



Mission-Based T&E

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Chris Wilcox

US Army Evaluation Center

410-306-0475

chris.wilcox1@us.army.mil




MBT&E Background




MBT&E Framework

- **ATEC Mission Based Test & Evaluation is consistent with**
 - OSD P&R directives for reporting METL-based Readiness
 - Joint GEF certification for Deployment of Operational Forces
 - JCIDS Capability based Acquisition
 - DoD Systems Engineering guide for Systems of Systems (SE for SoS)
 - DOT&E Joint Test & Evaluation Methodology (JTEM)

 **Based on Generic, General Purpose Measures/Conditions/Standards**

- TPFData List TO&E (standing) C-METL OSD P&R Readiness
- TPFDeployment Data MTOF (transient) D-METL Joint GEF Certification

 **Based on Mission, Situation Specific Measures/Conditions/Standards**

TPFDL: Time Phased Force Data List for deployment planning
 TPFDL: Time Phased Force Deployment Data for deployment execution
 TO&E: Table of Organization and Equipment for a standing unit
 MTOF: Mission Task Organized Force (modeling & simulation term)
 C-METL: Core METL defined by Army Force Generation (ARFORGEN) for commonality between units of the same type
 D-METL: Directed METL defined by Army Force Generation (ARFORGEN) for a unit with specific deployment orders
 GEF: Joint Guidance for Employment of Forces for unit certification prior to deployment
 P&R: OSD Personnel & Readiness directives for METL-based readiness reporting
 JCIDS: Joint Capability Integrated Development System



MBT&E Framework



Case Study Introduction



Case Study

- The purpose of this case study is to to present the concepts and operation of the MBT&E methodology using a example.
- The intent is to involve the audience in the development of an MBT&E strategy and to focus discussions.
- The information presented in the case study is fictional.



Case Study

- Joint Capabilities Integration and Development System conducting a capabilities-based assessment of modular combat brigades.
- Brigade Combat Team supported by Reconnaissance Attack battalion from Combat Aviation Brigade.
- 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).



Case Study

- 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.
 - Current aviation unit response time from call for fires to prosecuted target as much as 45 minutes, depending on current location and location of the support call (50 nm).
 - Current quick-response call for fires from other assets (artillery and current air-launched munition set) not reliably available or not desired due to need to minimize collateral damage in dense urban terrain.
- Gap 2: Immediate response (<15 minutes) and extended surveillance (>45 minutes) needed to develop situational intelligence.
 - Success seen in using pre-planned reconnaissance/surveillance assets (RSAs) to observe suspicious behavior of initial target leading to other, more valuable, targets.
 - 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.
 - Currently, targets taking as much as 45 minutes to move from initial observation area to centralized base. (Based on pre-planned RSA missions.)



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 Procedure



MBT&E Procedure

Step 1

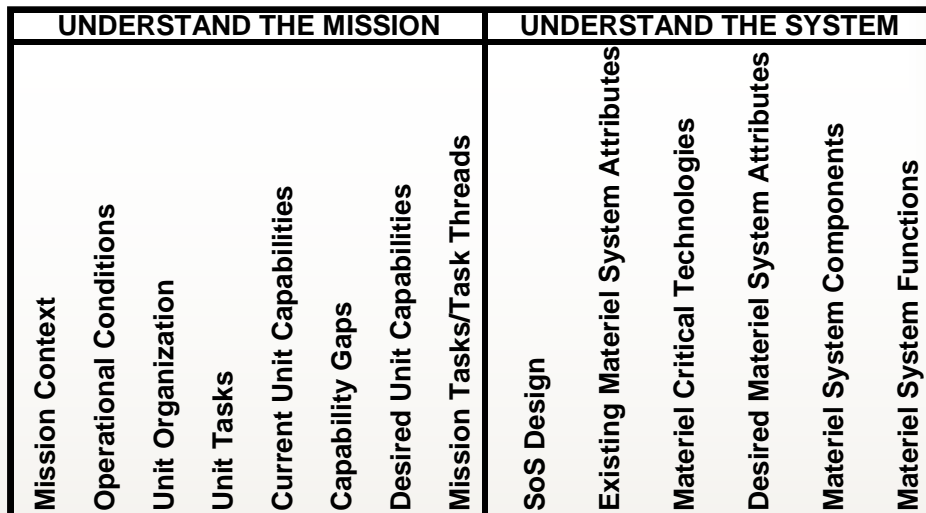
Collect Information



Collect Information (Step 1)

Currently building/maintaining document list.

| Document Title | Who to ask? |
|--|----------------------|
| Functional Area Analysis | TRADOC |
| Functional Need Analysis | TRADOC |
| Functional Solution Analysis | TRADOC |
| Analysis of Alternatives | TRADOC |
| Operational Mode Summary/Mission Profile | TRADOC |
| Initial Capabilities Document | TRADOC |
| DoDAF OV-1 (Appendix A) | |
| Capabilities Documents (CDD, CPD) | |
| DoDAF OV-1 (Appendix A) | TRADOC |
| DoDAF OV-2 (Appendix A) | |
| DoDAF OV-4 (Appendix A) | |
| DoDAF OV-5 (Appendix A) | |
| DoDAF OV-6C (Appendix A) | |
| DoDAF SV-2 (Appendix A) | |
| DoDAF SV-4 (Appendix A) | |
| DoDAF SV-5 (Appendix A) | |
| DoDAF SV-6 (Appendix A) | |
| COI/Cs | TRADOC |
| Army Universal Task List, FM 7-15 | HQDA |
| Unit Mission Training Plan | TRADOC/School House |
| Support Unit Mission Training Plans | TRADOC/School House |
| Universal Joint Task List, CJCSM 3500 | Joint Staff (online) |
| System Threat Assessment Report | PM |
| Technology Development Strategy | PM |
| Acquisition Strategy | PM |
| Work Breakdown Structure | |
| Material Fielding Plan | PM |
| System Performance Specification | PM |



| Document Title | Who to ask? | Mission Context | Operational Conditions | Unit Organization | Unit Tasks | Current Unit Capabilities | Capability Gaps | Desired Unit Capabilities | Mission Tasks/Task Threads | SoS Design | Existing Materiel System Attributes | Materiel Critical Technologies | Desired Materiel System Attributes | Materiel System Components | Materiel System Functions |
|--|----------------------|-----------------|------------------------|-------------------|------------|---------------------------|-----------------|---------------------------|----------------------------|------------|-------------------------------------|--------------------------------|------------------------------------|----------------------------|---------------------------|
| Functional Area Analysis | TRADOC | X | m | m | m | m | X | X | m | | | | | | |
| Functional Need Analysis | TRADOC | | m | m | m | m | X | X | m | | | | | | |
| Functional Solution Analysis | TRADOC | | | | | | | X | m | | | | | | |
| Analysis of Alternatives | TRADOC | | X | X | X | | | X | m | | | | X | m | X |
| Operational Mode Summary/Mission Profile | TRADOC | | X | X | X | | | X | X | | | | | | |
| Initial Capabilities Document | TRADOC | | X | m | | | | X | X | | | | | X | |
| DoDAF OV-1 (Appendix A) | | | X | X | X | X | | X | X | | | | X | X | X |
| DoDAF OV-2 (Appendix A) | | | X | | | | | X | X | | | | X | X | X |
| DoDAF OV-4 (Appendix A) | | | | | X | | | | X | | | | | | |
| DoDAF OV-5 (Appendix A) | | | | | X | | | | X | | | | | | |
| DoDAF OV-6C (Appendix A) | | | | | X | | | | X | | | | | | |
| DoDAF SV-2 (Appendix A) | | | | | X | | | | X | | | | | | X |
| DoDAF SV-4 (Appendix A) | | | | | X | | | | X | | | | | | X |
| DoDAF SV-5 (Appendix A) | | | | | X | | | | X | | | | | | X |
| DoDAF SV-6 (Appendix A) | | | | | X | | | | X | | | | | | X |
| COI/Cs | TRADOC | | | | X | | | X | X | | | | X | | |
| Army Universal Task List, FM 7-15 | HQDA | | | | X | | | X | X | | | | X | | |
| Unit Mission Training Plan | TRADOC/School House | | | | X | | | X | X | | | | X | | |
| Support Unit Mission Training Plans | TRADOC/School House | | | | X | | | X | X | | | | X | | |
| Universal Joint Task List, CJCSM 3500 | Joint Staff (online) | | | | X | | | X | X | | | | X | | |
| System Threat Assessment Report | PM | | | | X | | | | | | | | | | |
| Technology Development Strategy | PM | | | | | | | | | m | | | X | | X |
| Acquisition Strategy | PM | | | | | | | | | m | | | X | | X |
| Work Breakdown Structure | | | | | | | | | | | | | X | | X |
| Material Fielding Plan | PM | | | | | | | | | | | | X | | X |
| System Performance Specification | PM | | | | | | | | | | | | X | | X |

X = provides
m = may provide



MBT&E Procedure

Steps 2-5

Understand the Mission



MBT&E Procedure

Step 2

Define the Mission Context



Focused Mission Case

- Strategic End State: Restore secure stable environment
 - Mission 1: Restore basic services
 - [Basic services restored to 80% of the population.]
 - Mission 2: Create a professional security forces
 - [Security forces able to maintain order.]
 - Mission 3: Provide area security.
 - [Create conditions for government to function and citizens to live, work and play.]
- Scenario for Mission 3: BCT establishes platoon sized Combat Outposts in cleared areas to prevent local insurgent forces/foreign fighter cells from operating. Units conduct patrolling and presence operations to reassure civilian population and disrupt insurgent operations in the area of operations. Attack Recon Company (AH 64) supports ground units with aerial recon, cooperative engagement of High Payoff Targets and attack of time sensitive targets.



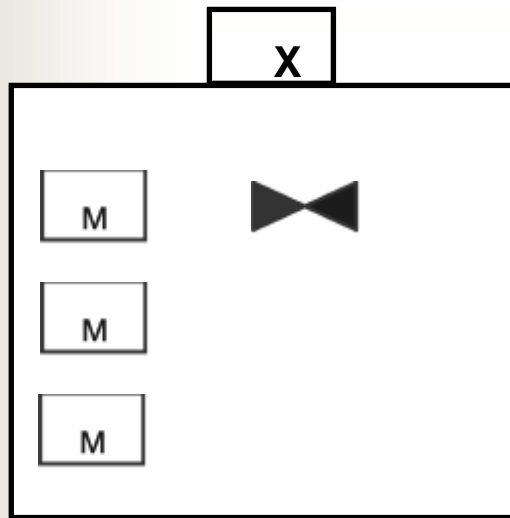
Case Study (Fictional)

Scenario Operational Setting

- Situation
 - Brigade Combat Team conducting full spectrum operations within an assigned Area of Operations.
 - Active insurgency with mix of discontented local tribes and foreign extremist fighters equipped with modern communications and MANPADS.
 - Subordinate Combined Arms Battalions operating platoon sized Combat Outposts throughout the AO
 - Insurgent leadership conducts planning and coordination meetings at varying times and locations to reduce vulnerability to attack with meeting times normally limited to less than 1 hour.
 - Insurgent gatherings are CCIR for BCT Cdr and insurgent leaders are High Payoff Tgts
- BCT Mission: Secure the BCT AO in order to set conditions for local civilians to carry on normal activities and handover responsibility to HN Forces
- Execution
 - Commander's Intent
 - Locating and eliminating insurgent leadership is critical to our ability to establish a secure environment for the civilian population.
 - Equally important is the need to ensure positive identification and avoid collateral damage. Unintentional civilian casualties will severely undermine the mission by throwing support to the insurgents.



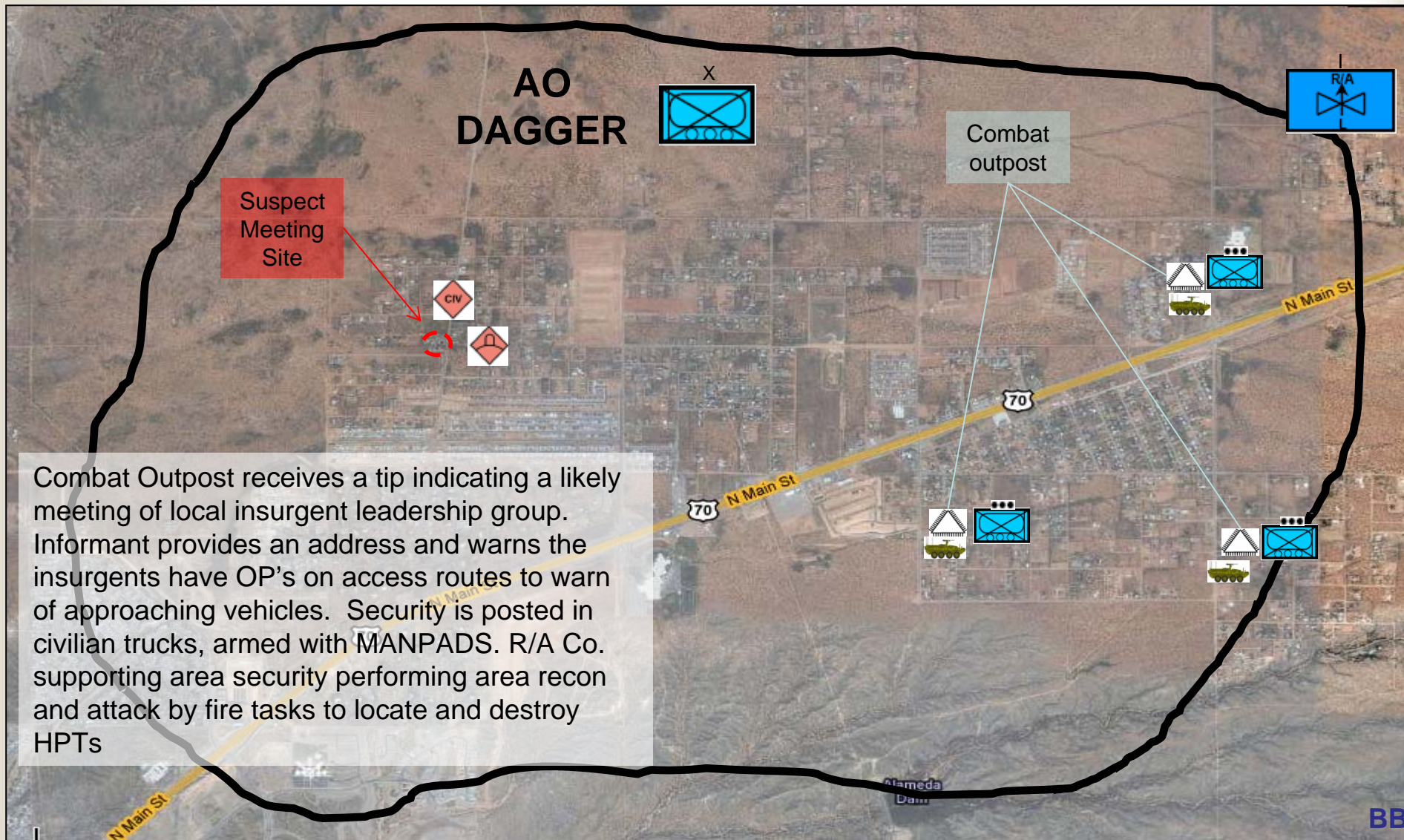
Task Organization



Brigade Combat Team (BCT) task organized with 3 Stryker battalions and 1 Attack Helicopter battalion from the Corps Aviation Brigade



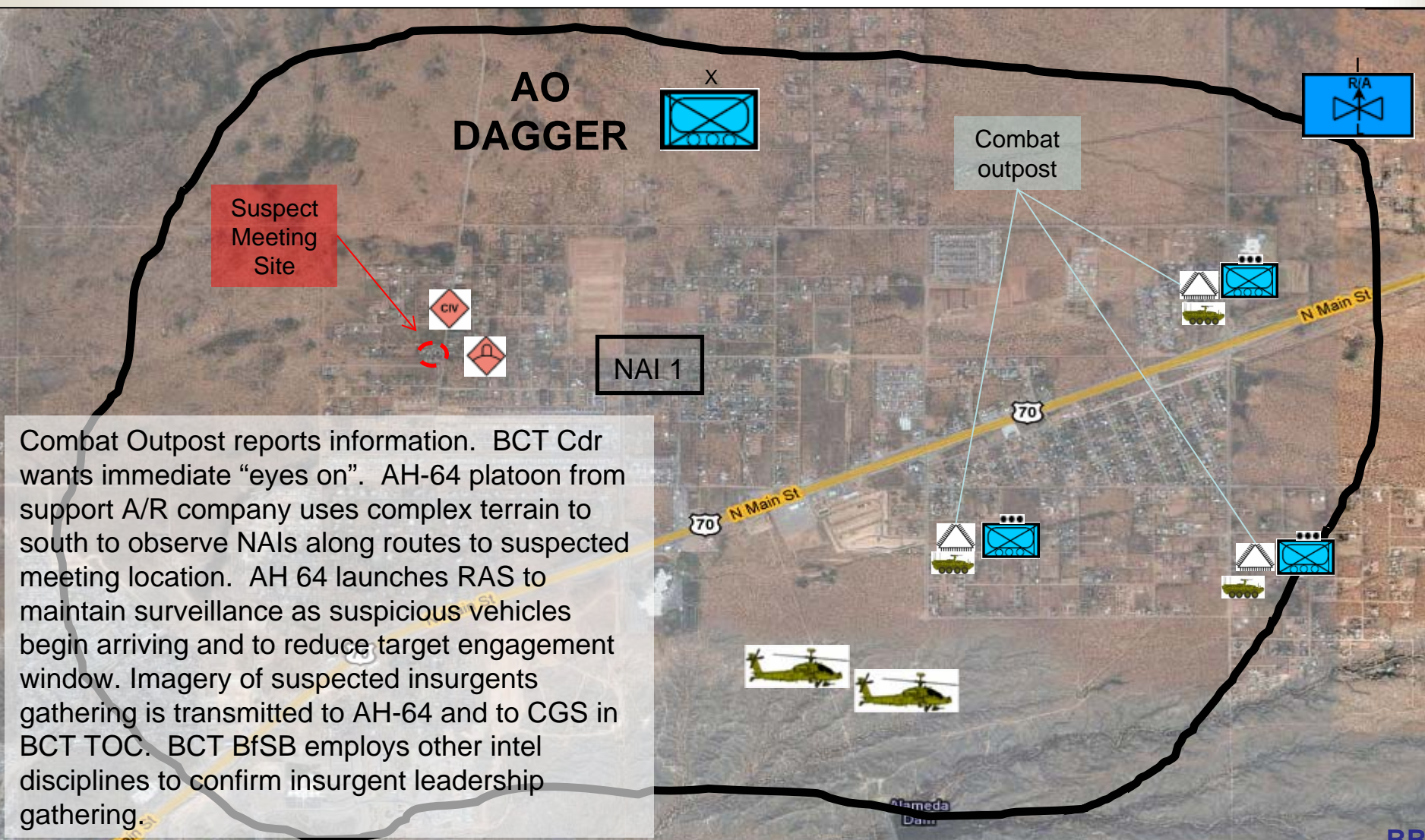
Current Situation



Combat Outpost receives a tip indicating a likely meeting of local insurgent leadership group. Informant provides an address and warns the insurgents have OP's on access routes to warn of approaching vehicles. Security is posted in civilian trucks, armed with MANPADS. R/A Co. supporting area security performing area recon and attack by fire tasks to locate and destroy HPTs



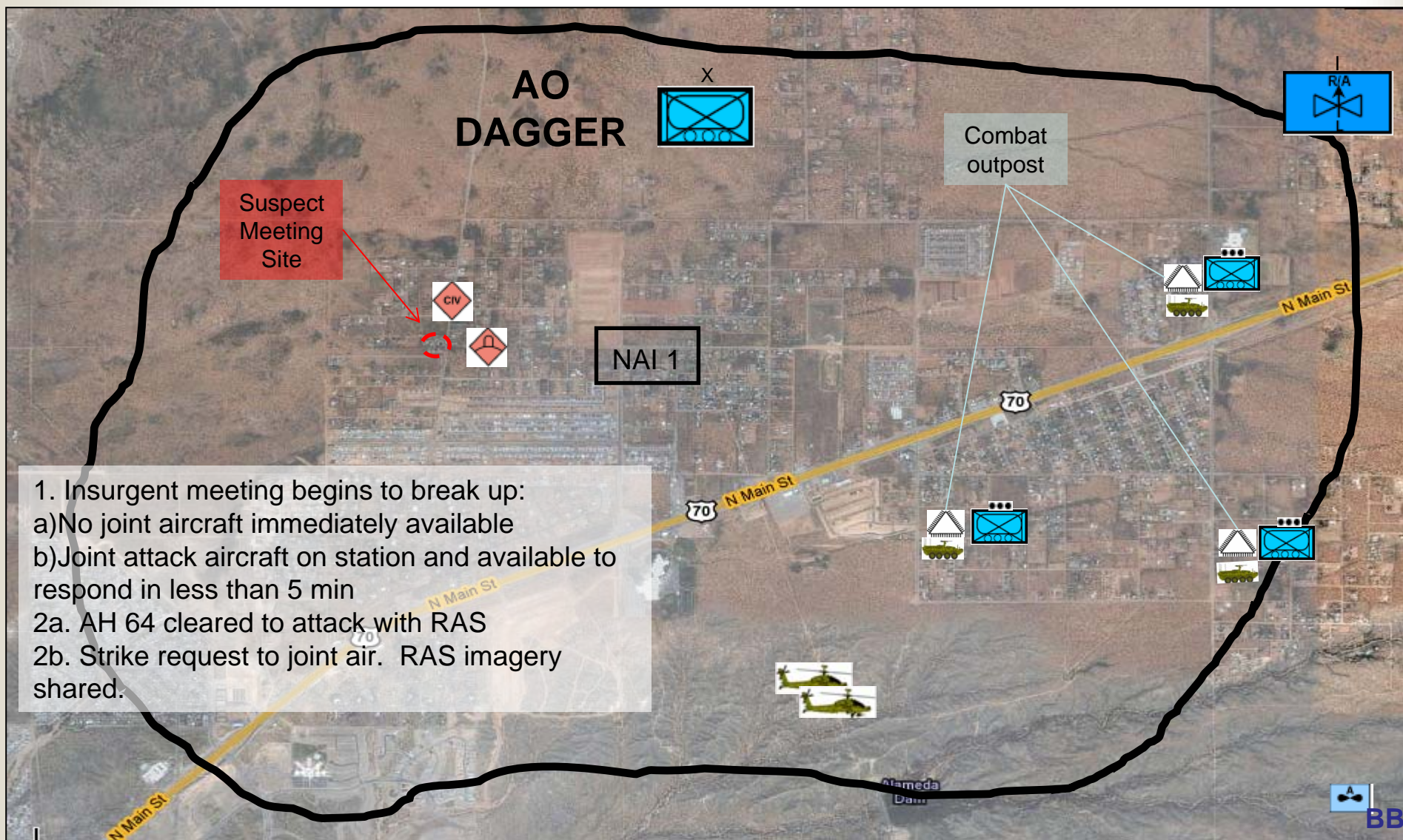
Current Situation



Combat Outpost reports information. BCT Cdr wants immediate "eyes on". AH-64 platoon from support A/R company uses complex terrain to south to observe NAIs along routes to suspected meeting location. AH 64 launches RAS to maintain surveillance as suspicious vehicles begin arriving and to reduce target engagement window. Imagery of suspected insurgents gathering is transmitted to AH-64 and to CGS in BCT TOC. BCT BfSB employs other intel disciplines to confirm insurgent leadership gathering.



Current Situation



Suspect Meeting Site

AO
DAGGER

NAI 1

Combat outpost

1. Insurgent meeting begins to break up:
a) No joint aircraft immediately available
b) Joint attack aircraft on station and available to respond in less than 5 min
2a. AH 64 cleared to attack with RAS
2b. Strike request to joint air. RAS imagery shared.



Operational Conditions

- **Mission 3: In RAS context.**
 - **Conduct Dynamic Targeting (OP 3.1.9):** To achieve timely and accurate detection and prosecution of time-sensitive targets through integration of dynamic ISR support and operations in support of the operational level JFC's intent.¹
 - **Conduct Air to Surface Attack (ART 3.3.1.2):** Use fixed- and rotary-wing aircraft-mounted weapon systems to destroy, suppress, or neutralize equipment (including aircraft on the ground), materiel, personnel, fortifications, and facilities.²
- **Summary of operational conditions (METT-TC)**
 - **Mission:** Employ Lethal Fire Support (ART 3.3.1)
 - Joint Task: TA 3.2.1 Conduct Fire Support
 - Army Task: ART 1.4.1 Conduct Lethal Direct Fire against a Surface Target
 - **Enemy:** Vehicles, and Personnel in open. Personnel in buildings.
 - **Troops:** SBCT; R/A Company (AH 64); joint air attack teams (USAF and USN).
 - **Terrain & Weather:** Urban, desert, mountain, all weather
 - **Time Available:**
 - Clock Hours: Daylight, Night and Crossover.
 - Planning Time: Extensive coordination planning. Engagement plan developed as situation unfolds.
 - **Civil Considerations:** Limited collateral damage. Positive ID of targets necessary (friendlylies in the area).

1. CJCSM 3500.04C Universal Joint Task List

2. FM 7-15 The Army Universal Task List



MBT&E Procedure

Step 3

Develop the Mission Tasks



Mission Analysis

- Area Reconnaissance and Lethal Direct Fire against surface targets (As requested by supported BCT Cdr).
 - Plan Mission [Mission planned and mission data loaded on data cartridge.]
 - Weapon Load Planning.
 - Complete Performance Planning Calculations.
 - Prepare for Mission [Aircraft report 'go' status and lined up at tactical assembly area.]
 - Load Aircraft and Weapon Status Check.
 - Lineup for takeoff.
 - Execute Mission [R and A mission executed as requested by ground units.]
 - TAA to AO
 - **Support Ground Unit in AO**
 - AO to TAA



Mission Analysis

- Support Ground Units in AO
 - Check in with ground units [Contact with ground units is established]
 - Accept attack mission [Attack mission is accepted by aviation unit.]
 - Employ RAS [Aviation units arrive at engagement area (EA).]
 - Launch RAS Munition [RAS munition is launched and is flying normally.]
 - Guide RAS to EA [RAS munition arrives in target area.]
 - Gather situational information [SA is understood and target is identified.]
 - Decide on employment technique [Engagement technique is selected.]
 - Engage Target [Target is engaged and destroyed.]
 - 1. Engage with RAS [Target is destroyed by RAS.]
 - 2. Engage with onboard munitions [Target is destroyed by selected munition.]
 - 3. Call in Joint Air Attack Team [Target is destroyed by supporting aircraft.]
 - Battle Damage Assessment [Target state is determined.]
 - Decide on re-attack or return to supporting position [Followon action is identified.]



Mission Analysis

- Support in AO →
 - Check in with ground units →
 - Accept attack mission →
 - Employ RAS →
 - Launch RAS Munition →
 - Guide RAS to AO →
 - Gather situational information →
 - Decide on employment technique →
 - Engage Target →
 - 1. Engage with RAS →
 - 2. Engage with onboard munitions →
 - 3. Call in JAAT →
 - Battle Damage Assessment →
 - Decide on re-attack or return to supporting position →
- ART 3.3.1.2 Conduct Air to Surface Attack
- ART 5.1.2.1 Est. Coordination & Liaison
- ART 5.1.1.1 Receive the Mission
- ARTEP 01-2-5183 Tactical Air Movement
- **RAS 7 Launch RAS**
- **RAS 15 Control RAS**
- ART 2.3.4 Conduct Surveillance; ART 5.1.4.1 Monitor Situation
- TC 251-1422 Perform Firing Techniques
 - same as above
 - **RAS 10 Modify RAS Warhead Setting; RAS 9 Modify RAS Employment Setting**
- TC 251-1458 Engage with Point Target Weapon System
- ARTEP 01-2-0106.01 Conduct JAAT Operations
- ART 5.1.4.3.1 Conduct BDA
- ART 5.1.4.3.3 Provide re-attack recommendation
- TC 251-1405 Transmit Tactical Report



MBT&E Procedure

Step 4

Develop the Supporting Tasks



Supporting Tasks

- Conditional Tasks

- Deny Enemy Engagement [Enemy can not engage aircraft.]
 - ART 5.7.1 Protect against Enemy Hazards in the A.O.
- Jettison Launcher [Launcher with munitions is jettisoned.]
 - TC 251-1070 Respond to Emergencies

- Enabling Tasks

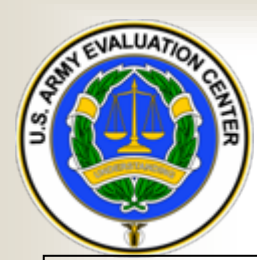
- Replace IR Coolant Bottle [Spent coolant bottle is removed, replacement bottle is installed, and missile provides a “go” status.]
 - ARTEP 01-2-5212 Perform helicopter repairs and required inspections of aircraft subsystems
- Training [Aircrew is trained and certified in RAS control tasks.]
 - ART 5.1.2.5 Conduct Pre Operations Checks and Inspections



MBT&E Procedure

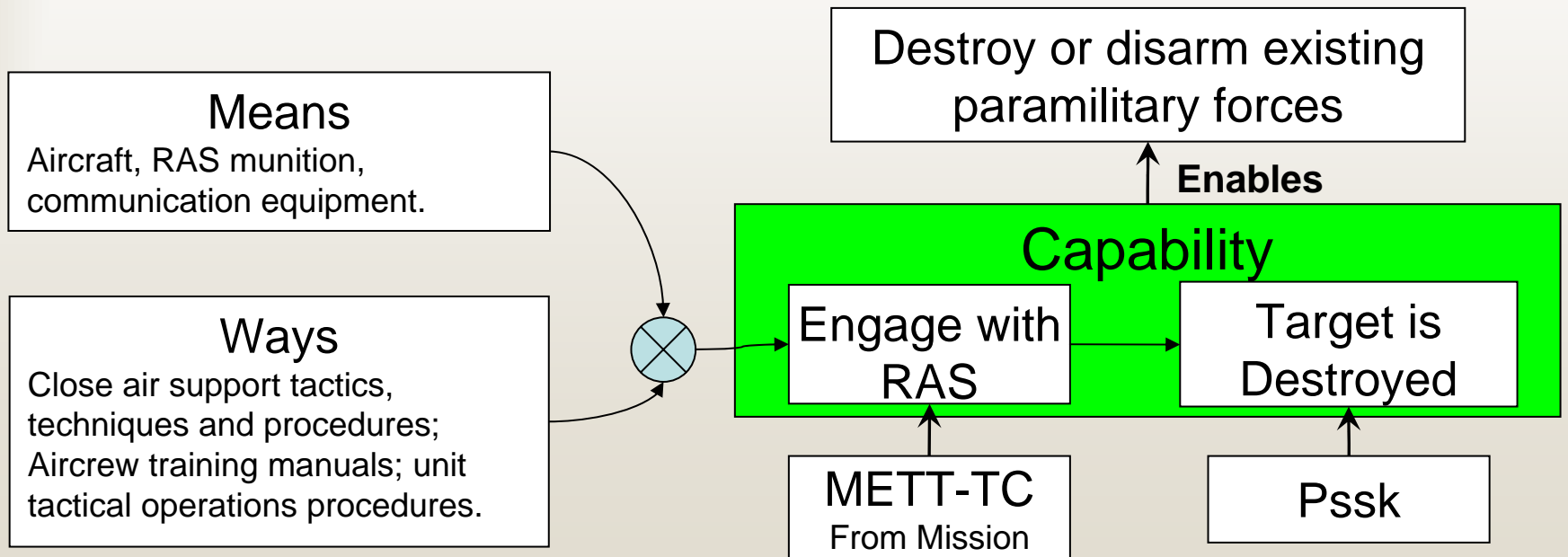
Step 5

Identify Task Capabilities



Associate Tasks with Requirements

- 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%.}**





Afternoon Break

1500-1515



MBT&E Procedure

Steps 6-8

Understand the System &
Associate Capabilities with Attributes



MBT&E Procedure

Step 6

Determine the SoS Components



SoS Description

- 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.]
- Simulator [Exercise aircrews in RAS TTPs.]
- Remote Designator [Designate Target]
- Mission Planning System [Load and performance planning downloaded on cartridge.]



SoS Description

- Aligned with PM's Work Breakdown Structure
- RAS Munition [1. Provide situational information, 2. Destroy target.]
 - Seeker [Provide situational images, acquire and track target.]
 - Motor [Provide Thrust.]
 - Warhead [Provide lethal effects.]
 - Guidance and Control System [Guide munition.]
 - Wings [Provide lift.]
 - Tactical Data Link (TDL) [Communicate with controlling asset.]



SoS Description

- Aligned with Critical Technologies List
- Motor identified as a critical technology
 - Proposed miniature air-breathing engine not previously demonstrated.
 - Planned wind tunnel test prior to MS B.
- Miniature control data link.
 - Capability to provide positive/fail-safe control of a miniature munition not previously demonstrated.
 - Planned captive flight testing prior to MS B.



MBT&E Procedure

Step 7

Develop System Attributes



Associate Materiel with Requirements

- RAS Munition [1. Provide situational information, 2. Destroy target.] **{In-flight Reliability; % 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.}**
 - Motor [Provide Thrust.] **{Low observable smoke.}**
 - Warhead [Provide lethal effects.] **{Probability of a kill given a hit; Pk/h, >95%.}**
 - C&G [Guide munition.] **{Probability of a hit given a shot; Ph/s, >90%.}**
 - Tactical Data Link [Receive control signals. Transmit target information.] **{Positive communication link range >60 nm.}**



MBT&E Procedure

Step 8

Associate Capabilities with Attributes



Linking task to materiel

- 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%.}

- 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%.}



Enabling Attributes

- Materiel system attributes that apply to all tasks.
 - Electromagnetic Survivability [Materiel system is protected from electromagnetic interference.]
 - Information Assurance [Materiel system is protected from IO attack and critical information is not compromised.]
 - Reliability [Materiel system has sufficient time between failures to enable execution of soldier tasks.]
 - Maintainability [Materiel system is maintainable by field/fleet maintainers and operators.]



MBT&E Procedure

Steps 9-15

Design the T&E



MBT&E Procedure

Step 9

Unconstrained Operational Conditions



Operational Conditions

- Engage with RAS

- Mission: Close Air Support, Interdiction Attack, Suppression of Enemy Air Defenses
- Enemy: Vehicles, Personnel, Vehicles with Countermeasures
- Troops: rotary wing, fixed wing, unmanned aerial systems
- Terrain and Weather: Terrain: Urban, Mountain, Desert, Jungle. Weather: Clear, Dust, Fog, Rain, Snow.
- Time: Clock Hours: Day, Night, Crossover. Time Available: Deliberate, Hasty Planning
- Civil Considerations: Positive ID, Weapons Free, Collateral Damage Considerations.



• RAS Munition - Seeker

- Mission: All
- Enemy: **Vehicles, Personnel, Vehicles with Countermeasures**
- Troops: All
- Terrain and Weather: Terrain: All. Weather: **Clear, Dust, Fog, Rain, Snow.**
- Time: Clock Hours: **Day, Night, Crossover.** Time Available: Deliberate, Hasty Planning
- Civil Considerations: **Positive ID, Weapons Free,** Collateral Damage Considerations.



Strategy Benefits

MBT&E enables Strategy Development to

- Prioritize by End-Results, Mission-Task effectiveness, SoS-Task performance, and Operational Variables that are **most stressing** to System characteristics and performance
- Employ these **most stressing** circumstances to integrate technical, Developmental, Force Development, and Operational testing.
- Articulate results in **the language** of the Warfighter.



MBT&E Procedure

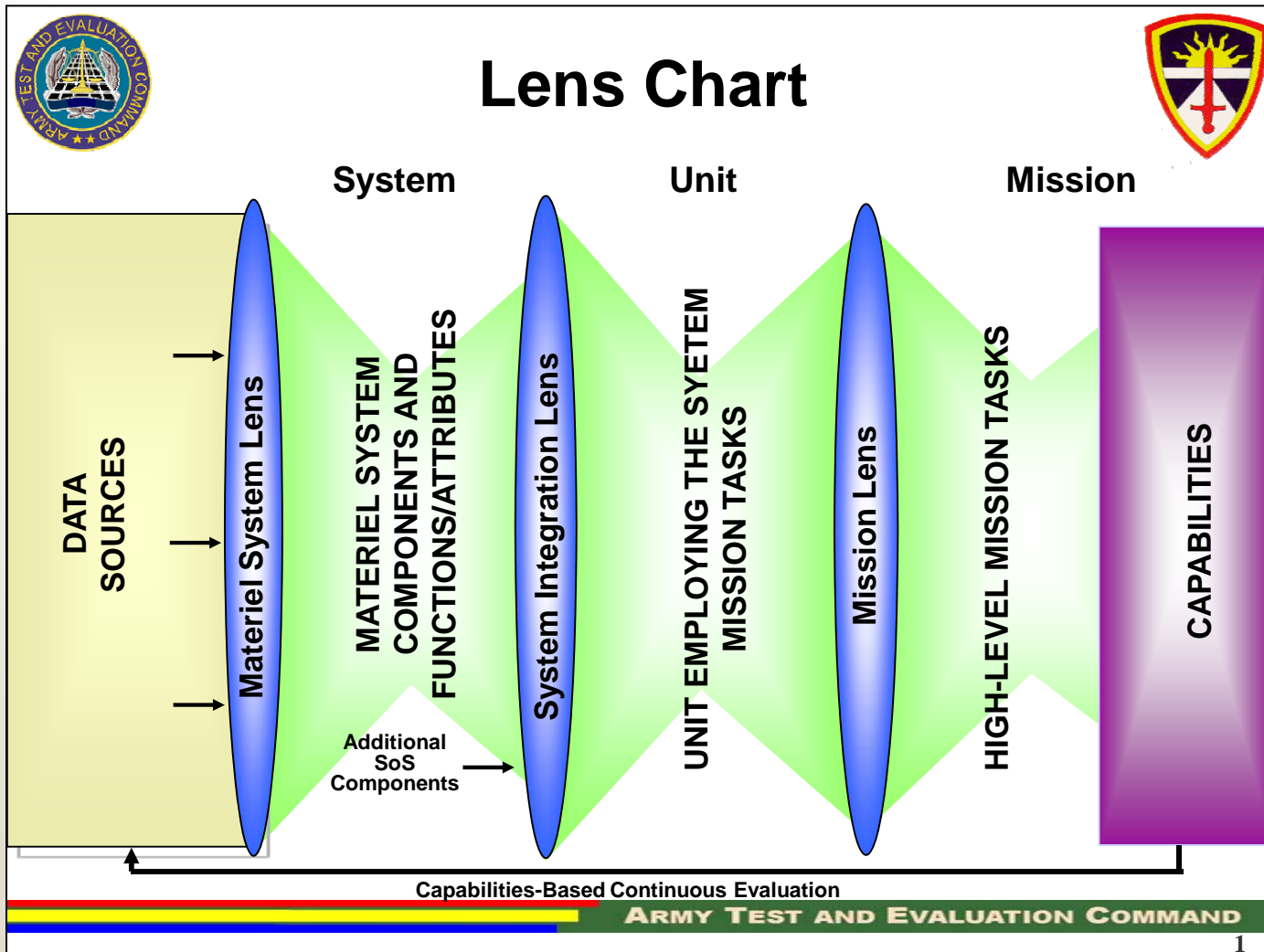
Step 10

Develop the Evaluation Strategy



Evaluation Strategy Summary

- Outline Summary or Lens Chart.





MBT&E Procedure

Step 11

Develop the Evaluation Measures



Operational Measures

- Air to Surface Attack (ART 3.3.1 Employ Lethal Fire Support) {Time to target observation <15 minutes.}
 - Operational Measure: % missions enemy is observed.
 - OM: % missions course of action is completed (Engage RAS or JAAT).*
 - OM: Time to first target observation.*
 - OM: Stowed kills.

- 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) {Pssk >80%.}

- OM: % missions target is destroyed.*
- OM: Time of engagement (attack order to target hit).*
- OM: Operator rating of engagement procedures.
- OM: Pssk (demonstrated and predicted).

* Measure referenced in FM 7-15, *The Army Universal Task List*.



Technical Measures

- Aircraft TDL [Control RAS during flight.] {Positive communication link range > 60nm}
 - Technical Measure: Average maximum positive control range.
 - TM: RAS position, speed and attitude information accuracy.
- RAS Munition [1. Provide situational information, 2. Destroy target.] {Prel; % non-essential function failure > 93%.} {Loiter time > 45 minutes.}
 - TM: In-flight reliability (% non essential function failures)*
 - TM: Maximum loiter time (predicted and demonstrated)*
- Seeker [Provide situational images, acquire and track target.] {Minimum Delta-Temperature.} {Operate with all semi-active laser code frequencies.}
 - TM: Minimum delta-temperature.*
 - TM: Verification of SAL code performance.*
 - TM: SAL acquisition range.*



MBT&E Procedure

Step 12

Assign Measures to Data Sources



Link to Data Sources

- Chronologically linked to data source

| Task | Operational Measure | Materiel System | Technical Measure |
|-------------------|---|-----------------|--|
| 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 |

| Task | Operational Measure | Materiel 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 | | | |

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



Link to Data Sources

- Critical technologies linked to capabilities.

| Task | Operational Measure | Material System | Technical Measure | Captive Flight P1 | Motor Static Runs | Motor Wind Tunnel Runs | Integrated Flight Simulations |
|--|---------------------|-----------------|-------------------|-------------------|-------------------|------------------------|-------------------------------|
| Engage with RAS | | | | | | | |
| A/C TDL* | X | | | | | | |
| Average maximum positive control range | X | | | | | | |
| RAS position, speed and attitude info accuracy | X | | | | | | |
| RAS Munition | | | | | X | | |
| Motor* | | X | X | | | | |
| Thrust vs. Time | | X | X | | | | |

- Capabilities assessed through continuum of T&E

| Task | Operational Measure | Material System | System | Technical Measure | DT Flight Tests | LUT/OT-B | Analysis | MS C | Analysis | IOT |
|----------------------------------|---------------------|-----------------|--------|-------------------|-----------------|----------|----------|------|----------|-----|
| Close Air Support | | | | | X | X | X | | X | X |
| % missions enemy is observed | X | X | | | | | | | X | |
| % missions COA is completed | | X | | | | | | | X | |
| Time to first target observation | X | X | | | | | | | X | |
| Stowed Kills | | | X | | | | X | | | |



MBT&E Procedure

Step 13

Constrained Operational Conditions



Constrained Op Conditions

- RAS Munition – Seeker, Minimum delta-T
 - Terrain and Weather: Terrain: All. Weather: **Clear, Dust, Fog, Rain, Snow.**
 - Identified Data Sources: Tower Tests, Captive Flight, DT Flight Tests, HWIL.
 - Fog, rain and snow not available to be controlled during any of these tests.
- T&E Limitation
 - Limitation: Not able to test the performance of the seeker under fog, rain and snow.
 - Impact: Not able to evaluate seeker performance under these conditions.
 - Current Mitigation: Integrated flight simulation (IFS) may be used to analyze seeker performance under these conditions.



T&E Alternate COA

- T&E Limitation: Not able to test the performance of the seeker under fog, rain and snow.
- Recommended COA
 - Use IFS to characterize predicted seeker performance under fog, rain and snow conditions.
 - Conduct chamber “tower” test to confirm degraded performance in worst condition.



MBT&E Procedure

Step 14

Develop Data Source Requirements



Data Source Requirements

- Use design of experiments given constrained operational conditions.
- Engage with RAS
 - OM: % missions target is destroyed
 - OM: Time of engagement (attack order to target hit).
- Engage with RAS Operational Conditions
 - Mission: **Close Air Support, Interdiction Attack, SEAD**
 - Enemy: Vehicles, Personnel, Vehicles with Countermeasures
 - Troops: **Rotary wing, fixed wing, unmanned aerial systems**
 - Terrain and Weather: Terrain: **Urban, Mountain, Desert, Jungle.**
Weather: Clear, Dust, Fog, Rain, Snow.
 - Time: Clock Hours: Day, Night, Crossover. **Time Available:**
Deliberate, Hasty Planning
 - Civil Considerations: Positive ID, Weapons Free, Collateral Damage Considerations.



DOE Recommendation

- Desire to test with 3 crews

Option 1: random draw of 3 crews.

- Pro: Smallest number of runs (24).
- Con: Can not separate crew performance

Option 2: Test each run once for each crew.

- Pro: Can separate crew performance
- Con: Maximum number of runs (72).

| Mission | Troops | Terrain | Time Available |
|---------|--------|---------|----------------|
| SEAD | UAS | Desert | Planned |
| CAS | F/W | Urban | Planned |
| SEAD | UAS | Urban | Planned |
| CAS | F/W | Desert | Hasty |
| IA | R/W | Urban | Planned |
| IA | F/W | Urban | Planned |
| IA | F/W | Desert | Hasty |
| SEAD | R/W | Desert | Hasty |
| IA | R/W | Urban | Hasty |
| SEAD | F/W | Desert | Planned |
| CAS | UAS | Desert | Hasty |
| CAS | F/W | Desert | Planned |
| SEAD | F/W | Urban | Hasty |
| IA | UAS | Desert | Planned |
| IA | UAS | Urban | Hasty |
| CAS | R/W | Desert | Planned |
| SEAD | R/W | Urban | Planned |
| IA | R/W | Desert | Hasty |
| SEAD | UAS | Desert | Hasty |
| SEAD | UAS | Urban | Hasty |
| CAS | F/W | Urban | Hasty |
| CAS | R/W | Urban | Hasty |
| IA | R/W | Desert | Planned |
| CAS | UAS | Urban | Planned |



DOE Recommendation

Option 3 (recommended): Partial factorial using crews.

- Pro: Medium set of runs (48).
- Pro: Can separate crew performance to acceptable level.
- Con: More than minimum set of runs.

| | Mission | Troops | Terrain | Time Available | Crew | | Mission | Troops | Terrain | Time Available | Crew |
|----|---------|--------|---------|----------------|------|----|---------|--------|---------|----------------|------|
| 1 | SEAD | F/W | Desert | Planned | C | 25 | CAS | F/W | Desert | Planned | A |
| 2 | CAS | R/W | Desert | Hasty | B | 26 | IA | R/W | Desert | Hasty | B |
| 3 | SEAD | R/W | Desert | Planned | B | 27 | CAS | R/W | Urban | Planned | A |
| 4 | IA | F/W | Desert | Hasty | C | 28 | IA | UAS | Desert | Planned | C |
| 5 | SEAD | UAS | Urban | Hasty | A | 29 | SEAD | F/W | Urban | Hasty | C |
| 6 | IA | F/W | Desert | Planned | A | 30 | CAS | UAS | Desert | Planned | B |
| 7 | SEAD | UAS | Desert | Hasty | B | 31 | IA | UAS | Urban | Hasty | C |
| 8 | CAS | F/W | Desert | Hasty | C | 32 | SEAD | F/W | Desert | Hasty | B |
| 9 | IA | R/W | Urban | Planned | B | 33 | CAS | UAS | Urban | Planned | C |
| 10 | CAS | R/W | Urban | Planned | B | 34 | CAS | R/W | Desert | Hasty | A |
| 11 | SEAD | R/W | Urban | Planned | C | 35 | CAS | R/W | Desert | Planned | C |
| 12 | IA | UAS | Desert | Hasty | A | 36 | IA | R/W | Urban | Planned | C |
| 13 | IA | UAS | Urban | Hasty | B | 37 | SEAD | F/W | Urban | Planned | A |
| 14 | CAS | F/W | Urban | Planned | C | 38 | CAS | UAS | Desert | Hasty | C |
| 15 | SEAD | UAS | Urban | Planned | B | 39 | SEAD | UAS | Desert | Planned | A |
| 16 | SEAD | F/W | Desert | Hasty | A | 40 | IA | UAS | Urban | Planned | A |
| 17 | CAS | F/W | Urban | Hasty | A | 41 | IA | F/W | Urban | Planned | C |
| 18 | SEAD | R/W | Urban | Hasty | B | 42 | CAS | UAS | Desert | Planned | A |
| 19 | SEAD | UAS | Urban | Planned | C | 43 | SEAD | R/W | Desert | Hasty | C |
| 20 | IA | UAS | Desert | Planned | B | 44 | CAS | F/W | Desert | Planned | B |
| 21 | IA | R/W | Desert | Planned | A | 45 | CAS | UAS | Urban | Hasty | B |
| 22 | CAS | R/W | Urban | Hasty | C | 46 | IA | F/W | Urban | Hasty | B |
| 23 | SEAD | F/W | Urban | Planned | B | 47 | IA | R/W | Urban | Hasty | A |
| 24 | CAS | UAS | Urban | Hasty | A | 48 | SEAD | R/W | Urban | Planned | A |



MBT&E Procedure

Step 15

Develop T&E Databases



MBT&E Toolbox



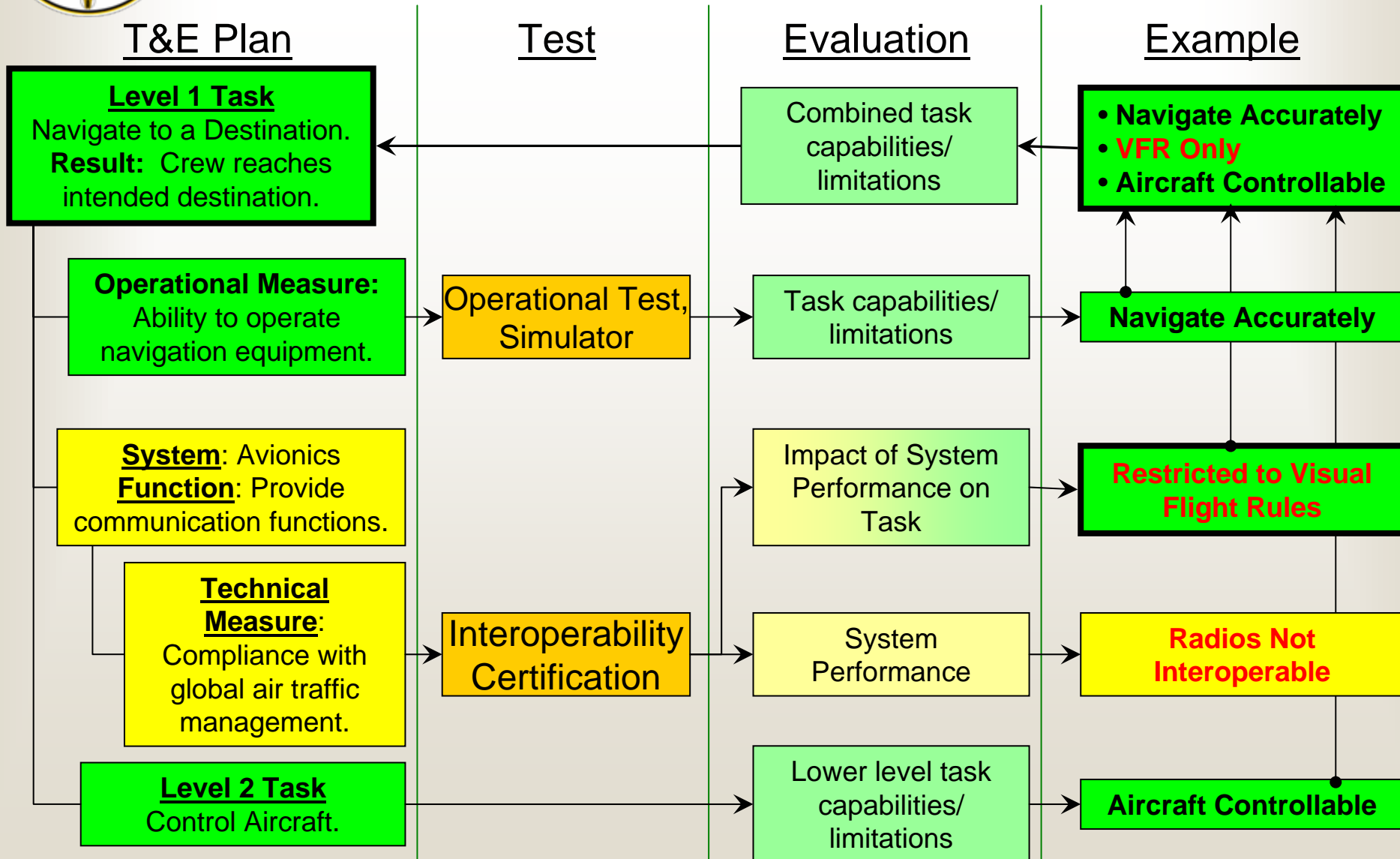
MBT&E Procedure

Steps 16-19

Determine the Results &
Report the Results



Report Example





Case Study Results (Fictional)

• Summary Results

| Task | Operational Measure | Material System | Technical Measure | Requirement | Result |
|--------------------------|----------------------------------|-----------------|-------------------|----------------------|---|
| Close Air Support | | | | | |
| | Time to first target observation | | | < 15 min (13 min) | 14.6 min |
| | Stowed Kills | | | NC | Predicted: 3, 6, 12 Demonstrated: 2, 5, 11 |
| Employ RAS | | | | | |
| | 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 |
| Engage with RAS | | | | | |
| | % 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%.



MBT&E Procedure

Steps 19

Report the Results



Evaluation Report

• Effectiveness

Employ Lethal Fire Support

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

• Suitability

Replace IR Coolant Bottle (enabling task)

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

Training (enabling task)

- Able to task qualify and conduct RAS missions.

Reliability (enabling attribute)

- The RAS demonstrated a reliability of 82% (time to essential function failure). This supported a stowed kill rate of 3 to 12 targets per sortie (2 aircraft) based on load out.

Maintainability (enabling tasks)

- OPTEMPO was supported with a mean time to repair of 1.2 hours and anticipated stockpiles at the ammunition supply point.



Evaluation Report

- **Survivability**

Electromagnetic Survivability (enabling attribute)

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

Information Assurance (enabling attribute)

- The RAS was able to deny all information operations attacks.

Jettison Launcher (conditional task)

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



Case Study

- **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.
 - Current aviation unit response time from call for fires to prosecuted target as much as 45 minutes, depending on current location and location of the support call (50 nm).
 - Current quick-response call for fires from other assets (artillery and current air-launched munition set) not reliably available or not desired due to need to minimize collateral damage in dense urban terrain.

Employ Lethal Fire Support

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



Case Study

- **Function Need Analysis**

- Gap 2: Immediate response (<15 minutes) and extended surveillance (>45 minutes) needed to develop situational intelligence.
 - Success seen in using pre-planned reconnaissance/surveillance assets (RSAs) to observe suspicious behavior of initial target leading to other, more valuable, targets.
 - 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.
 - Currently, targets taking as much as 45 minutes to move from initial observation area to centralized base. (Based on pre-planned RSA missions.)

Employ Lethal Fire Support

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



MBT&E Tutorial

Discussions

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Questions

-

Answers



MBT&E Point of Contact

Christopher Wilcox

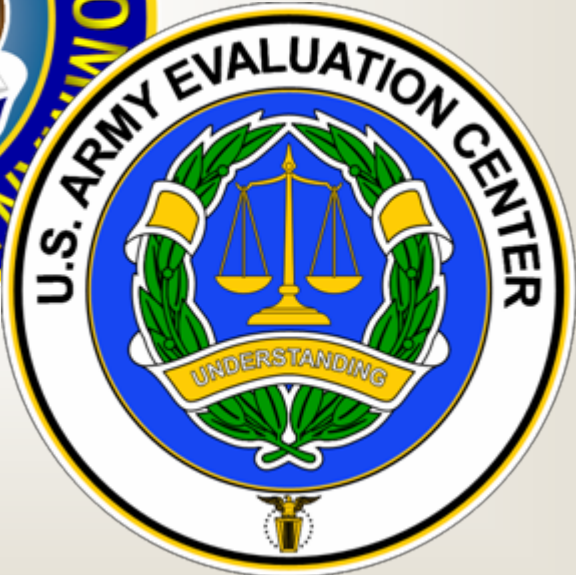
US Army Evaluation Center
ATTN: TEAE-AVA (Mr. Chris Wilcox)
4120 Susquehanna Ave.
Aberdeen Proving Ground, MD 21005

Office: (410) 306-0475

Mobile: (410) 652-0168

Fax: (410) 306-0398

chris.wilcox1@us.army.mil





Backup slides