



# Mission-Based Capability Assessment in Net-Centric SoS

NDIA 26<sup>th</sup> T&E Conference

1 March 10

*Army Proven  
Battle Ready*

# Purpose

- To present and overview the MBT&E methodology (framework and process).
- To engage in question/answer discussions on the MBT&E methodology and obtain audience feedback.
- To provide summary of observations, notes, lessons learned.



# Agenda

# MBT&E Background



## Why was MBT&E developed?

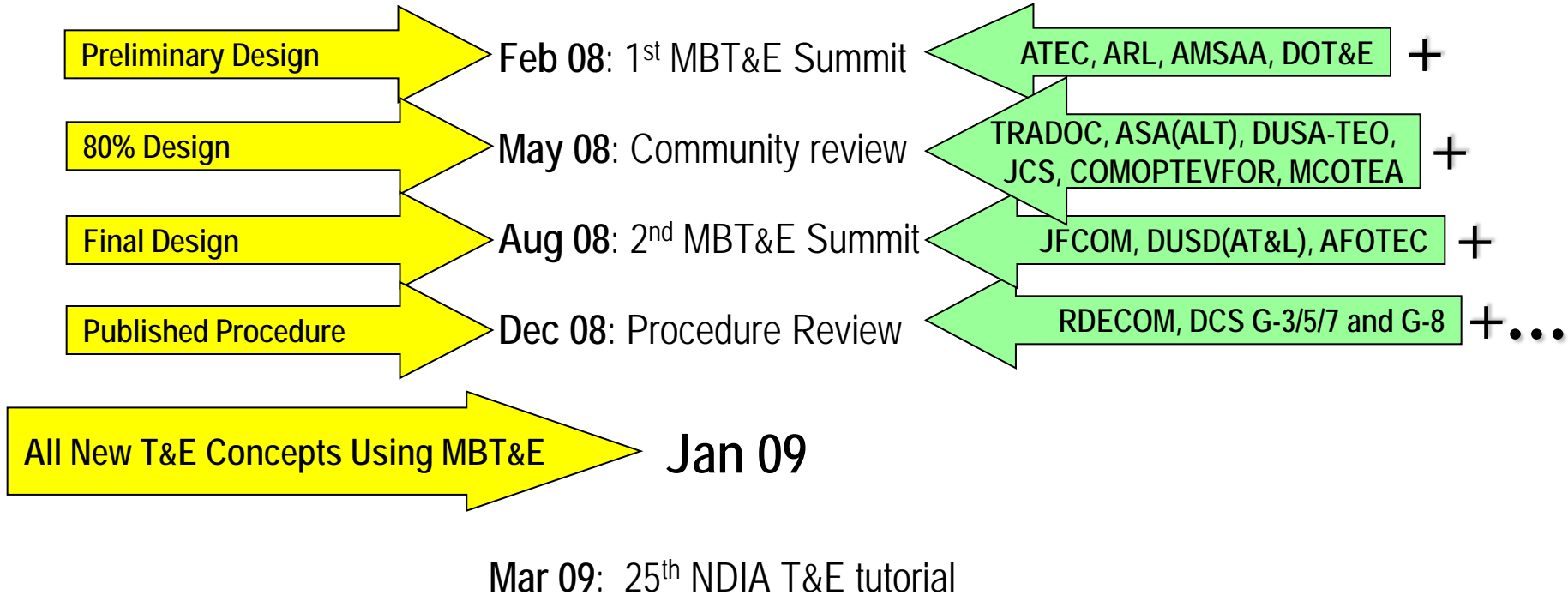
- Develop a T&E methodology that fully addresses recent acquisition initiatives.
- Provide “feedback” directly to the joint capabilities integration and development system (JCIDS) in terms of the war fighter’s mission.
- Enable robust and systematic system-of-systems T&E.

*“We will continue to examine and challenge our most basic institutional assumptions, organizational structure paradigms, policies, and procedures to better serve the Army.”*

CG, ATEC Commander’s Priorities for FY 10-15



# How is MBT&E being implemented?



MBT&E methodology has been applied by ATEC to support:

- Rapid Programs
- Programs of Record during:
  - Early planning stages;
  - T&E execution; and
  - T&E reporting.



# Observations during Planning

- MBT&E strategies being developed
  - Unit mission tasks developed and linked to AUTL
  - ATEC System Team linking all T&E requirements to the tasks
  - Task context flowed into T&E requirements
- Task context enhancing T&E design
  - Evaluation measure design focused on operational context
  - DT designed using operational techniques and procedures
  - OT designed to support evaluation of tasks and COI/Cs

**Integrated T&E strategies in place**

# Observations during Reporting

- Linkages developed in planning support:
  - Understanding of how system technical performance impacted desired capabilities
  - Integration of individual test results into “accumulated” evaluation of effectiveness, suitability and survivability
- Conclusions more than a restatement of test results
  - MBT&E Capabilities = task + desired result
  - Conclusions telling “what the data means” in terms of capabilities

Conclusions in war fighter’s language





# MBT&E Overview

## Mission-Based Test and Evaluation

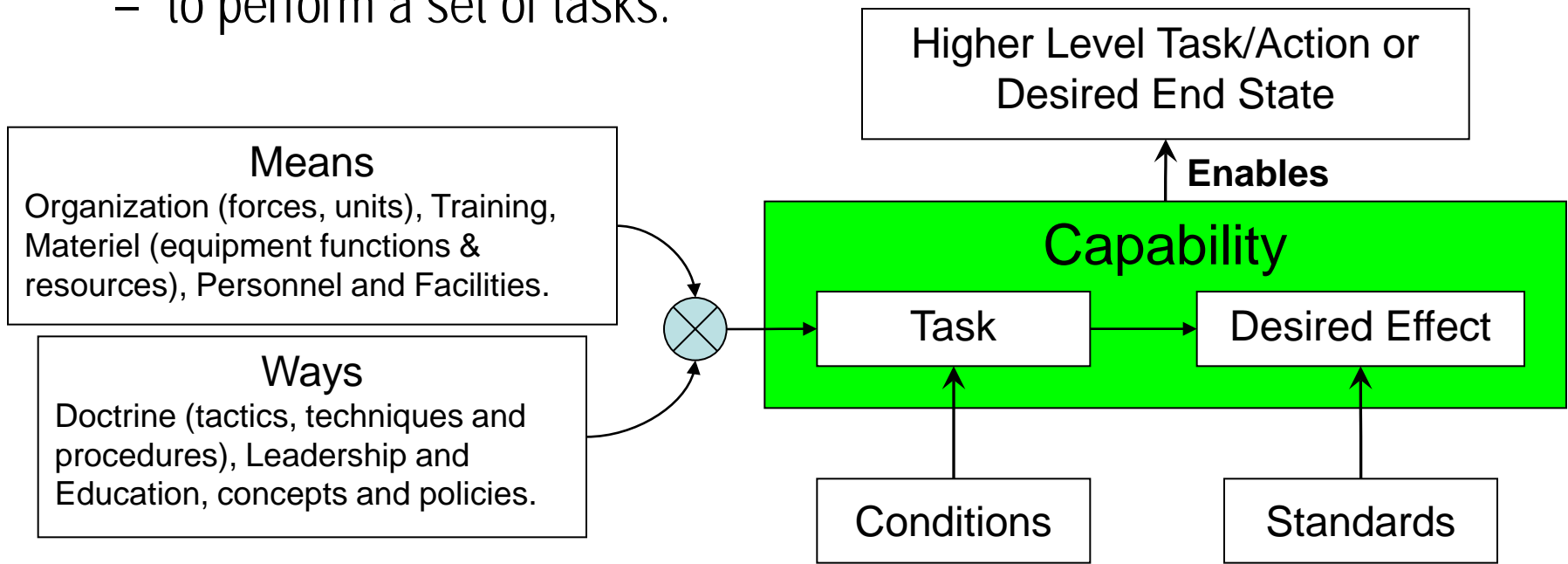
is a methodology that focuses T&E on the **capabilities** provided to the war fighter. It provides a framework and procedure to:

- **link capabilities to the attributes** of the materiel system-of-systems;
- develop evaluation measures that **assess capabilities and attributes**;
- and link the evaluation measures to all **available data sources**.

# Framework Building Block

Capability<sup>1</sup> – The ability to achieve a desired effect [or result, outcome, or consequence of a task<sup>2</sup>] ...

- under specified standards and conditions
- through a combination of means and ways
- to perform a set of tasks.



1. CJCSI 3170.01F, May 2007

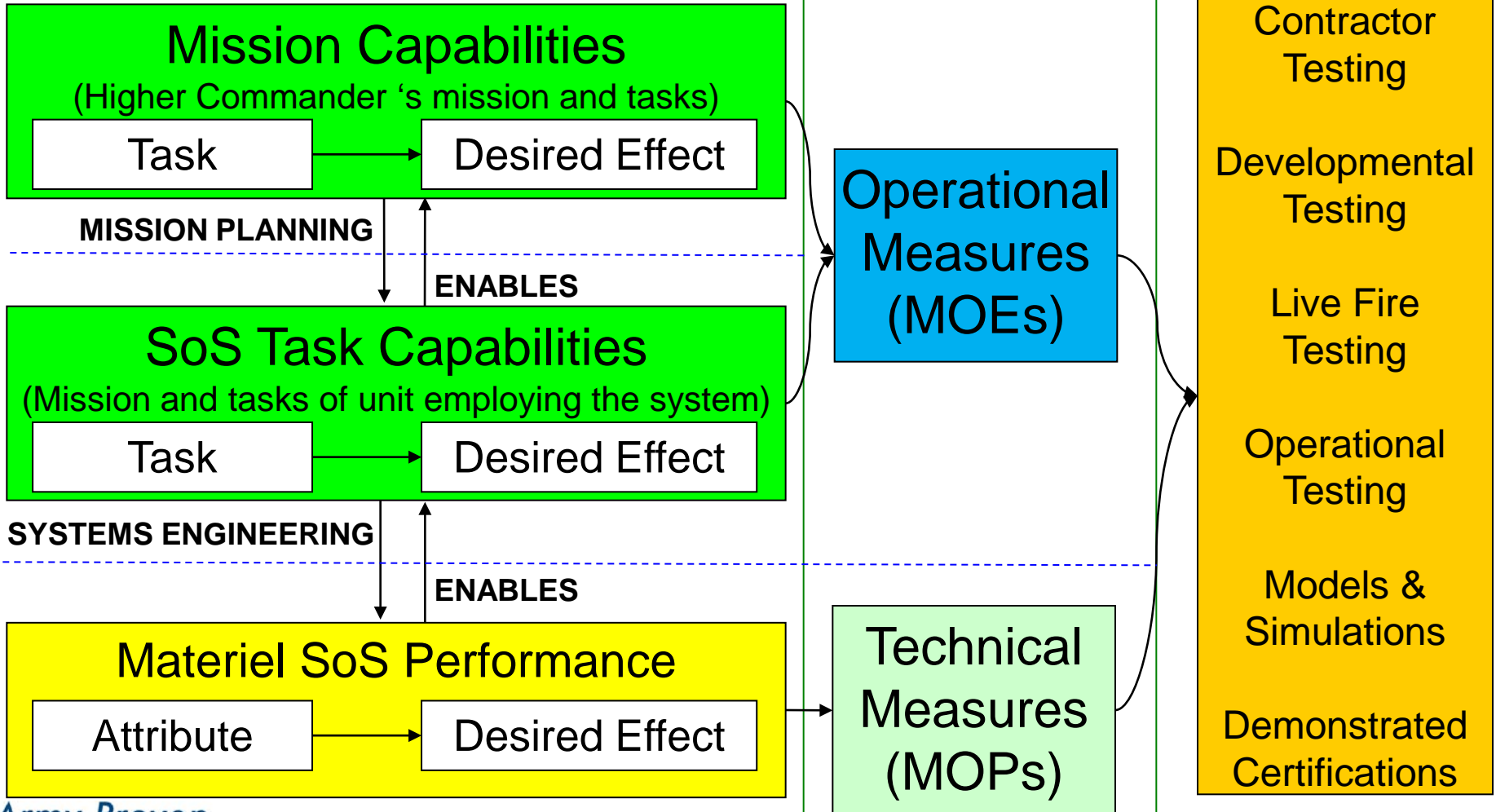
2. Taken from JP 1-02, Mar 2007, definition of effect.

# MBT&E Framework

## MISSION AND SYSTEM

## EVALUATED BY

## TESTED BY



*Army Proven  
Battle Ready*

# MBT&E Process

- Process divided into steps.
- Steps divided into 5 major purpose areas.

PLANNING

## UNDERSTAND THE MISSION

- Mission context, task and conditions.

## UNDERSTAND THE SYSTEM

- Materiel components and attributes.

- **Linkages between** mission and materiel.

## DESIGN THE TEST AND EVALUATION

- Test design and evaluation measures.

EXECUTING & REPORTING

## DETERMINE THE RESULTS

- Execute test and evaluation.

## REPORT THE RESULTS

- Format and report the results.

# Case Study Intro

# Case Study

- Functional Area Analysis

- Combat brigades required to support noncontiguous operations.
  - Ground units conducting simultaneous full spectrum operations in separate locations.
  - Aviation units providing support to simultaneous operations (one aviation team supporting more than one ground unit operation).
- Capability: Attack time-sensitive targets based on maneuver ground units call for fire (eyes-on) and limited intelligence (developing situation).

- Function Need Analysis

- Gap 1: Time sensitive targets need to be engaged within 15 minutes.
  - High priority targets, once identified, need to be destroyed before they have a chance to escape or hide in dense urban terrain, approx 15-20 minutes.
- Gap 2: Immediate response (<15 minutes) and extended surveillance (>45 minutes) needed to develop situational intelligence.
  - Currently, initial targets are being lost due to response time from observation to re-tasking of RSAs and inability of ground units to continue to surveil initial targets in dense urban terrain unobserved. Most targets lost within 15 minutes.

# Case Study

- Functional Solution Analysis
  - Reconnaissance/Attack System (RAS)
    - Air-launched loitering sensor/munition.
    - Man-in-the-loop control and targeting after launch.
    - IR and SAL seeker
  
- RAS ICD/Draft CDD
  - Air-launched (AH-64D, F/A-18E/F, and UAS based on aircraft supporting ground operations).
  - Loiter Capability (>45 minutes, based on time it takes aviation units to move from one location to another.)
  - Multi-purpose warhead (Structure, Vehicle, Personnel targets, based on expanded target set.)
  - Range (50nm, based on distributed operations.)
  - Time to Target (<15 minutes to 50 nm)
  - Probability of single-shot kill (Pssk) (>80%)

# MBT&E Process





## UNDERSTAND THE MISSION

- **Determine Operations/Mission/Tasks:** Develop a description of high-level operations/mission/tasks and their desired end states/results. Determine Joint, network and SoS construct.
- **Determine Operational Conditions:** Determine the essential elements of mission, enemy, terrain and weather, troops and support available, time available, and civil considerations (METT-TC).
- **Document/Conduct Mission Analysis:** Develop SoS mission task threads and alternate task threads where applicable. Determine task desired end states/results.
- **Link to Authoritative Task Lists:** Develop linkages between the tasks identified above and the appropriate authoritative task lists. (UJTL, AUTL, unit Mission Training Plans, etc.)
- **Determine Conditional Tasks:** Conditional tasks are performed during a mission but are only required due to some influencing condition. Examples: avoid threat missile, reset network node, etc.
- **Determine Enabling Tasks:** Mission enabling tasks are conducted in order to enable the SoS mission tasks to be performed. Examples: train, deploy, maintain, etc.
- **Identify Required Capabilities:** Identify the capabilities required to support each task with a reference to applicable requirements documents. (CDD, CPD, etc.)
- **Associate Tasks with Capabilities:** Link the capabilities we have with the mission, conditional and enabling tasks.



# Case Study

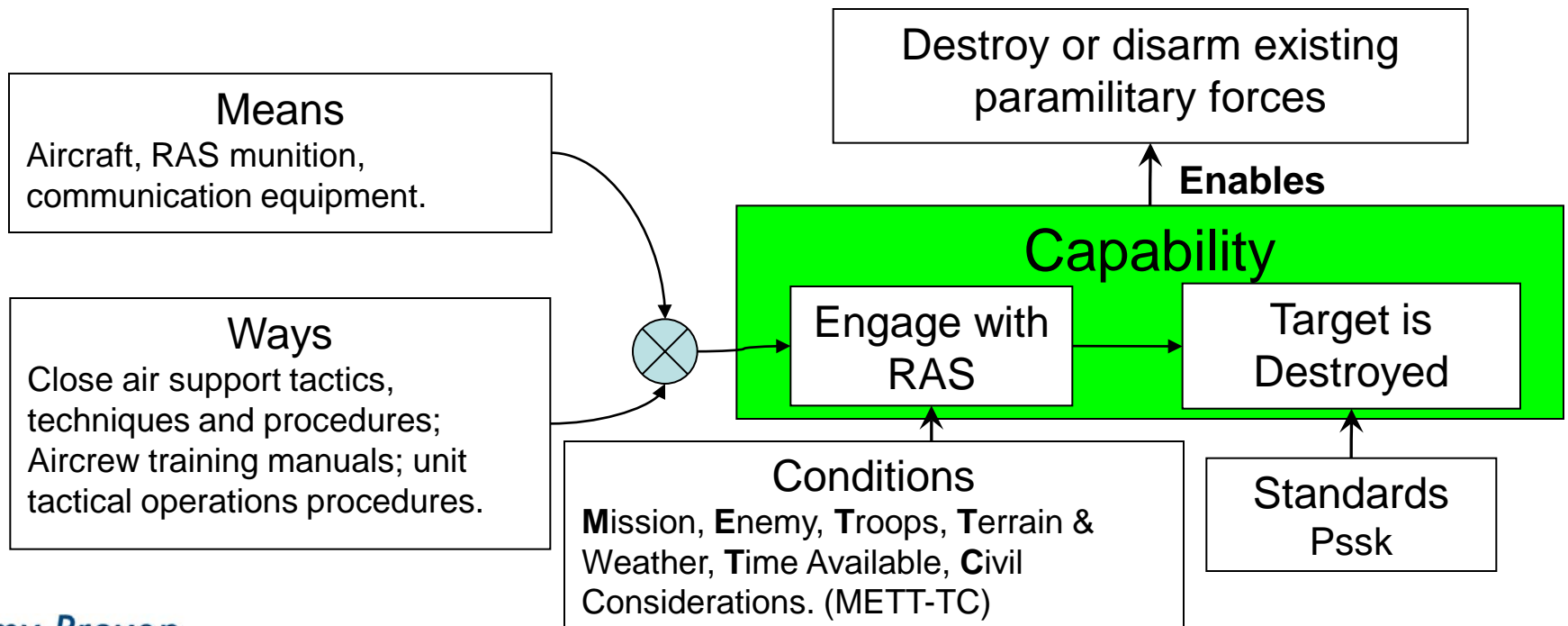
## Mission Analysis (Taken from FAA, Developed by AST and TRADOC.)

### 1.0 Support Ground Units in AO

- 1.1 Check in with BCT Commander [Contact with BCT Cdr is established]
  - 1.1.1 Accept attack mission [Attack mission is accepted by aviation unit.]
- 1.2 Employ RAS [Aviation units arrive at engagement area (EA).]
  - 1.2.1 Launch RAS Munition [RAS munition is launched and is flying normally.]
  - 1.2.2 Guide RAS to EA [RAS munition arrives in target area.]
  - 1.2.3 Gather situational information [SA is understood and target is identified.]
- 1.3 Decide on employment technique [Engagement technique is selected.]
- 1.4 Engage Target [Target is engaged and destroyed.]
  - 1.4.1 Engage with RAS [RAS flies to target.]
  - 1.4.2. Engage with onboard munitions [Selected munition functions against target.]
  - 1.4.3 Call in Joint Air Attack Team [Selected munition(s) function against target.]
- 1.5 Battle Damage Assessment [Target state is determined.]
- 1.6 Decide on re-attack or return to supporting position [Follow-on action is identified.]

# Case Study

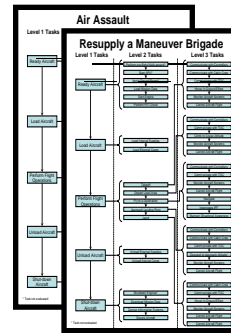
- Air to Surface Attack (ART 3.3.1 Employ Lethal Fire Support) {Time to target observation < 15 minutes.}
- Support SBCT in AO (ART 1.4.1 Conduct Lethal Direct Fire)
- Employ RAS (RAS 7) {Positive control range > 50 nm.}
- Engage with RAS (TC 251-1522 Perform Firing Techniques) {Probability of Single-Shot Kill (Pssk) > 80%.}



# Note: Task Types

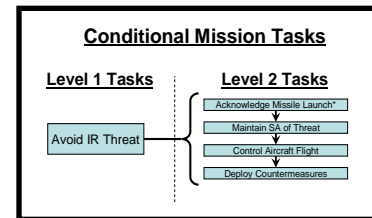
Mission execution tasks.

- Tasks that describe a discrete action that the unit (system and its operators) must perform in order to accomplish its main mission.



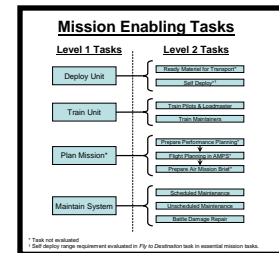
Conditional mission tasks.

- Tasks that are performed during the mission that become required due to some influencing condition.



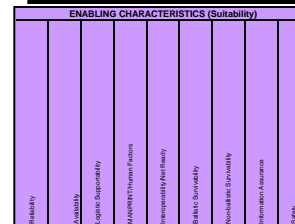
Mission enabling tasks.

- Tasks that enable the mission execution and conditional tasks to be performed. They usually occur before or after the mission.



Enabling Attributes

- System attributes that affect **all** tasks.



Normally aggregated into **Effectiveness** and **Survivability**

Normally aggregated into **Suitability**



## UNDERSTAND THE SYSTEM

- **Develop a system description starting from the SoS level:** Components at the lowest level should be able to be linked to identifiable functions (shall do's) and enabling attributes (shall be's).
- **Identify Attributes Required:** Identify the system's attributes required to support the component functions/shall be's with reference to applicable requirements documents. (CDD, CPD, Performance Specification, etc.)
- **Associate System with Attributes:** Link the attributes determined above with the system components.
- **Associate System Attributes with Task Capabilities:** Determine how the system components support the task capability. Determine redundant system support capability.
- **Determine Mission Enabling Attributes:** Mission Enabling Attributes are system enabling attributes that are not specific to a particular task capability – they address all tasks.

# Case Study

## SoS Description

### **Mission Essential**

- AH-64D [Transport / deliver missile.]
  - Launcher [Control, communicate, launch missile.]
  - Tactical Data Link [Control RAS during flight.]
  - Avionics [Communicate with ground forces.]
- RAS Munition [1. Provide situational information, 2. Destroy target.]

### **TTP Dependent**

- Remote Designator [Designate Target]

### **Training**

- Simulator [Exercise aircrews in RAS TTPs.]

### **Mission Support**

- Mission Planning System [Load and performance planning downloaded on cartridge.]

# Case Study

## Linking Task to Materiel

### TASK CAPABILITY

- Air to Surface Attack (ART 3.3.1 Employ Lethal Fire Support) {Time to target observation <15 minutes.}
- Support Ground Unit in AOS (ART 1.4.1 Conduct Lethal Direct Fires)
- Employ RAS (RAS 7) {Positive control range >50 nm.}
- Engage with RAS (TC 251-1522 Perform Firing Techniques) {Pssk >80%.}



Task capability linked to SoS attribute performance

### SoS PERFORMANCE

- Aircraft TDL [Control RAS during flight.] {Positive communication link range > 60nm}
- RAS Munition [1. Provide situational information, 2. Destroy target.] {Prel; % non-essential function failure > 93%.} {Loiter time > 45 minutes.}
  - Seeker [Provide situational images, acquire and track target.] {Minimum Delta-Temperature.} {Operate with all semi-active laser code frequencies.}
  - Warhead [Provide lethal effects.] {Pk/h, >95%.}
  - C&G [Guide munition.] {Ph/s, >90%.}

## Note: What Works Best

- **SoS description aligned with PM's Work Breakdown Structure**
  - Facilitates sharing of T&E data during contractor testing.
  - Aligns tasks with contractor requirements.
- **Operational conditions carried through to system attributes.**
  - Facilitates analysis of what operational conditions are applicable during DT.
  - Provides integrated T&E picture.





## DESIGN THE TEST AND EVALUATION

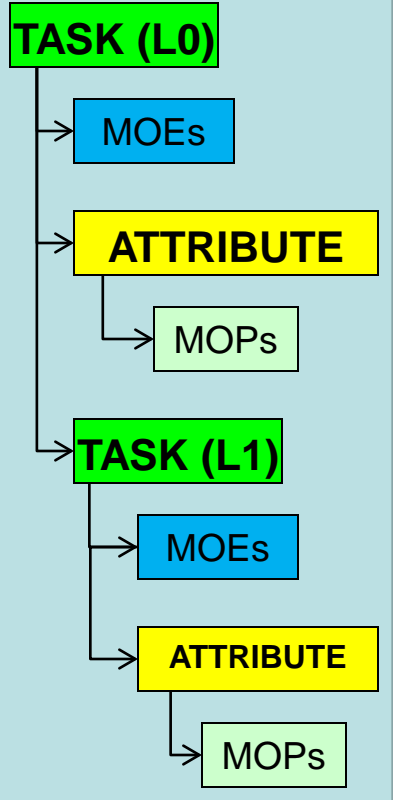
- **Determine the operational factors and conditions:** Factors/conditions based on the task capability required and the system attributes.
- **Develop evaluation measures:** Measures support the evaluation of task capabilities (Measures of Effectiveness), and system attributes (Measures of Performance).
- **Complete linkages from measure -to- system -to- task.**
- **Develop linkages between measures and COIs/Criteria.**
- **Assign one or more data sources to each evaluation measure:** Review data source matrix to determine: T&E execution risk, developmental risk by assessing when critical technologies are demonstrated; and determine appropriate use of M&S.
- **Determine the T&E limitations:** Determine the operational conditions that can/can not be addressed by the identified data sources.
- **Develop detailed measure design.** Determine data elements required from the data source.
- **Develop design of experiments.** Determine the operational conditions required for each run, sortie or sample.

# Case Study

## Link Measures to Data Sources

### Example

#### Construct



Task	Operational Measure	Material System	Technical Measure	Tower Tests	Captive Flight P1	Motor Static Runs	Motor Wind Tunnel Runs	MS B	Arena Tests	HWIL (seeker)	Armor Penetration P2 (seeker)	DT Flight Tests	M&S (Lethality)	IFS	LUT/OT-B	Certifications	MS C	Logistics Demonstration	IFS	Full-up System Live Fire	Analysis	IOT	Full-rate Production decision
Close Air Support	% missions enemy is observed % missions COA is completed Time to first target observation Stowed Kills																						
Support in AO																							
Employ RAS																							
Engage with RAS																							
	A/C TDL*		Average maximum positive control range																				
			RAS position, speed and attitude info accuracy																				
	RAS Munition		In-flight Reliability																				
			Maximum loiter time																				
	Seeker																						
	Guidance and Control																						
	G&C S/W																						
	Warhead																						
	Motor*		Thrust vs. Time																				



## DETERMINE THE RESULTS

## REPORT THE RESULTS

- **Execute test, run M&S, record data:** Review data for integrity and authentication. Adjust T&E program based on impacts of changes in schedule and system design.
- **Analyze Data:** Performance results are compared to standards for the task capabilities and system attributes.
- **Determine system attribute performance.** Report to PM for system improvements.
- **Determine task capabilities and limitations:** Determine task capability C&L directly from task capability measure results. Determine task capability C&L based on system attribute measure results.
- **Determine task C&L impact on high-level mission task capabilities:** Determine ability to achieve desired end state directly from capability measures. Determine ability to achieve desired end state from task capability C&Ls

# Case Study Results (Fictional)

Task	Operational Measure	Material System	Technical Measure	Requirement	Result
<b>Close Air Support</b>					
	Time to first target observation			< 15 min (13 min)	14.6 min
	Stowed Kills			NC	Predicted: 3, 6, 12 Demonstrated: 2, 5, 11
<b>Employ RAS</b>					
	Rating of control			NC	4.7/5 Excellent
	A/C TDL				
	Positive Control Range			50 km	62 km
	RAS Munition				
	Avg Max Loiter Time			45 min	52 min
<b>Engage with RAS</b>					
	% missions target is destroyed			NC	84%
	Time of Engagement			< 15 min (2 min)	1.6 min
	Pssk			80%	P: 76%, D: 69%
	RAS Munition				
	In-flight Reliability			93%	82%
	Guidance and Control				
	Ph/s Predicted			90%	95%
	Ph/s Observed			NC	84%
	Warhead				
	Pk/h Predicted			95%	97%
	Pk/h Observed			NC	100%

**Employ Lethal Fire Support**

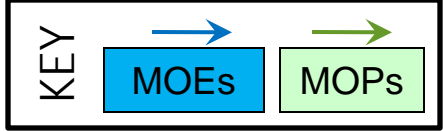
- Able to arrive in the engagement area within 15 minutes.
- Able to arrive in the engagement area and destroy the target within 16.2 minutes.
- Able to destroy from 3 to 12 targets per sortie (2 aircraft) based on load out.

**Employ RAS**

- Able to employ the RAS up to a range of 62 km with a loiter time of 52 minutes.

**Engage with RAS**

- Able to engage the target within 2 minutes.
- Able to engage and destroy targets with a probability of single shot kill of 76%, +/- 4%.



NC: No defined criteria.



# Evaluation Report

Employment of the RAS supports the engagement of threat forces in AO and contributes to the unit's ability to destroy/disarm existing paramilitary forces

## EFFECTIVENESS

### Employ Lethal Fire Support

- Able to arrive in the engagement area within 15 minutes and destroy the target within 16.2 minutes.
- Able to employ the RAS up to a range of 62 km with a loiter time of 52 minutes.
- Able to engage and destroy targets with a probability of single shot kill of 76%, +/- 4%.
- This supported a stowed kill rate of 3 to 12 targets per sortie (2 aircraft) based on load out.

## SUITABILITY

### Replace IR Coolant Bottle (enabling task)

- Able to replace a spent IR coolant bottle within 15 minutes on the flight line.

### Reliability (enabling attribute)

- The RAS demonstrated a reliability of 82% (time to essential function failure).

### Maintainability (enabling tasks)

- OPTEMPO was supported with a mean time to repair of 1.2 hours and anticipated stockpiles.

## SURVIVABILITY

### Electromagnetic Survivability (enabling attribute)

- The RAS was compatible with existing and induced electromagnetic environments.

### Jettison Launcher (conditional task)

- Jettison of the launcher was demonstrated for each load configuration.

# Note: Suitability impact on Effectiveness

SUITABILITY

## Reliability (enabling attribute)

- The RAS demonstrated a reliability of 82% (time to essential function failure).



Suitability  
Enables  
Effectiveness

EFFECTIVENESS

## Employ Lethal Fire Support

- Able to engage and destroy targets with a probability of single shot kill of 76%, +/- 4%.
- This supported a stowed kill rate of 3 to 12 targets per sortie (2 aircraft) based on load out.

# Lessons Learned



# Observed impacts to OT

- Increased and earlier focus on mission scenario.
  - Combat, Materiel Developers and Independent Evaluation collaborative development of mission tasks. Aligning expectations.
- Increased focus on OT data requirements.
  - Operational measures developed to evaluate task capability. Synchronized with DOT&E definition of MOEs.
- Detailed identification of data and instrumentation needs.
  - Leading to areas where common instrumentation can be applied.





# Observed impacts to DT

- Operational context being applied to DT procedures.
  - Identifying more opportunities for integrated DT/OT.
  - DT done under operational conditions can be integrated with OT.
- Increased input from T&E.
  - DT supporting both ATEC evaluation and PM contract verification. Collaborative effort between ATEC and PM.
- Data pedigree being established.
  - Contracts being written to allow for greater “transparency.”
  - Sharing data more readily.

# Observed Impacts to PM

- Early and synergistic evaluation of operational performance.
  - Impact on operational capability sought during technology development. Observable risk mitigation results.
- Alignment of Independent evaluation with PM/Contractor systems engineering.
  - More synergistic use of available contractor test and DT data.
- Leveling of expectations.
  - Reduced “surprises” due to interpretation of requirements.



# Summary Observations

- Focus on Operational and Support Capabilities
  - Conclusions, based on **demonstrated performance**, presented in terms of **unit capability**.
  - Focus on capabilities of the unit **drives test and evaluation requirements**. Feeds design of experiments.
  - Linkages between the task and system attributes provides **early scoping of T&E requirements**.
- Synergistic T&E
  - Mission context used to “operationalize” CT and DT and **enables blending of the data across all events**.
  - Use of **common instrumentation** across test events facilitates combining of data from multiple events.
  - T&E requirements able to be **incorporated into contractor test requirements** as part of contracts.

## ***BOTTOM LINE: We can now:***

- identify the “strengths and weaknesses of a system and its components, and the effect on operational capabilities and limitations”; and
- provide “collaborative planning and collaborative execution of test phases and events to provide shared data”.



# MBT&E Tutorial

Discussions

-

Questions

-

Answers

## MBT&E Point of Contact

Christopher Wilcox

US Army Test and Evaluation Command

US Army Evaluation Center

ATTN: TEAE-SE (Mr. Chris Wilcox)

4120 Susquehanna Ave.

Aberdeen Proving Ground, MD 21005

Office: (410) 306-0449

Fax: (410) 306-1945

[chris.wilcox1@us.army.mil](mailto:chris.wilcox1@us.army.mil)



- end