Early Integration of Test & Evaluation Subject Matter Experts in the Acquisition Life Cycle

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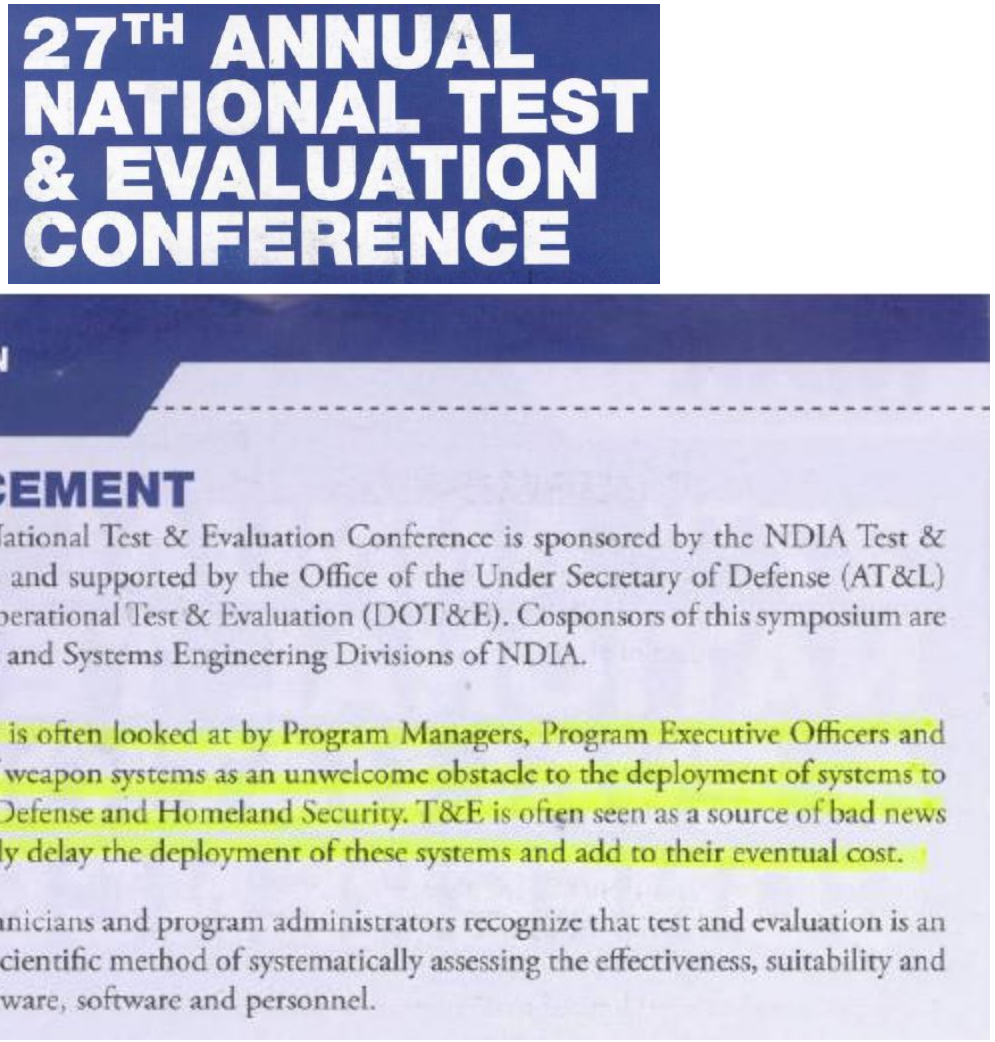
Agenda

- What is Test & Evaluation (T&E)?
- Current T&E Execution
- Envisioned T&E Execution
- Achieving Better Integration
  - Soft Systems Methodology (SSM)
  - Test Sketches
- Summary

What is T&E? (1 of 2)



27TH ANNUAL NATIONAL TEST & EVALUATION CONFERENCE

TEST & EVALUATION
CALL FOR PAPERS

ANNOUNCEMENT

The 27th Annual National Test & Evaluation Conference is sponsored by the NDIA Test & Evaluation Division and supported by the Office of the Under Secretary of Defense (AT&L) and the Director, Operational Test & Evaluation (DOT&E). Cosponsors of this symposium are the C4ISR Division and Systems Engineering Divisions of NDIA.

Test and Evaluation is often looked at by Program Managers, Program Executive Officers and other proponents of weapon systems as an unwelcome obstacle to the deployment of systems to the Department of Defense and Homeland Security. T&E is often seen as a source of bad news which can potentially delay the deployment of these systems and add to their eventual cost.

Most engineers, technicians and program administrators recognize that test and evaluation is an integral part of the scientific method of systematically assessing the effectiveness, suitability and survivability of hardware, software and personnel.

What is T&E? (2 of 2)

- **Test and Evaluation (T&E) is where the rubber meets the road in the acquisition process**

  System performance is compared to requirements

- **The Defense Acquisition Guidebook states:**

  The fundamental purpose of T&E is to provide knowledge to assist in managing the risks involved in developing, producing, operating, and sustaining systems and capabilities.

- **T&E Subject Matter Experts represent:**

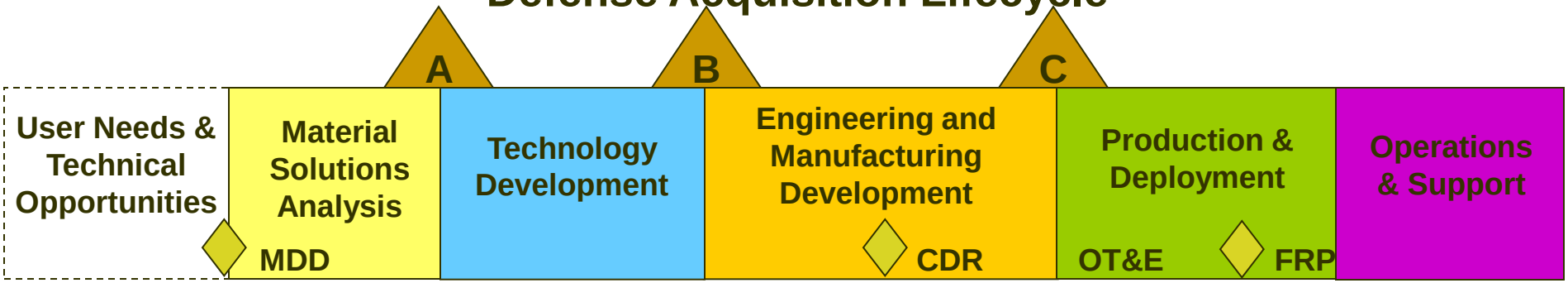
  - **Vendor T&E - system integration**
  - **Developmental T&E (DT&E) - verifies and validates specifications**
  - **Operational T&E (OT&E) - measures operational effectiveness and suitability**

Why Talk about T&E?

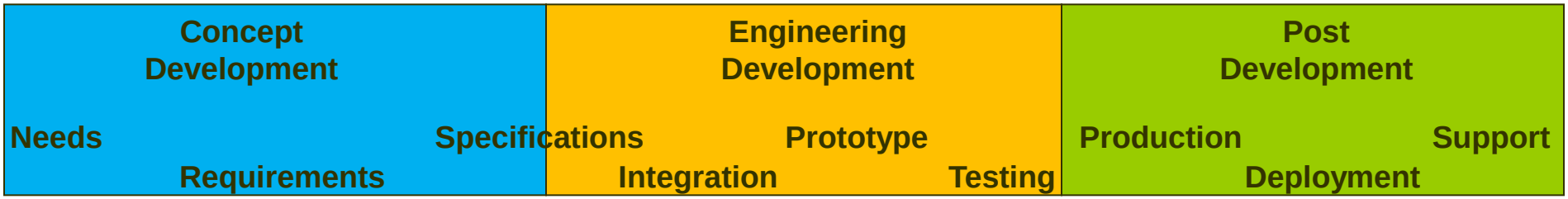
- **Current T&E is not adequately executed across the acquisition process**
  - **Pressure from both sides of timeline – acquisition delays and desired earlier deployment**
  - **Expensive and scarce T&E resources are needed for more complex systems**
  - **Lack of project management (PM) understanding of T&E Tasks and vice versa**

Envisioned T&E Execution

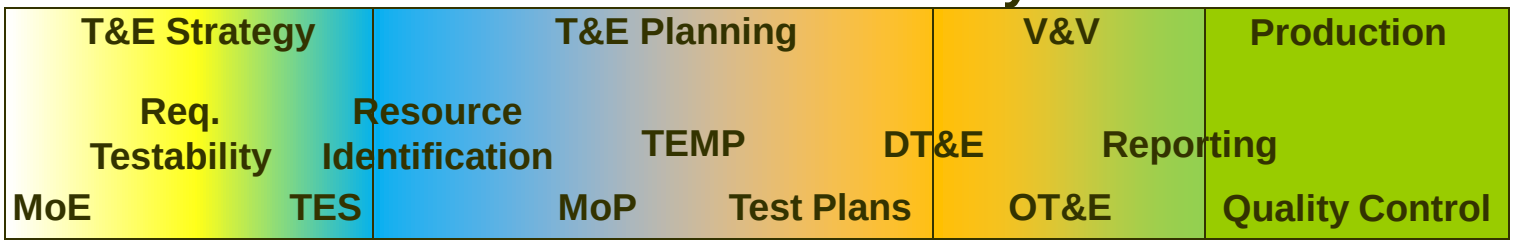
Defense Acquisition Lifecycle



Systems Engineering Lifecycle



Envisioned T&E Lifecycle



Envisioned T&E Execution

T&E should be an integrated venture across the lifecycle.

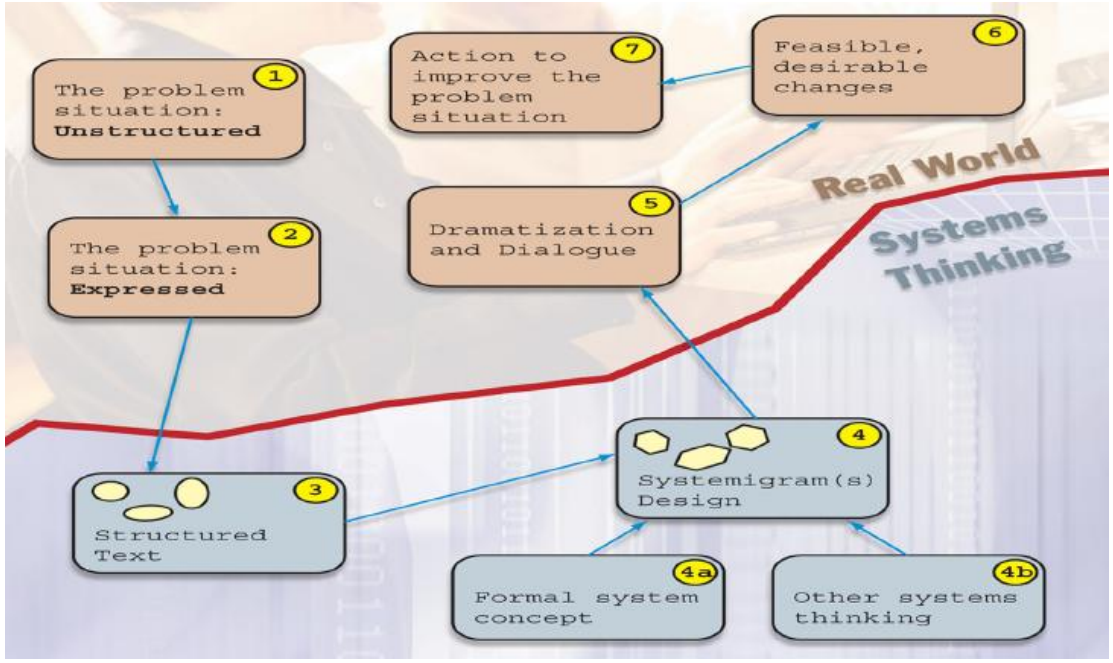
PM, SE, and T&E SMEs need to work together to identify proper levels of integration.

Soft Systems Methodology (SSM) can help this complex programmatic "human" problem.

Soft Systems Methodology (SSM)

- **Soft Systems Methodology is an approach to solving complex unstructured human problem situations based on holistic analysis and systems thinking (Wageningen International, 2008).**

- **SSM involves identifying the real world problem, the theoretical solution, and the feasible changes needed to reach the solution.**



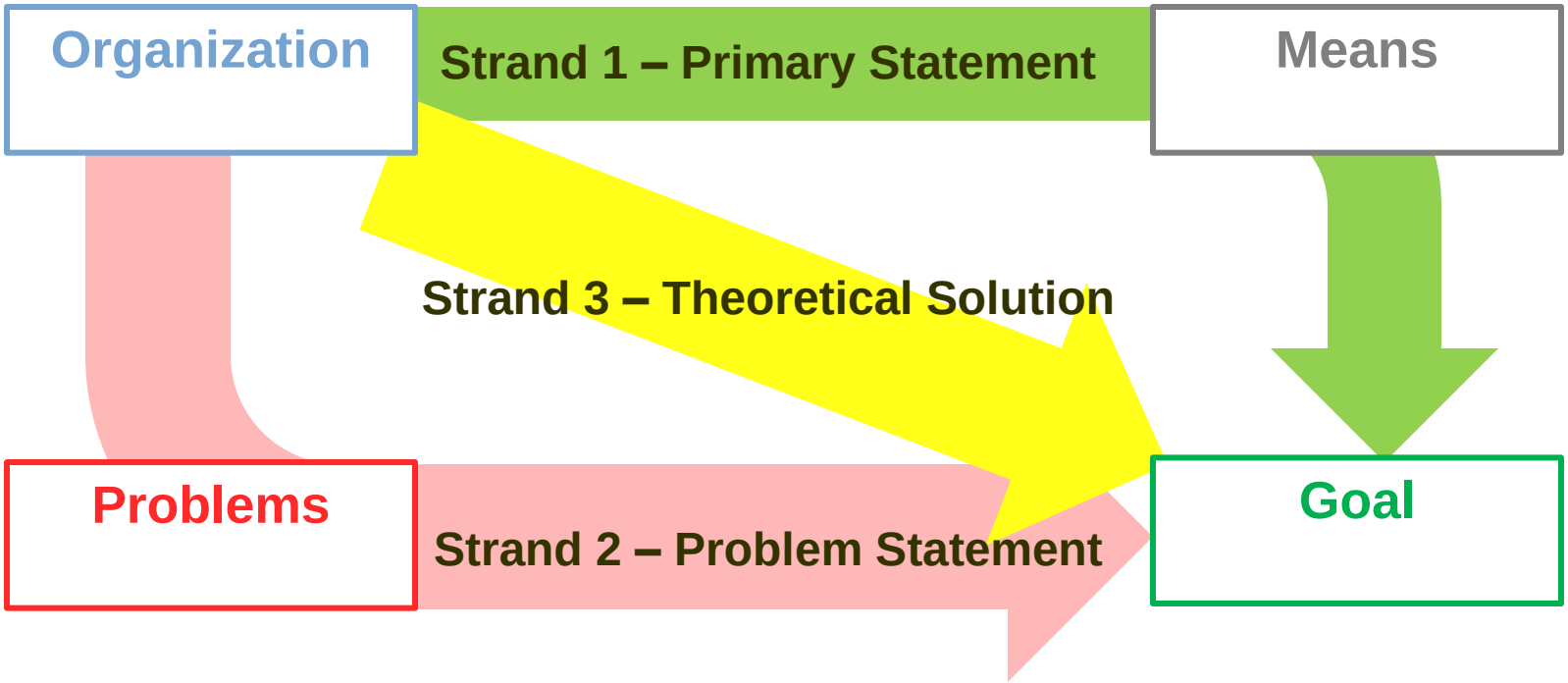
Boardman's Soft System Methodology Model
(Eigbe, Sauser, & Boardman, 2009)

SSM Application to T&E Integration

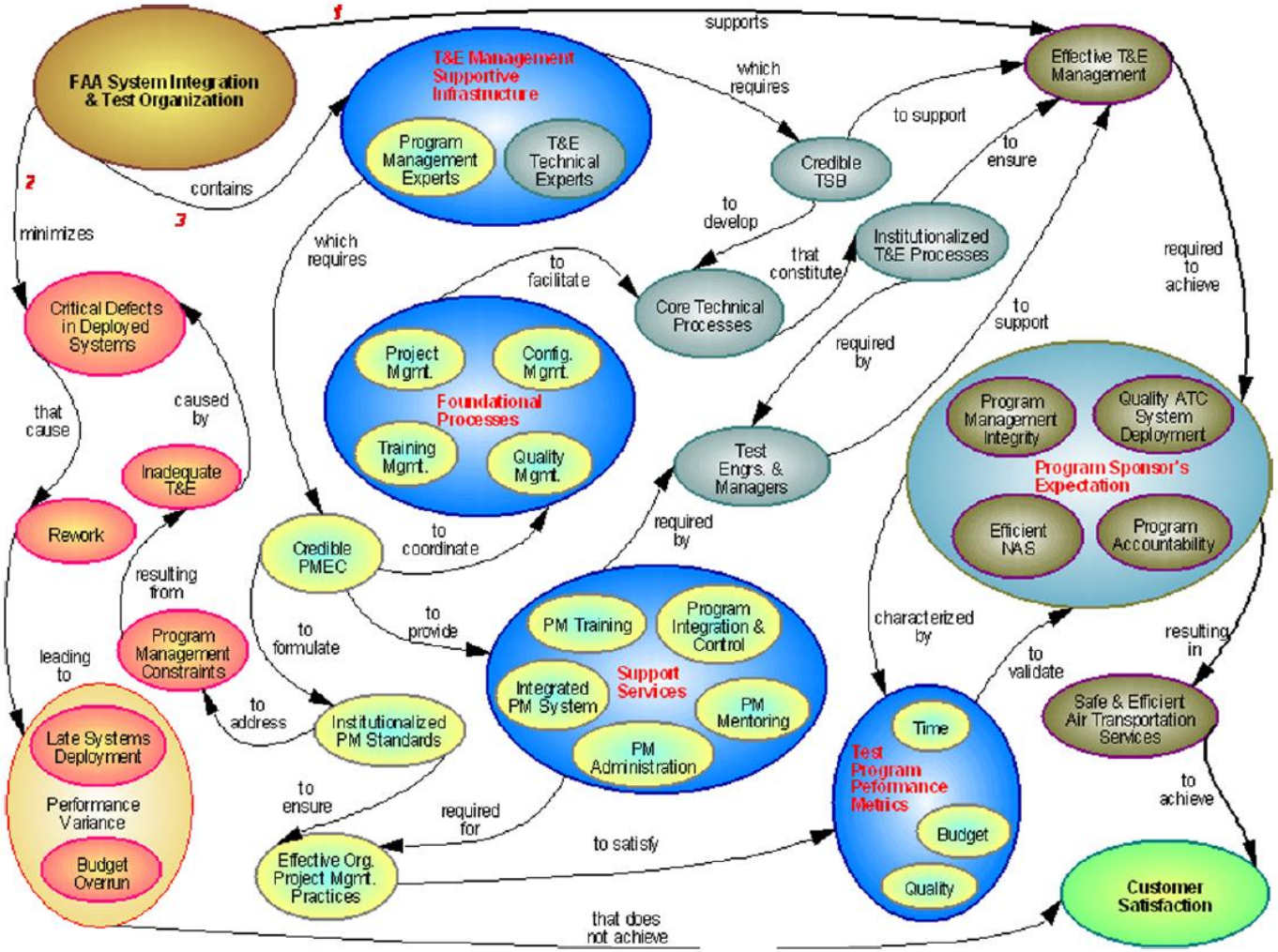
- **Project / Program Management can use SSM EARLY in the lifecycle to develop the proper organizational structure and processes for a successful program.**
  - **Early SSM will help PM identify the points of view of all the individual program nodes, T&E included.**
  - **Early SSM will identify the necessary relationships and processes used to meet the end goal.**
  - **SSM captures all of this in a Systemigram.**

Systemigrams

- Systemigrams are network diagrams that describe how the relationships and processes of an organization are used to meet the end goal. The information is represented with pictures and words along three "strands."



Example Systemigram *(Eigbe, Sauser, & Boardman, 2009)*



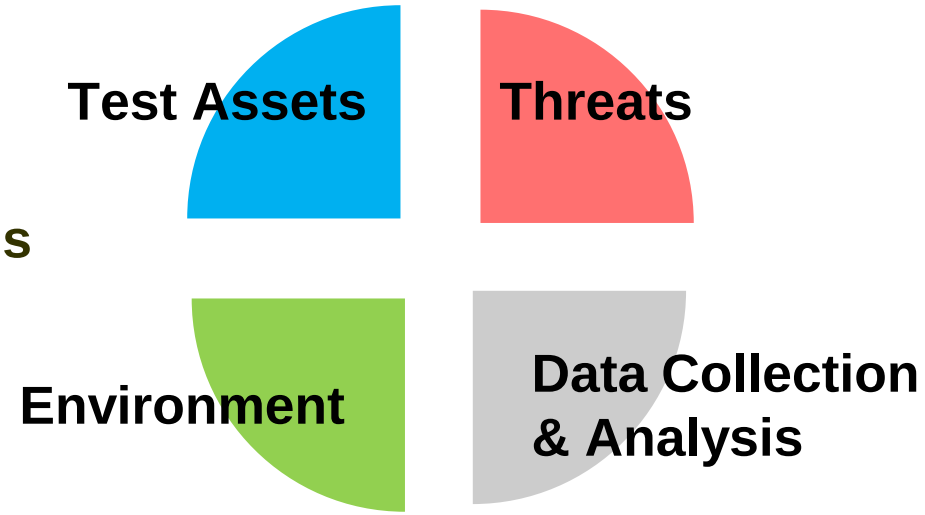
T&E SMEs

- What should the T&E SMEs do during early acquisition?
  - Expertise as operators is often put to use for requirements development, but this does not use their unique skill set
- How to deal with constant personnel rollover?
- How to gain more confidence that requirements are testable?

- T&E SMEs can use SSM-like ideas EARLY in the lifecycle to plan for successful integrated test events.

Test Sketch (1 of 3)

- **We propose the Test Sketch to identify the resources needed to validate/verify requirements.**
  - **Investigates**
    - **Test Assets**
    - **Threats**
    - **Environment**
    - **Data Collection & Analysis**



Test Sketch (2 of 3)

- **Test Assets / Enablers**
  - A rough estimate of the number of operators, support personnel and test systems necessary to satisfy the requirement
- **Targets / Threats / Mission Objective**
  - What is needed to simulate the objective / requirement?
- **Environment**
  - Where should the system be tested?
- **Data Collection & Analysis**
  - Equipment and methods needed (specialized vs. general)
  - Analysis method

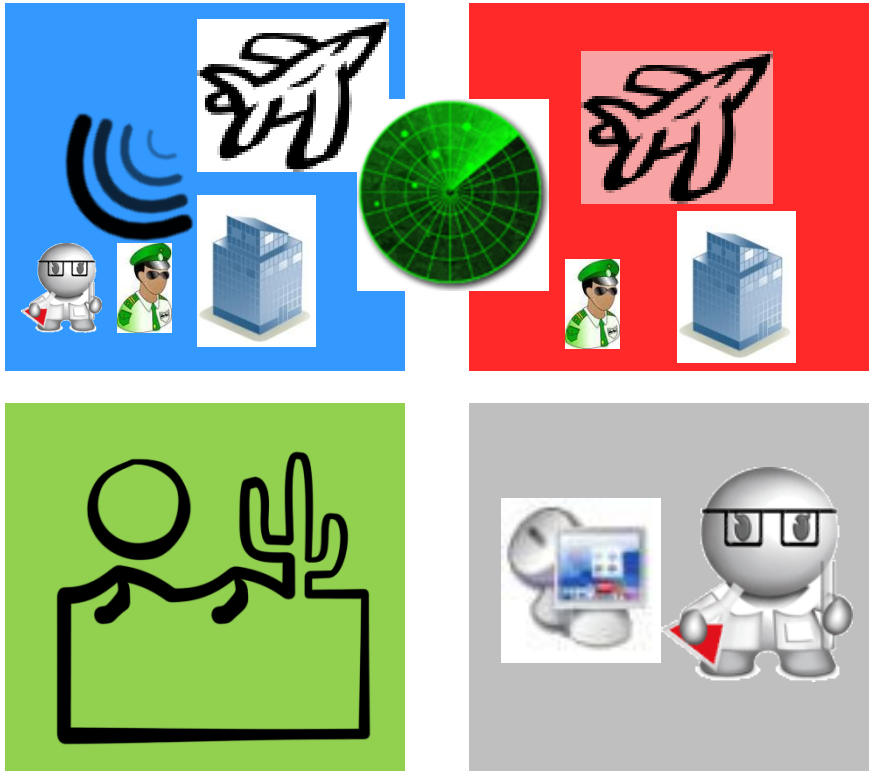
Test Sketch (3 of 3)

- SMEs quickly sketch out the necessary steps to verify/validate a requirement
- Rough estimate to be applied to each requirement in a high level document (KPPs in the CPD for example).
- Used to go beyond the “is it testable” exercise used during requirements development
- The Test Sketch can be used estimate resource needs to validate a proposed requirement.
- Provides an efficient way to transfer T&E responsibilities between personnel

Test Sketch Example (1 of 5)

System – Air to Air Sensor Platform

Test Measure of Effectiveness – Maximum # of False Tracks per Hour

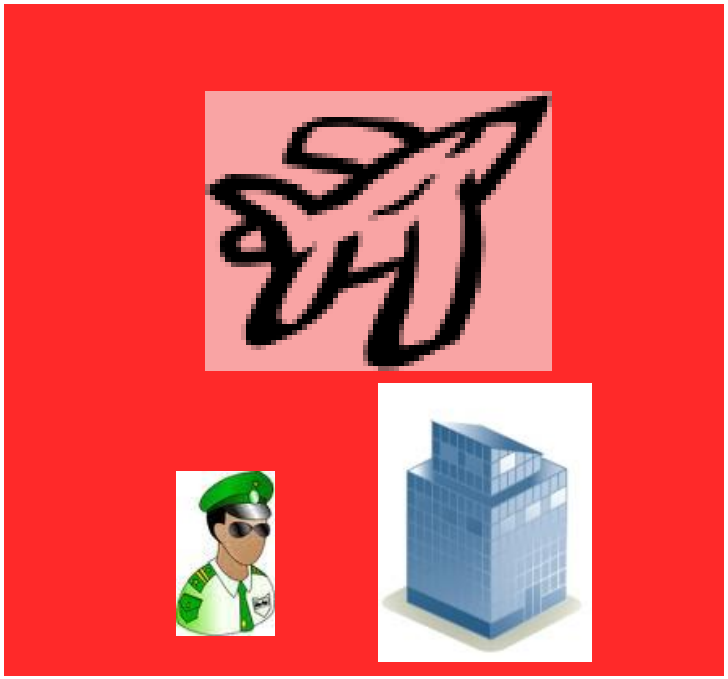


Test Sketch Example (2 of 5)

- Test Assets
  - Sensors
  - Aircraft
    - Associated systems
  - Aircrew
  - Maintenance Personnel
  - Facilities

Test Sketch Example (3 of 5)

- **Target / Threat**
  - **System to be detected and tracked**
  - **Defensive systems**
  - **Operators**
  - **Maintainers**
  - **Facilities**

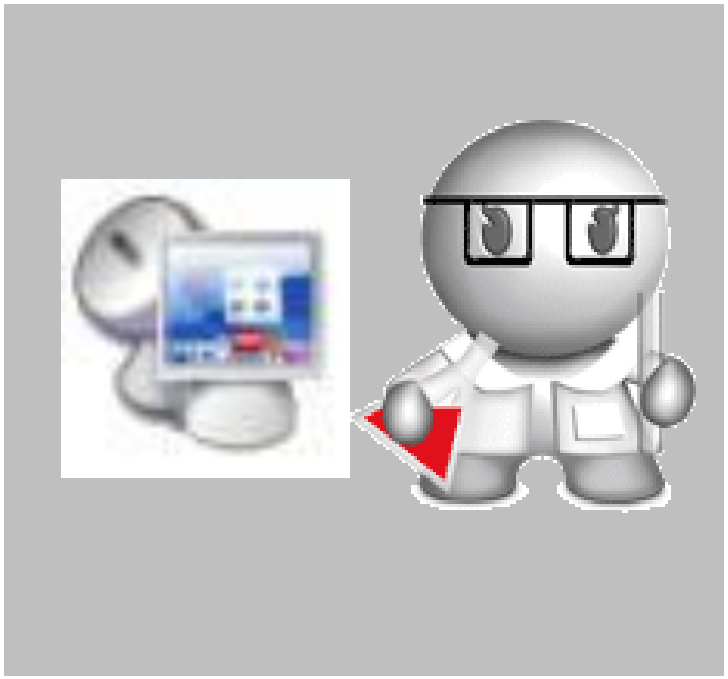


Test Sketch Example (4 of 5)

- Environment
  - Land/Water
  - Mountain/Flat
  - Size of airspace
  - Sanitized airspace

Test Sketch Example (5 of 5)

- **Data Collection/Analysis**
  - **Record good tracks vs. false tracks**
  - **Aircrew vs. analysts**
  - **Live vs. recorded**



Test Sketch Benefits

- Better resolution of testability for requirements
- Provide a smooth pass down from SME to SME given military operational tempo
- Creates a template for developing test documentation (T&E Master Plan, Test Plan)

Summary (1 of 2)

- Current T&E is not adequately executed across the lifecycle.
- T&E should be integrated across the lifecycle as indicated by DoD 5000.01, 5000.02 and the Defense Acquisition Guidebook.
- Early use of SSM by PM can lead to early and effective T&E integration in the lifecycle.
  - PM can use SSM to identify the relationships and processes needed to effectively integrate resources (T&E included) to create a successful program.
  - T&E can use SSM-like methods within its organizational structure to identify the necessary resources for successful integrated test events.
  - T&E SMEs can use SSM results to develop TES Sketches that identify necessary T&E resources

Summary (2 of 2)

- **Test Sketches**
  - Four categories
  - Deeper initial look into requirement testability
  - Directs T&E SME action during early acquisition
  - Level of detail is scalable to program maturity
  - Provides record for pass down to new T&E SMEs as military operational tempo dictates

References

- Department of Defense. *Defense Acquisition Guidebook.* (2010).
- Department of Defense*. Directive 5000.01.* (2007).
- Department of Defense*. Instruction 5000.02.* (2008).
- A. P. Eigbe, B. J. Sauser, and J. Boardman. *Soft Systems Analysis of the Unification of Test and Evaluation and Program Management: A Study of a Federal Aviation Administration's Strategy.* Systems Engineering, DOI: 10.1002/sys.20150 (2009).
- N. Sproles. *Coming to Grips with Measures of Effectiveness.* Systems Engineering (3), 50-58 (2000).
- Wageningen International. *Soft Systems Methodology.* (2008). Accessed at http://portals.wi.wur.nl/ppme/?Soft_Systems_Mthodology

Questions

?

Other ideas for PM & T&E SME integration?

Soft Systems Methodology

- **Other tools using SSM to apply to early T&E integration?**
- **What other organizations or parts of the acquisition cycle could benefit from applying SSM?**

Test Sketches

- Do you see utility in the concept?
- Are there current projects that could benefit from applying test sketches?
- Should the sketches be formal documents or informal notes?
- Is there a better name for “Test Sketches”?