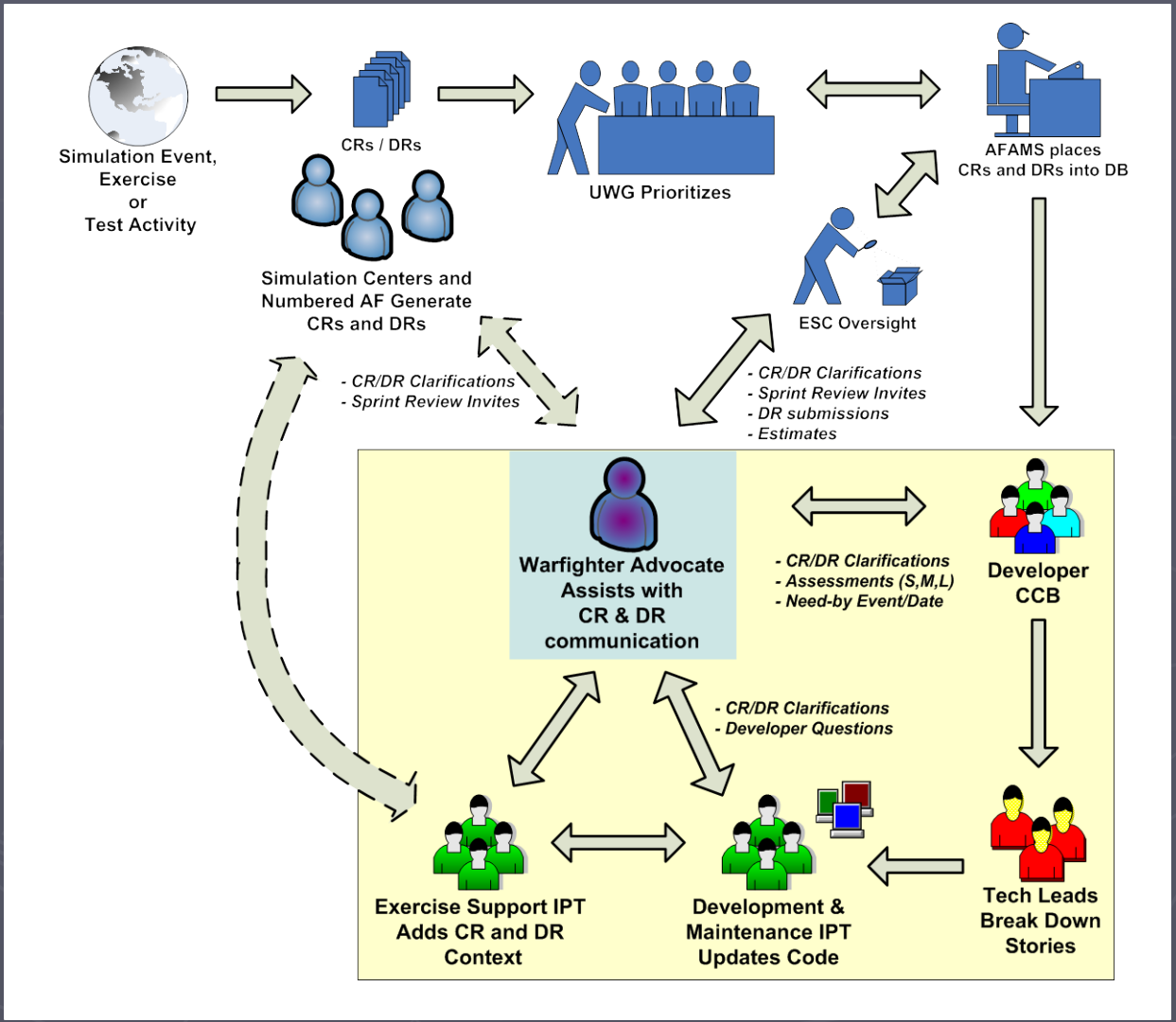
Layered Testing (cont)

- 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



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?