

**Josh Tribble**

MILITARY ANALYST  
AVW TECHNOLOGIES

Phone: 757-361-9587

E-mail: [tribble@avwtech.com](mailto:tribble@avwtech.com)

860 Greenbrier Circle, Suite 305  
Chesapeake, VA 23320

<http://www.avwtech.com>



# Agenda

## •Introduction

- Acquisition humor
- Complexity challenge = increasing risk
- Intro to Integrated T&E

## •Integrated T&E within systems engineering to manage risk

- Alignment of T&E processes within systems engineering process
- Integration of T&E organizations/processes throughout acquisition life cycle






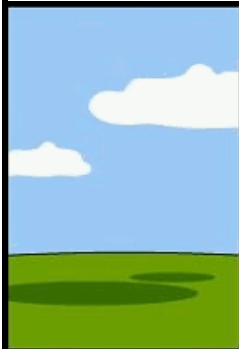


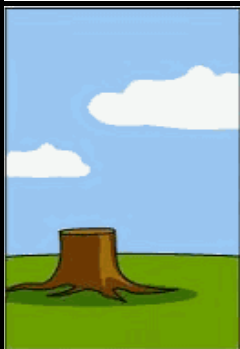
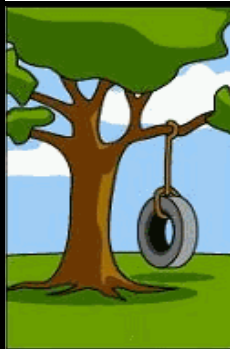
## •Enablers to implement IT&E within a program

- Risk based T&E planning and reporting
- AVW IT&E Database Toolset
- Other recommendations for implementing IT&E

## •Conclusion/ Q&A

*NOTE: My remarks are intended to spur thought on improving how we as testers can do business better to support the warfighter. While I hope this aligns well with DoD and Services T&E initiatives, I am not representing any government agencies' official position.*

# Acquisition 101?

				
How the user described it	How the requirement was understood	How the contractor designed it	How the programmer wrote it	How the PM/sponsor described it
				
How the project was documented	What was actually installed	How the Government was billed	How the helpdesk supported it	What the user really needed

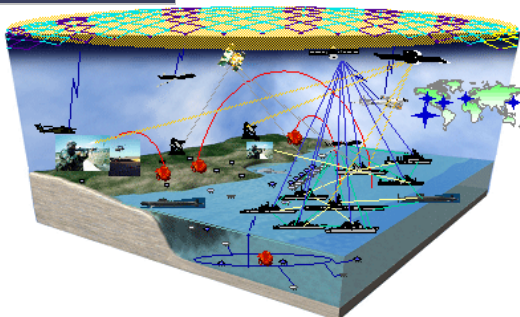
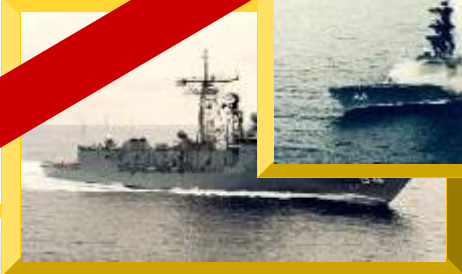
*How do we avoid this?*



# Complexity Challenge

- Open Architecture/Systems
- Complex C4I—GIG/FORCENet
- Joint Interoperability
- Emerging Technology & Materials
- Capabilities Based Requirements
- CAIV

- More difficult to develop
- More difficult to test
- Compressed timelines
- Compressed budgets
- MORE RISK...& HIGHER COSTS**



?

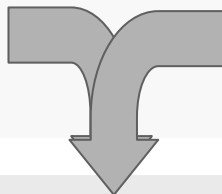
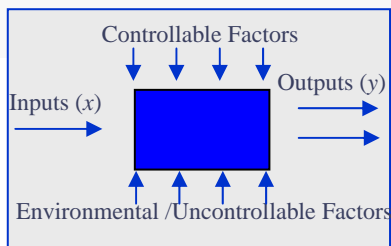
# ~~DT vs. OT~~ → IT

## DT

- Test to specs.
- Limited test environment perhaps in lab
- Focused on a specific set of criteria.
- Test threshold values not capability
- Critical technical parameters
- Integration testing designed around minimum performance criteria and interface spec.
- May not address all threats or missions.
- CT adds contractual issues

## OT

- Operational environment & threat with end users & support
- End-to-end mission perf. & support
- Production representative; system/family of systems
- Test overall capability of an item to meet user's mission needs and value added for mission accomplishment.
- Test the limitations and capabilities of an item so that:
- Employ and assess doctrine/TTP
- Independent IOT&E & LFT&E mandates (Title X)



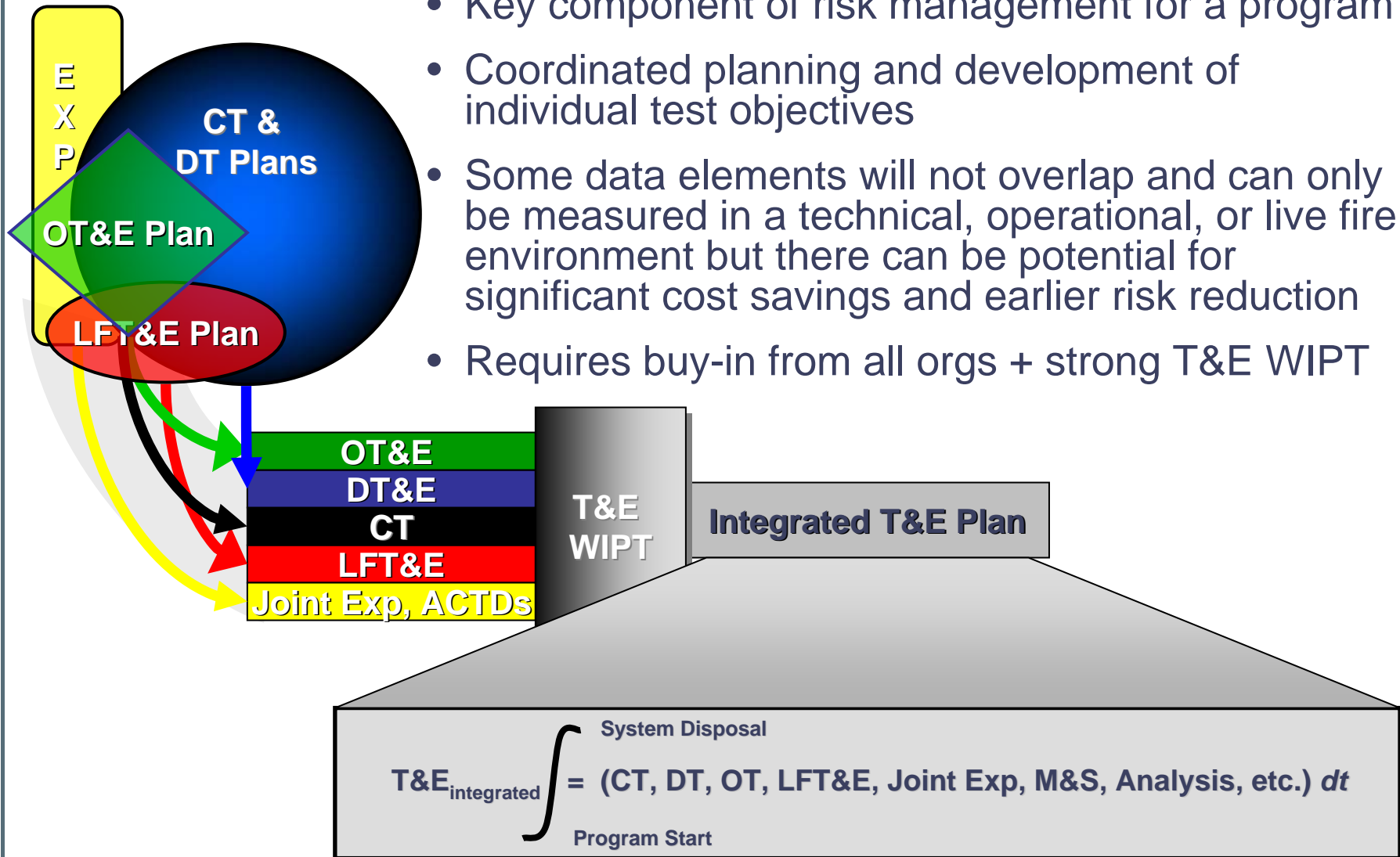
## **THIS MUST TRANSFORM INTO A CONTINUUM OF INTEGRATED TESTING**

- Increasing fidelity of technical and operational assessments
- Cooperating organizations
- Reduced budget and timeline ?
- Team/IPT structure not competitive

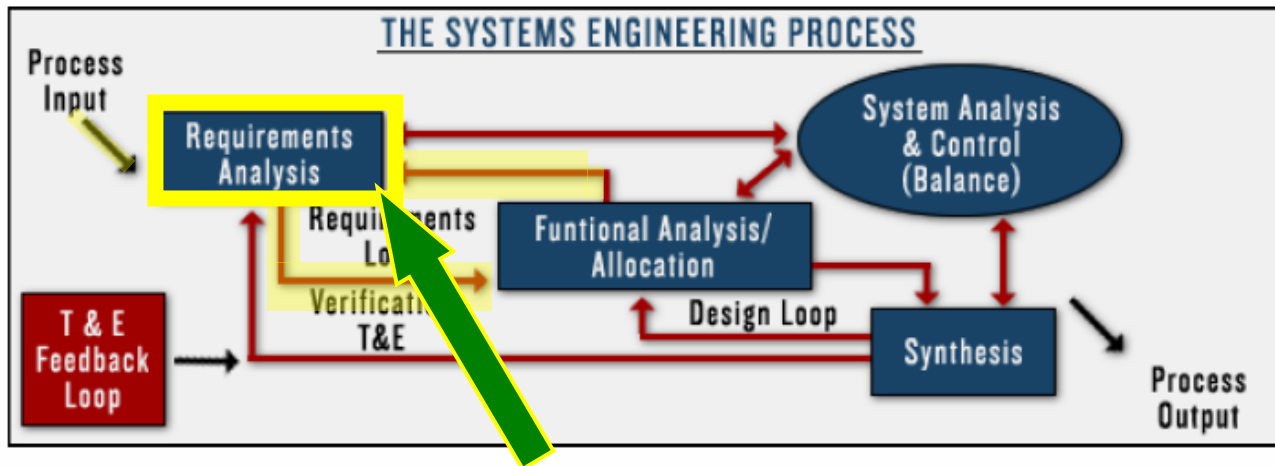


# Integrated T&E

- Key component of risk management for a program
- Coordinated planning and development of individual test objectives
- Some data elements will not overlap and can only be measured in a technical, operational, or live fire environment but there can be potential for significant cost savings and earlier risk reduction
- Requires buy-in from all orgs + strong T&E WIPT



# T&E During Sys Eng Tasks



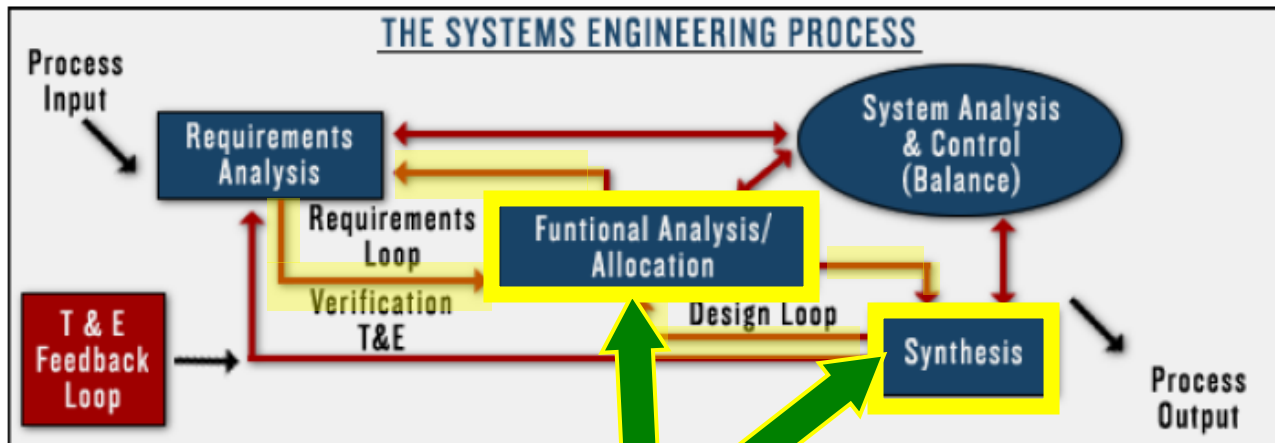
## ***Testers support by influencing:***

- Measurable, objective, meaningful reqs
- Reqs context & op scenarios
- Bounding system (technical/operational)
- Assisting mission / functional breakdown
- TPM selection
- Influencing HSI
- Prioritization of reqs (critical / need / want)
- IV&V of reqs flowdown + delivered technical and operational capabilities

## ***T&E is supported by insight into various aspects of project to facilitate efficient test planning:***

- Customer expectations
- Project & external constraints (CAIV...)
- Reqs context and intentions
- Life cycle support planning
- HSI planning/design
- Physical / logical architecture drivers
- Prioritization of requirements

# T&E During Sys Eng Tasks (Cont')



### ***Testers support by influencing:***

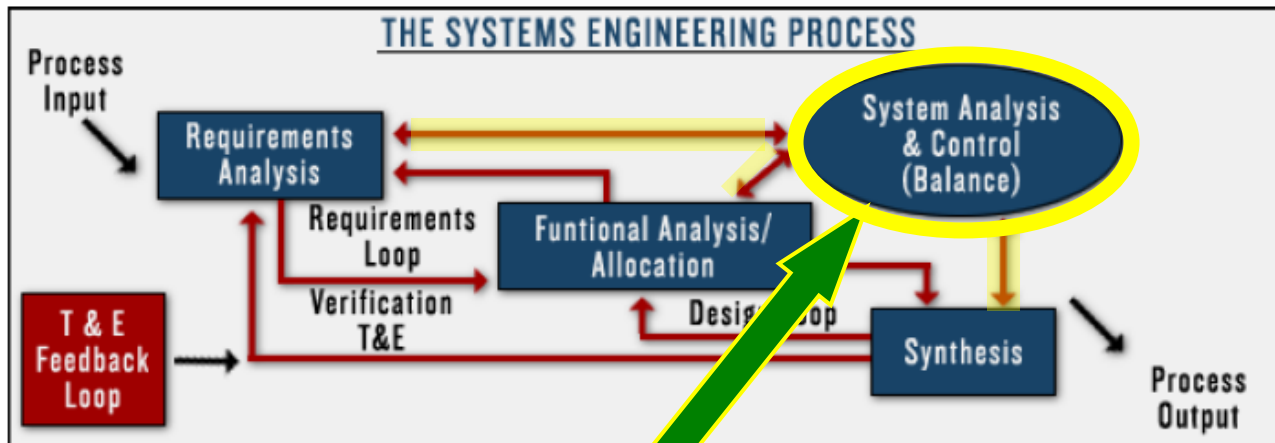
- Consistency in reqs/functional flowdown based on original intentions and op context
- Influencing HSI in detailed design including user reviews of HCI & functionality
- Verification of requirements implementation through limited component level tests
- Interface definition
- Prioritization of lower level requirements
- IV&V of reqs flowdown + delivered technical and operational capabilities
- M&S planning/development

### ***T&E supported by insight (which improves test planning efficiency) into:***

- Detailed reqs flowdown and prioritization
- Detailed life cycle support planning
- HSI planning/design
- Detailed architecture drivers
- ***& early collection of evaluation data:***
- Life cycle planning
- HSI design implementation
- Software eng. process assessment
- M&S V&V
- SCI/Component & interface test data



# T&E During Sys Eng Tasks (Cont')



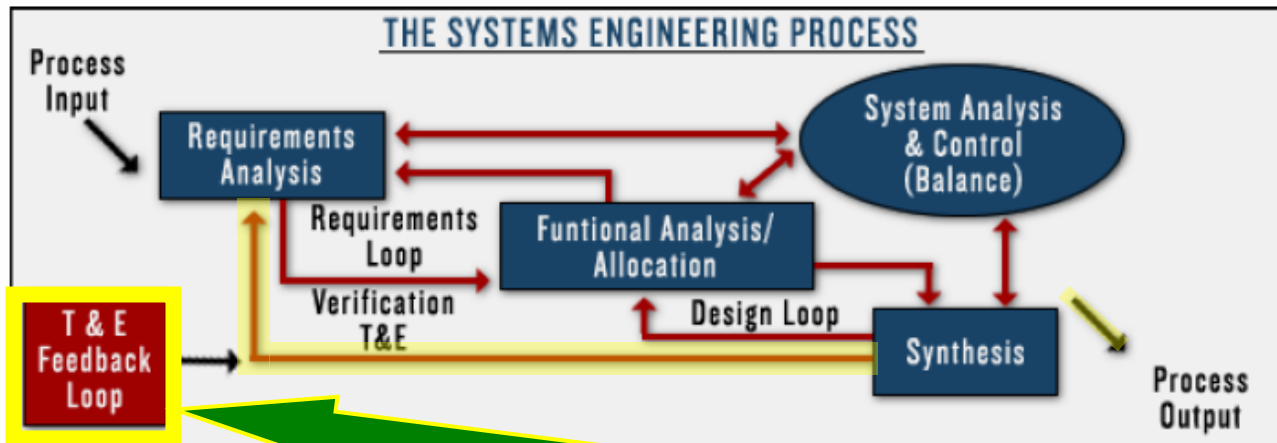
### *Testers support by influencing:*

- M&S analysis planning
- Monitoring M&S development
- Assisting in M&S analysis execution
- Independent evaluation of analysis results
- Evaluation of systems and software engineering process/process improvement
- Independent review of risk management and input of T&E issues as new/updated risks
- Objective TPM tracking
- Design for safety, life-cycle, interoperability, & survivability (instead of merely testing)

### *T&E is supported by insight into:*

- Capabilities and limitations from analysis that points to need for live testing
  - Pre and post-test predictions
  - Test design and noise factors selection (design of experiments), sensitivity studies
  - System & component trade-offs
- & collection of evaluation data:**
- Analytical and M&S based evaluation of system performance
  - M&S V&V

# T&E During Sys Eng Tasks (Cont')



### ***Testers support by:***

- Planning and executing tests to verify requirements and validate functions and mission capabilities
- Giving engineers insight into performance of system
- Independent internal and external agencies evaluation of the system

***[traditional T&E – with greater participation from systems engineers & increased use of standard engineering methodology for planning efficient tests***

### ***T&E is supported by systems engineers:***

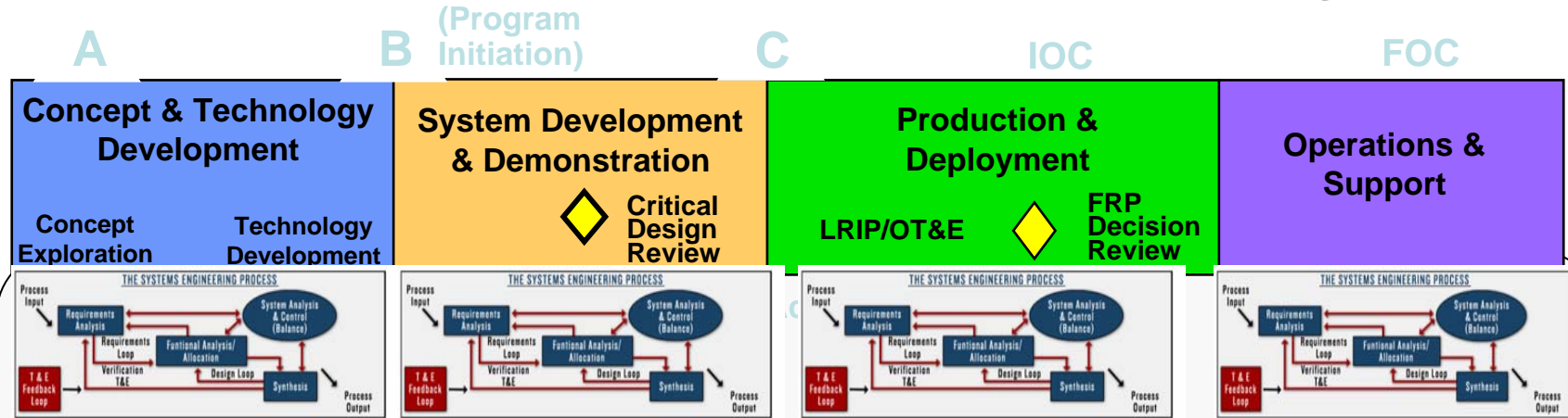
- Interpretation of technical results
- Determining impacts on HSI, life-cycle planning, IA, etc.
- Categorization of issues and problems

### ***T&E supports accurate decision making:***

- Proceeding with output to next acquisition phase, or
- Proceeding to next phase of testing, or
- Repeat of previous tasks while holding at this point in the acquisition cycle



# Systems Engineering + T&E within the Acquisition Cycle



<ul style="list-style-type: none"> <li>*Requirements Feasibility</li> <li>*Concept studies</li> <li>*CONOPS development</li> <li>*Mission/Function Experimentation</li> <li>*Joint</li> </ul>	<ul style="list-style-type: none"> <li>*Technology Feasibility</li> <li>*EDM DT</li> <li>*Design Review</li> <li>*EOA</li> <li>*M&amp;S</li> </ul>	<ul style="list-style-type: none"> <li>*Detailed Design</li> <li>*Design</li> </ul>	<ul style="list-style-type: none"> <li>*Lab/Land Based Test</li> </ul>	<ul style="list-style-type: none"> <li>*Production Readiness</li> </ul>	<ul style="list-style-type: none"> <li>*Federated Simulation Test</li> </ul>	<ul style="list-style-type: none"> <li>*TTP refinement</li> </ul>	<ul style="list-style-type: none"> <li>*Testing software upgrades</li> <li>*M&amp;S/DT/FOT&amp;E for system</li> <li>*Upgrades / new increments</li> <li>*Supportability data</li> <li>*Shock/qual</li> </ul>
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**MORE THAN TESTING ...**  
**CONTINUOUS EVALUATION THROUGHOUT THE LIFE CYCLE**

**RISK MANAGEMENT...**

**MISSION CAPABILITY DELIVERY...**

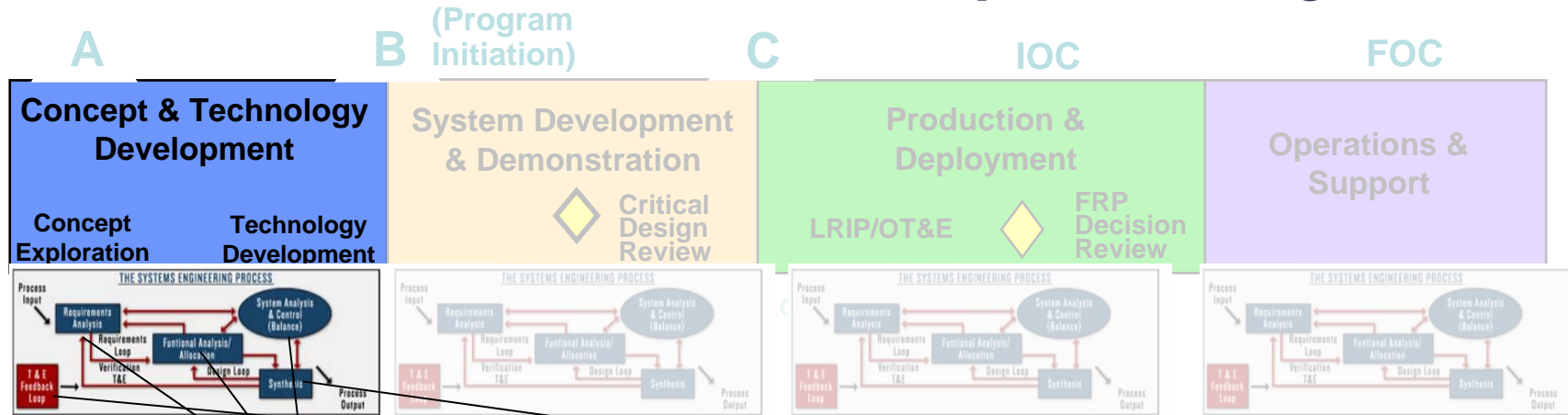
**INTEGRATED T&E & SYSTEMS ENGINEERING**

Ability to influence system design

System maturity & design/ upgrade cost



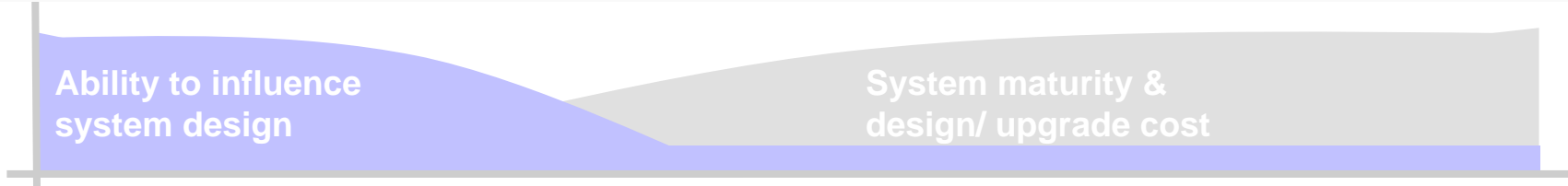
# Systems Engineering + T&E within the Acquisition Cycle



<b>T&amp;E ACTIVITIES DURING C&amp;TD PHASE</b>	<ul style="list-style-type: none"> <li>•Requirements testability review</li> <li>•Concept studies and analysis</li> <li>•CONOPS development</li> <li>•Mission/Functional analysis</li> <li>•Joint Experimentation/ACTD/ATD</li> </ul>	<ul style="list-style-type: none"> <li>•Technology Feasibility</li> <li>•EDM DT</li> <li>•Design Reviews</li> <li>•EOA</li> <li>•M&amp;S</li> </ul>	<b>Testers &amp; engineers not involved enough in this phase</b>

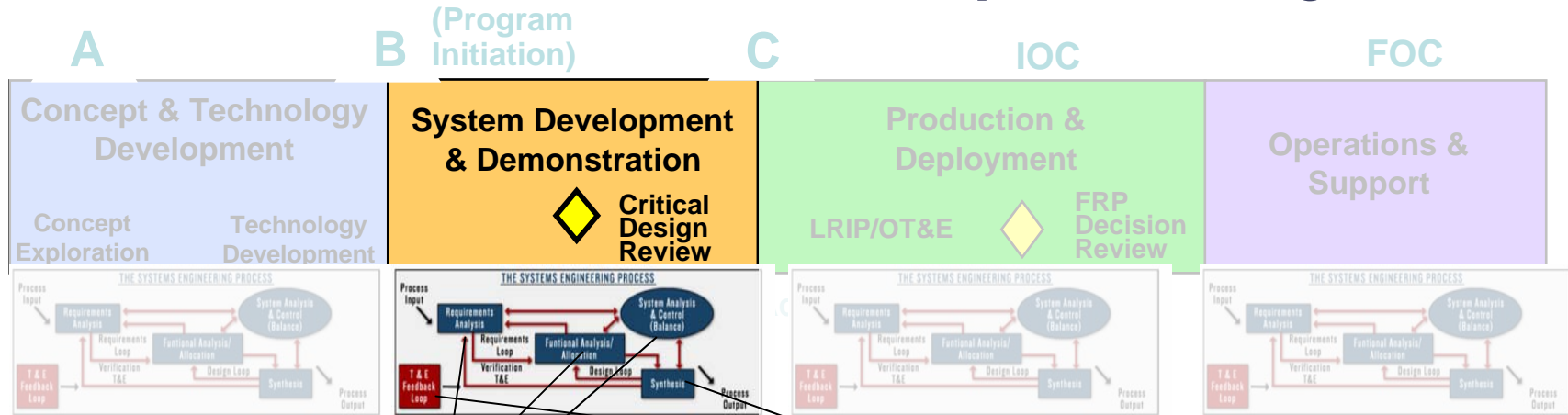


INTEGRATED T&E & SYSTEMS ENGINEERING





# Systems Engineering + T&E within the Acquisition Cycle



**T&E  
ACTIVITIES  
DURING  
SDD  
PHASE**

- Detailed Design Rvw
- Design OA
- Detailed CONOPS
- User reviews
- TTP development
- Trade studies
- Lab/Land Based Testing & M&S
- Limited field/at-sea testing & usability testing
- Testbed/surrogate LFT&E
- Supportability analysis/ initial logistics audit
- RAM analysis & testing (reliability growth)
- Certification process

***Inadequate linkage to C&TD mission and reqs analyses***

**RISK MANAGEMENT...**

**MISSION CAPABILITY DELIVERY...**

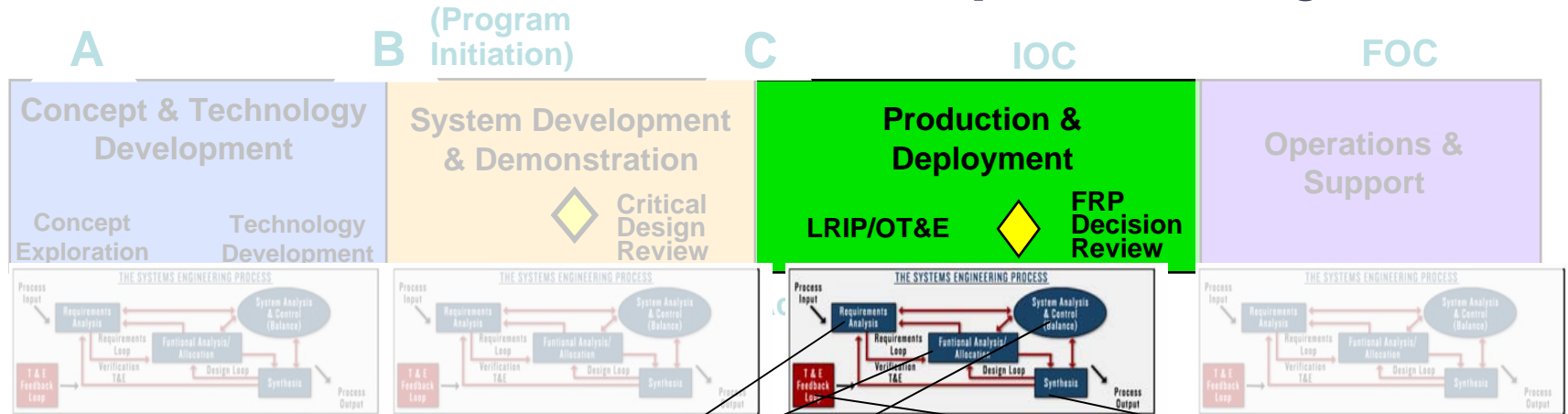
INTEGRATED T&E & SYSTEMS ENGINEERING

Ability to influence system design

System maturity & design/ upgrade cost



# Systems Engineering + T&E within the Acquisition Cycle



**Need to push as much of this to the left as possible**

**T&E ACTIVITIES DURING P&D PHASE**

- Production Readiness Reviews
- Detailed CONOPS
- Production H/W, S/W review
- Detailed TTP review/refinement
- Production in-process review w/ users & verification team
- Federated Simulation Testbed
- Production acceptance + mission validation DT/TECHEVAL and IOT&E
- HSI, Manpower, Personnel, Trng Eval
- System LFT&E & Shock Qual
- Final Independent Logistics Audit

**RISK MANAGEMENT...**

**MISSION CAPABILITY DELIVERY...**

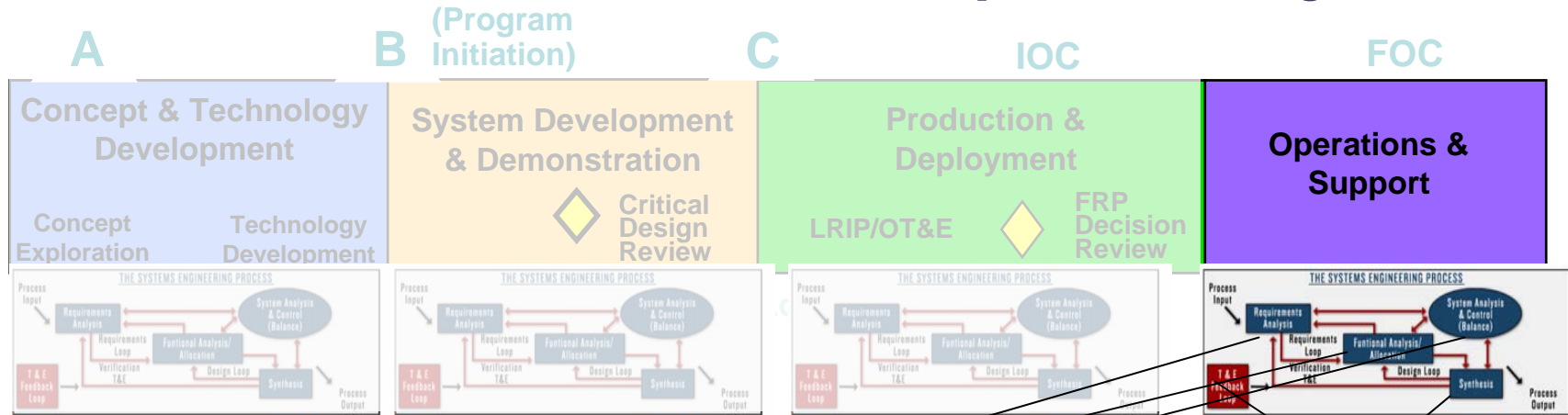
INTEGRATED T&E & SYSTEMS ENGINEERING

Ability to influence system design

System maturity & design/ upgrade cost



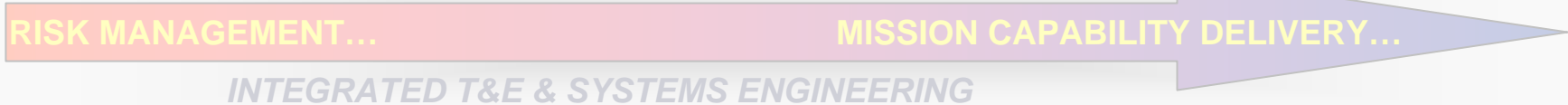
# Systems Engineering + T&E within the Acquisition Cycle



**Upgrades/ increments need better tie to req capability & tech maturity**

**T&E ACTIVITIES DURING O&S PHASE**

- TTP refinement
- Software/System problem characterization & tracking
- Upgrade/ P3I / spiral development requirements analysis
- Testing software upgrades
- M&S/DT/FOT&E for system fixes / upgrades / new increments
- RAM & supportability data collection
- Additional LFT&E/shock qual





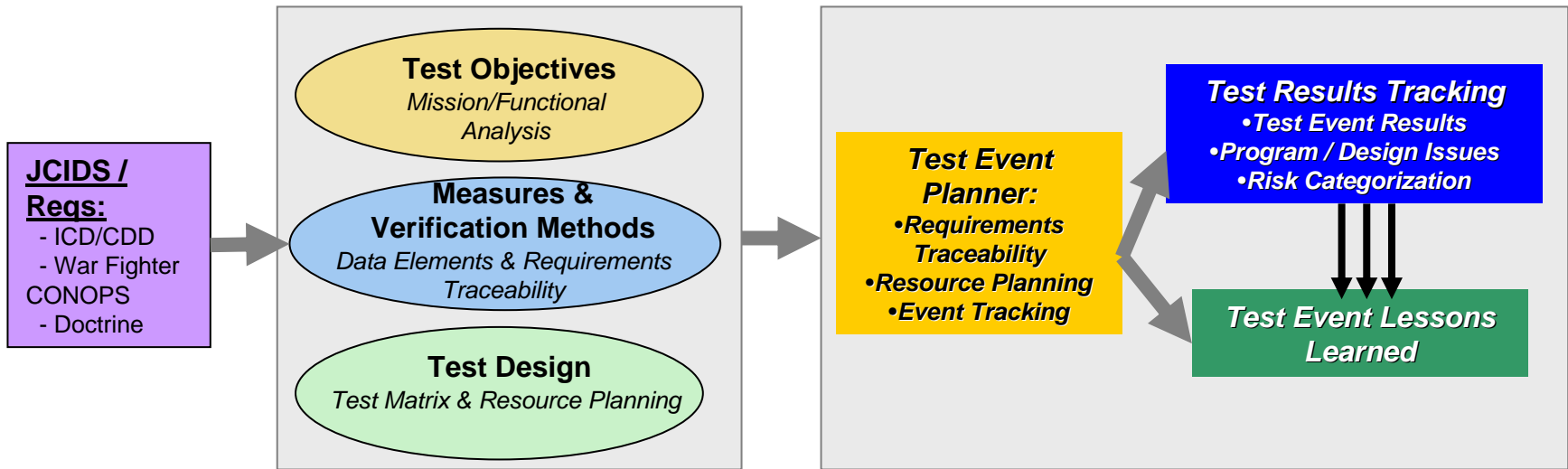
## Enablers for implementing IT&E for risk-management

- Actually implementing a process for IT&E with adequate buy-in is the first step
- Use software tools to step through planning and reporting processes and document IT&E
- Implement risk based test planning and reporting
- Other recommendations to follow...

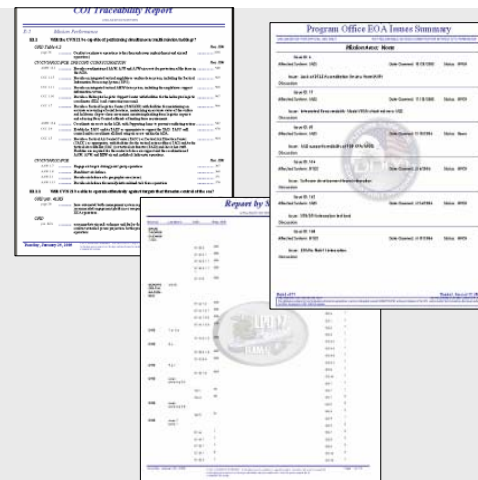




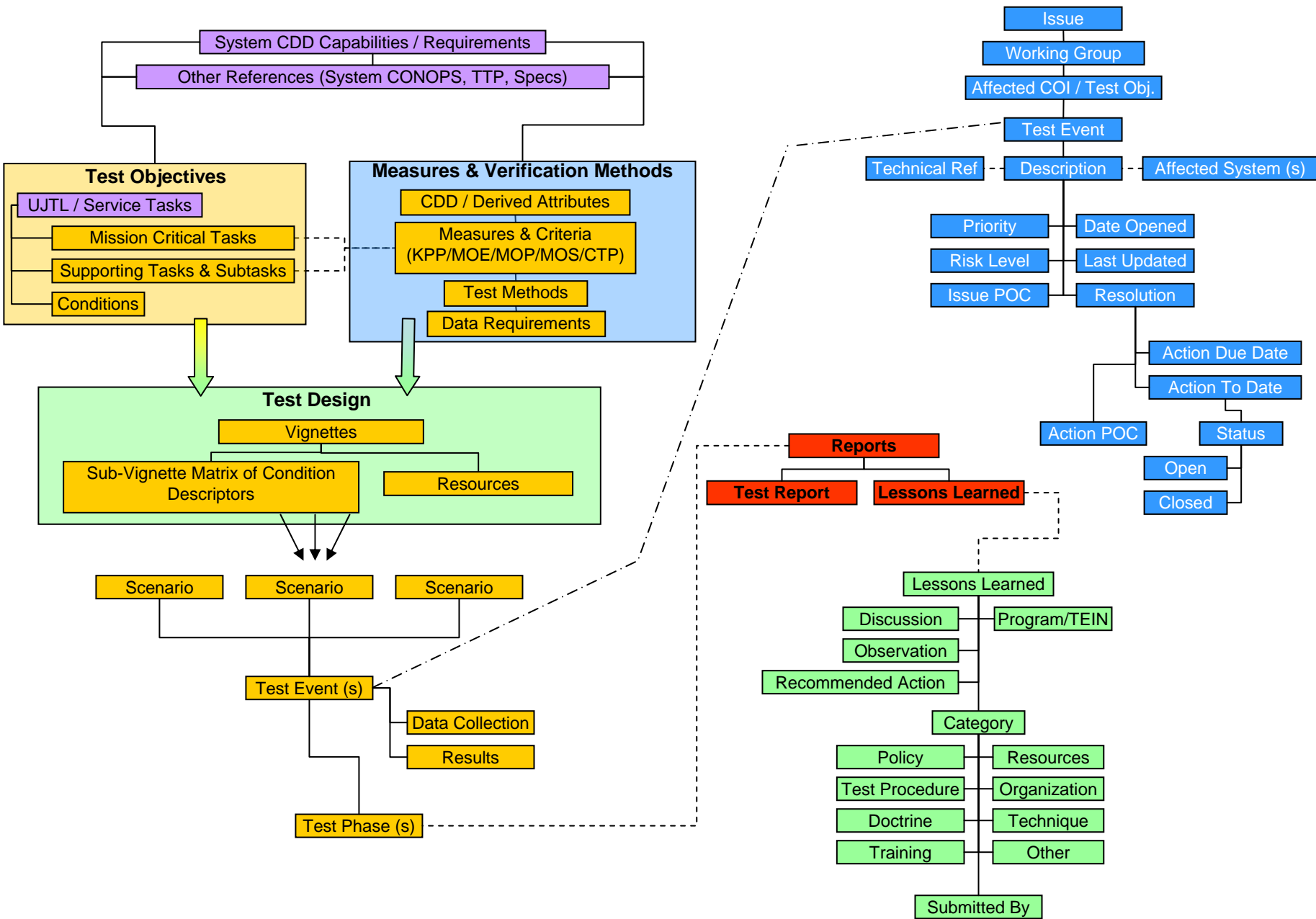
# T&E Framework Toolset



- TEMP Inputs
- Test Plan Inputs
- Test Report Inputs (Results and Issues)
- Tailored Reports for Issue Status to User



# T&E Framework Toolset Architecture

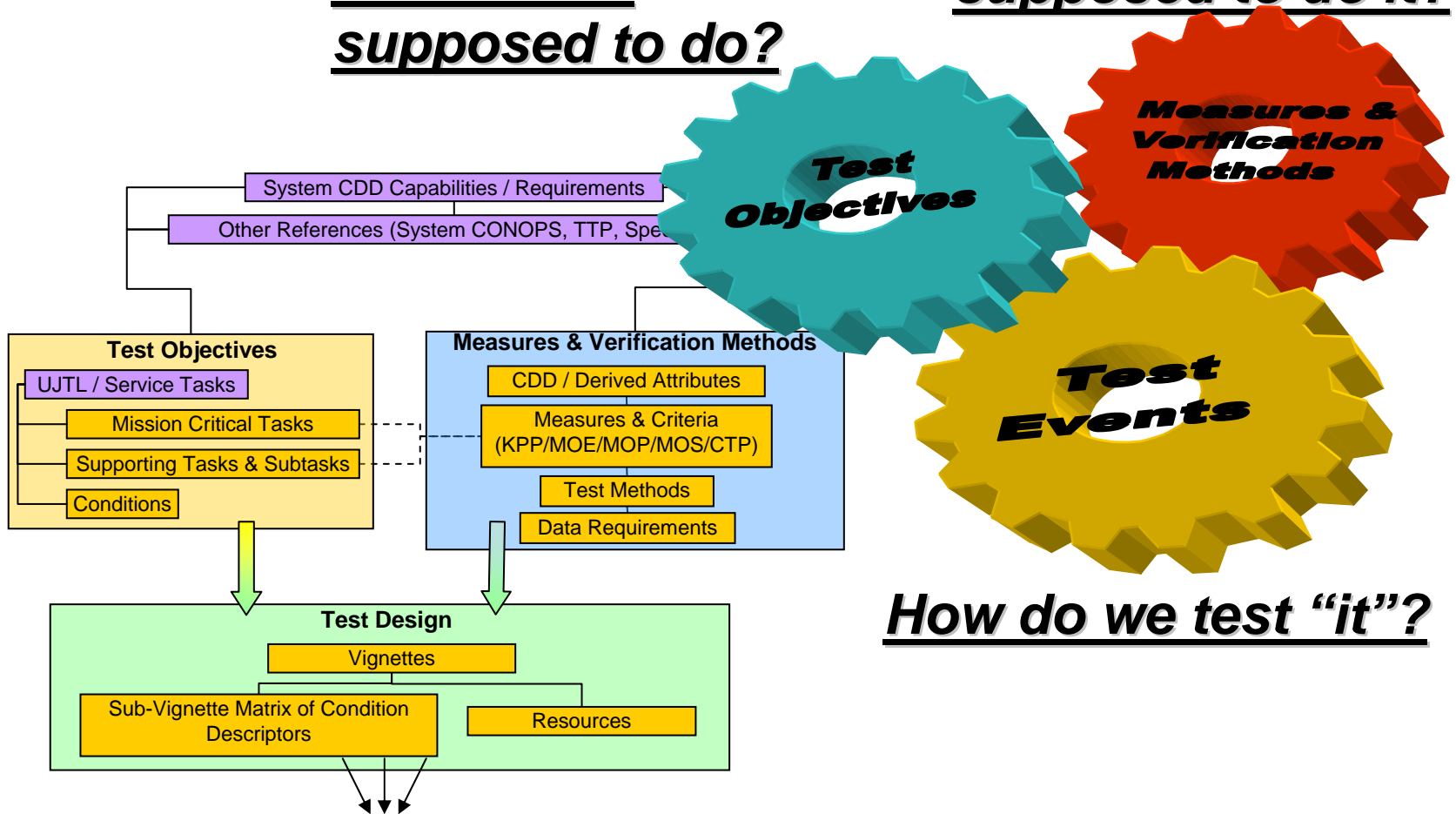


# T&E Framework Toolset

## Mission Based Test Design

What is "it" supposed to do?

How well is "it" supposed to do it?



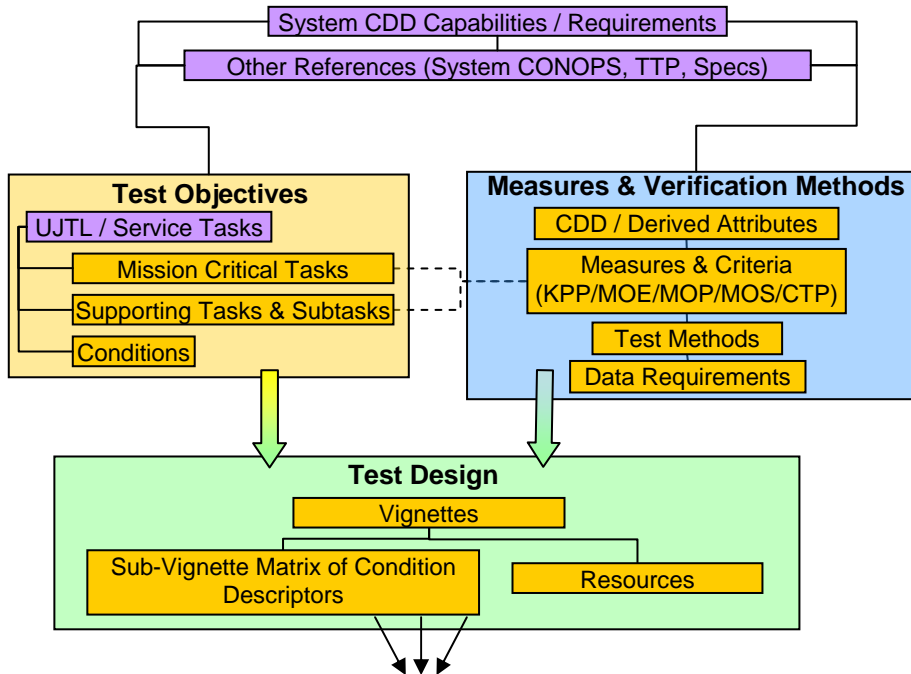
How do we test "it"?



# T&E Framework Toolset Functions/Capabilities



- Review of requirements, capabilities, mission tasks, or functional tasks
- Development of COIs/ Test Objectives
- Develop MOE/MOS/MOP/CTP and trace to test objectives and source requirements
- Develop test method and data requirements for each measure
- Group test objective/tasks into testable blocks (vignettes) and determine resources
- Develop test matrix based on conditions



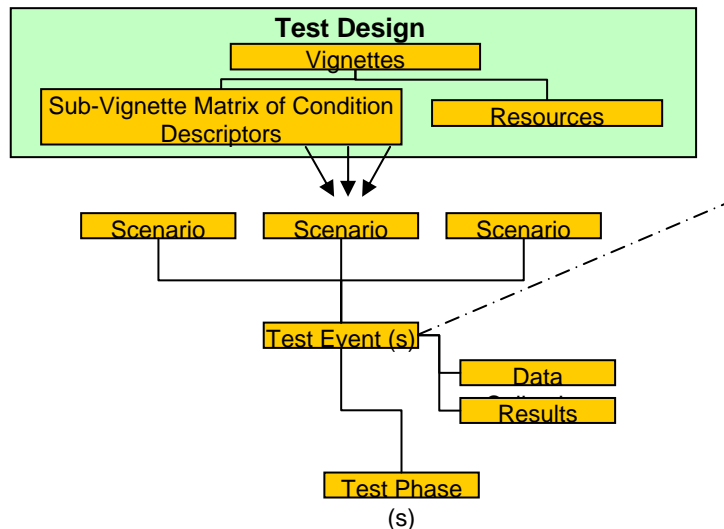


# T&E Framework Toolset Functions/Capabilities (cont')

Resource	Planned	Actual
Test Articles	\$0.00	
Test Sites & Instrumentation	\$0.00	
Test Support Equipment	\$0.00	
Threat Systems & Simulators	\$0.00	
Test Targets & Expendables	\$0.00	
Operational Force Test Support	\$0.00	
Simulations, Models & Test Beds	\$0.00	
Frequency Spectrum & Special Requirer	\$0.00	
Test & Evaluation Funding Requirements	\$0.00	
Manpower & Personal Training	\$0.00	
<b>Total</b>	<b>\$0.00</b>	

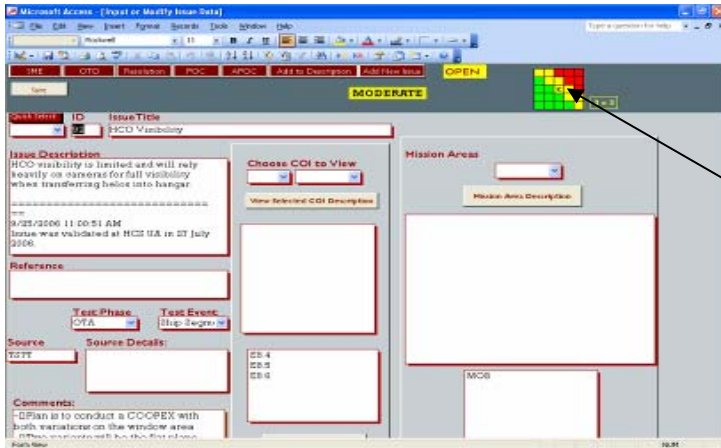
- Identification of test objectives and measures for a given event (exported from T&E Framework Tool)

- Resource and cost estimation to support TEMP, budget programming, test planning, and other efforts including ties for each resource to test objectives.

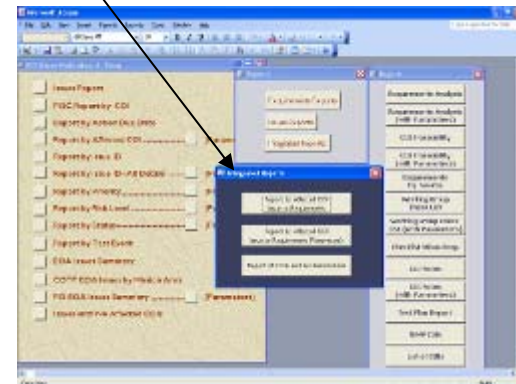
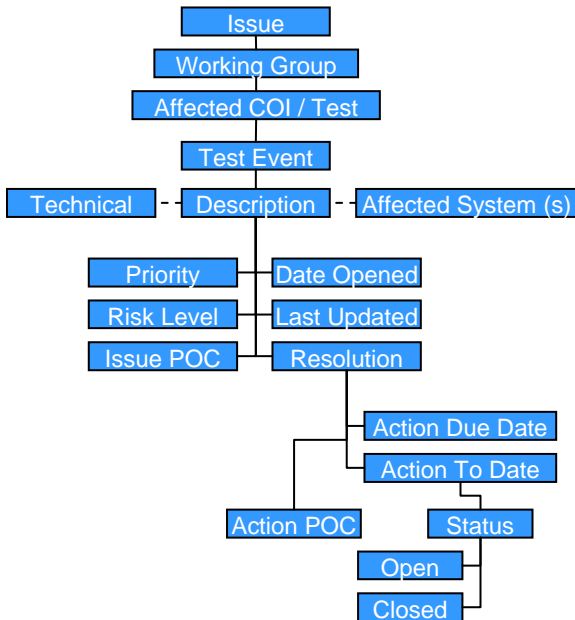




# T&E Framework Toolset Functions/Capabilities (cont')



- Traceability of test results to test event to objectives to parent requirements
- Risk based issue assessment
- Rapid reporting of issues
- Long term archiving of test results and program status
- User tailored reports to assess risks by function, mission area, system, req., etc.





# T&E Framework Toolset Functions/Capabilities (cont')

Microsoft Access

File Edit View Insert Format Records Tools Window Help

Quick Objects: DD(X) 1560

Open JULLS Submitted By

Category:

Test Event ID: OTAI

Title: Tailor Briefs for content

Lesson Learned: Work more with DA/PM to tailor briefs to ensure programmatic and old material is not included as well as updates from significant design changes (right tiger team/Pm removal of MADMAT and other pending changes). PDR and PDR lead briefings were a good idea and overall well executed, but needed more tailoring. Additionally, briefers need to better understand focus of the PDR, the background of the SMPs, and where the information they are presenting fits into the

Discussion: See above

Observation: See above

Recommended Action: Hold training session for briefers; review material ahead of time; remind briefers prior to start of focus; senior government/military COTF rep needs to step in and manage the briefer if they stray

Submitted By (P.L.S.)

Name: Josh Tribble

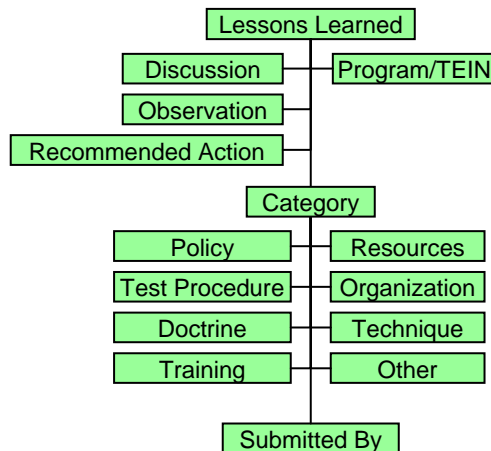
Phone: 757-361-9587

Email: tribble@avwtech.com

Rank:

Command:

- Lessons learned tracking in standard Joint/Service Lessons Learned formats
- Cross program visibility for T&E process maturation and cost reduction identification





# Risk Based Test Planning & Resourcing

Probability of Occurrence	Consequence	5	4	3	2	1
A – Frequently occurs during tests/operations (prob ~ 1.0)		II	II	I	I	I
B – Probably will occur during tests/operations		III	II	II	I	I
C – Occasionally may occur during tests/operations (prob ~ 0.5)		III	III	II	II	I
D – Remote chance to occur during tests/operations		III	III	III	II	II
E – Not likely to occur during tests/operations (prob ~ 0)		III	III	III	III	II

**Consequence Levels:**

- 1: prevents accomplishment of primary mission or presents a serious safety hazard
- 2: sig pri mission degradation w/o a work-around, secondary mission failure, or mod safety hazard
- 3: major secondary mission degradation w/o work-around; pri mission degradation w/ work-around
- 4: minor degradation/impact to primary and secondary missions
- 5: no impact to mission but operator annoyance or recommended enhancement

**Risk Levels:**

- I: High Risk – The spec/req/capability req significant CT, some independent DT and OT; highest pri for resource allocation; more test runs/ conditions permutations than other tests; most scrutiny required before integrating tests
- II: Moderate Risk – Requires some dedicated DT and OT; medium resource priority; less scrutiny before integrated tests completely
- III: Low/Manageable Risk – Little to no independence between CT, DT, OT, and LFT&E req; strong candidate for fully leveraging a small set of integrated tests for all data; lowest priority for resource allocation.

*This supports TEMP test event and resource allocation + detailed test planning; removes much of subjectivity surrounding allocation of scarce testing funding.*





# Risk Based Test *Reporting*

Probability of Occurrence	Consequence	5	4	3	2	1
A – Frequently occurs during tests/operations (prob ~ 1.0)		II	II	I	I	I
B – Probably will occur during tests/operations		III	II	II	I	I
C – Occasionally may occur during tests/operations (prob ~ 0.5)		III	III	II	II	I
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**Risk Levels:**

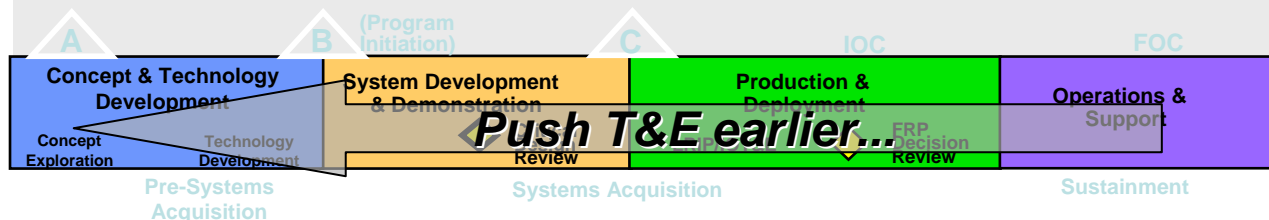
- I: High Risk – resolve prior to fielding & conduct major re-test of mission area prior to fielding with the most resources applied
- II: Moderate Risk – resolve prior to fielding and re-test the specific requirement as soon as possible (depending on the requirement, re-test may be allowed to be conducted during follow-on T&E after fielding); apply moderate amount of resources to re-test
- III: Low/Manageable Risk – resolve when possible but does not impact fielding; re-test at next available previously planned test event; lowest prioritization for test resources

*This could be tied directly to risk register and supports reporting of CT, DT, OT, LFT&E, M&S Runs, or any other analysis or test*



# Additional Recommendations

- Fully implement IT&E top-down and institutionalize with PEO/PM orgs
- closer align T&E Strategy/TEMP, Systems Engineering Management Plan, and Acquisition Strategy
- Maximize test data and usage of that data across test programs and fully align results to the program's risk registry
- Conduct assessment and testing as early as possible and with all organizations to support risk mitigation
- More test objective to requirements traceability in the TEMP
- Service T&E reorganize to Enterprise business model to drive IT&E plus alignment with JT&E, DOT&E



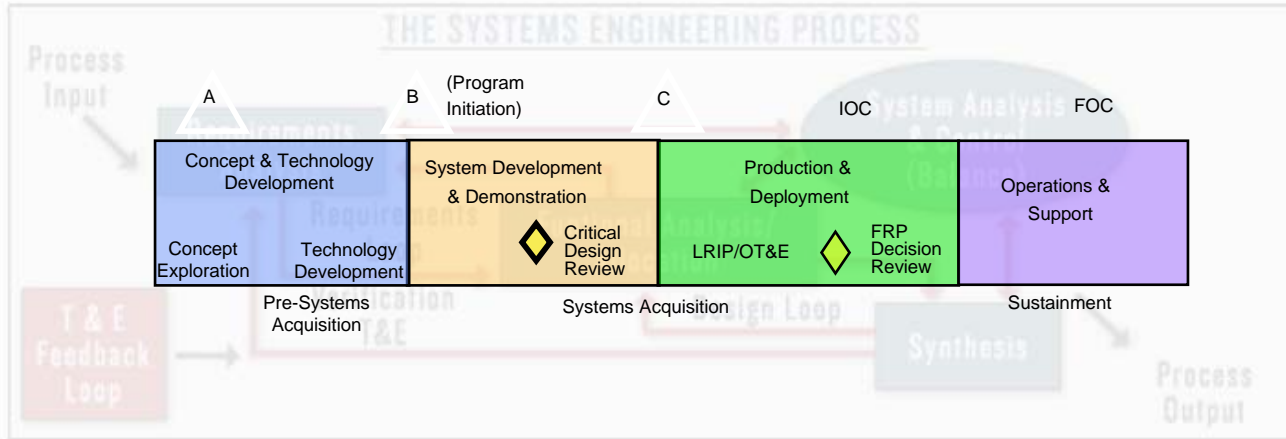
## Additional Recommendations (cont')

- Implement more systems engineering rigor across T&E
- Collect metrics on early risk mitigation efforts of T&E
- Develop and field in consolidated baselines to reduce testing, integrate across programs not just within
- Stress to threats and operating environments early and often
- Change T&E score-card to a risk assessment vs. capabilities; continuous feedback throughout tests; foster more cooperation including leveraging JT&E, Experimentation, Training Exercises
- Increase PM focus on life cycle, HSI, other factors beyond technical mission performance
- Coordinate use of standard statistical methodology for T&E including Design of Experiments

*(Note—similar presentations made to '05 & '06 NDIA Sys Eng Conferences)*



# Conclusion



# Questions?





# *Backups*



# Author Bio

- Former Naval officer
  - Active Duty: Surface Warfare Officer
    - Tomahawk, Aegis warfare experience + HM&E
    - COMOPTEVFOR Operational Test Director for land attack warfare systems
  - Reserve: OIC of Navy Reserve Embarked Security Det
- Current AVW experience
  - LPD-17 air defense (P<sub>RA</sub>) M&S management
  - Amphibious ship combat systems T&E
  - Joint Maritime Assault Connector JCIDS analysis
  - Current project: DD(X) OT&E support focusing on IOT&E planning, OA execution, M&S, and total ship test management



**10 years operational & 6 years acquisition experience focusing on  
T&E and systems engineering**



**Josh Tribble  
Military Analyst**

Phone: 757-361-9587  
E-mail: [tribble@avwtech.com](mailto:tribble@avwtech.com)  
860 Greenbrier Circle, Suite 305  
Chesapeake, VA 23320  
<http://www.avwtech.com>





# Company Profile



## Professional Engineering Services

ORD, ICD, CDD, TEMP, Systems Engineering, Systems Integration, M&S Management

## Test and Evaluation Support

TEMP, DT/OT, Test Management, Test Plans, Execution, Data Collection, Analysis

## Shipbuilder Engineering Management Consulting

Systems Engineering, Systems Integration, M&S Management



### Contract Vehicles:

Obtained GSA PES schedule CY04  
NAVSEA MAC member thru JJMA and CSC  
NAVSEA Seaport-E



### Corporate Highlights:

Total Ship / System of Systems Focus  
Expeditionary Warfare Expertise  
Mission Focused Systems Engineering and Analysis  
Matrix support leverage full corporate capabilities  
37 military analysts and IT/admin support  
Small veteran owned business since 2002  
*Headquarters in Chesapeake, VA*



**INNOVATIVE SOLUTIONS TO**  
**THE CHALLENGES OF THE FUTURE**

