INSTITUTE FOR DEFENSE ANALYSES

Mission Effectiveness Methodology in Operational Testing

Kristen L. Lambrecht
Bruce A. Simpson

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INSTITUTE FOR DEFENSE ANALYSES
4850 Mark Center Drive
Alexandria, Virginia 22311-1882

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About This Publication

This presentation provides a heuristic for developing mission-based metrics for evaluating weapons systems in an operational environment. The process can be applied across a range of weapons systems. The scope of the metrics is determined by looking at end-to-end mission accomplishment through the lens of the particular weapons system or upgrade to be tested. For each system, we look at the typical operator and to what unit the operator is assigned, or to whom that unit is providing support. The distinction is important as operators are given tasks while units are tasked to conduct missions. The presentation was developed for the ITEA Annual Symposium and will be published in the symposium proceedings.

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for the 32nd ITEA Symposium
20 August 2015

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IDA

What is our Test and Evaluation Mandate?

- **Title 10 defines Operational Test and Evaluation**
  - The field test under realistic combat conditions, of any item of
  - weapons, equipment, or munitions
  - for the purpose of determining the effectiveness and suitability of the weapons, equipment, or munitions
  - for use in combat by typical military users

- **Defense Acquisition Guidebook defines Operational Effectiveness**
  - Overall degree of mission accomplishment of a system when used by representative personnel
  - In an operational environment considering organization, training, doctrine, tactics, survivability or operational security, vulnerability, and threat

- **Guiding principles with which we develop mission-based metrics for evaluating systems**

- **Test a trained unit employing a system in an operationally representative environment with a focus on end-to-end mission evaluation**

IDA $\sum_{i=0}^{n} \text{Requirements}_i \neq$ Mission Accomplishment

- **Sometimes it's possible to meet all requirements and not be able to provide military utility**
  - Future Combat Systems (FCS) Tactical Unattended Ground Sensor (T-UGS) and Urban UGS (U-UGS)
- **Requirements documents are usually a list of technical specifications**
  - Contractors need specifications to build to that can be easily verified
  - Not a comprehensive list
- **Important aspects of mission accomplishment are not in the requirements documents**
  - Doctrine, training, and integration
  - Evolving threat
  - Organization, tactics, survivability or operational security, and vulnerability

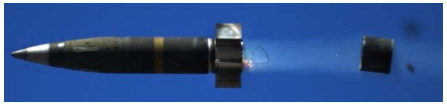
Where Can We Find Mission-Based Metrics?

- **How do we define mission accomplishment without "creating new requirements"?**
  - Capabilities Production Documents are often written in terms of technical specifications
  - Critical Operational Issues are *supposed to* include operational metrics, however they generally:
    - » Do not include measurable operational metrics
    - » Simply restate technical requirements

- **Mission Essential Task Lists provide training standards**
  - Don't test system capabilities
  - Subjective
  - Not quantifiable

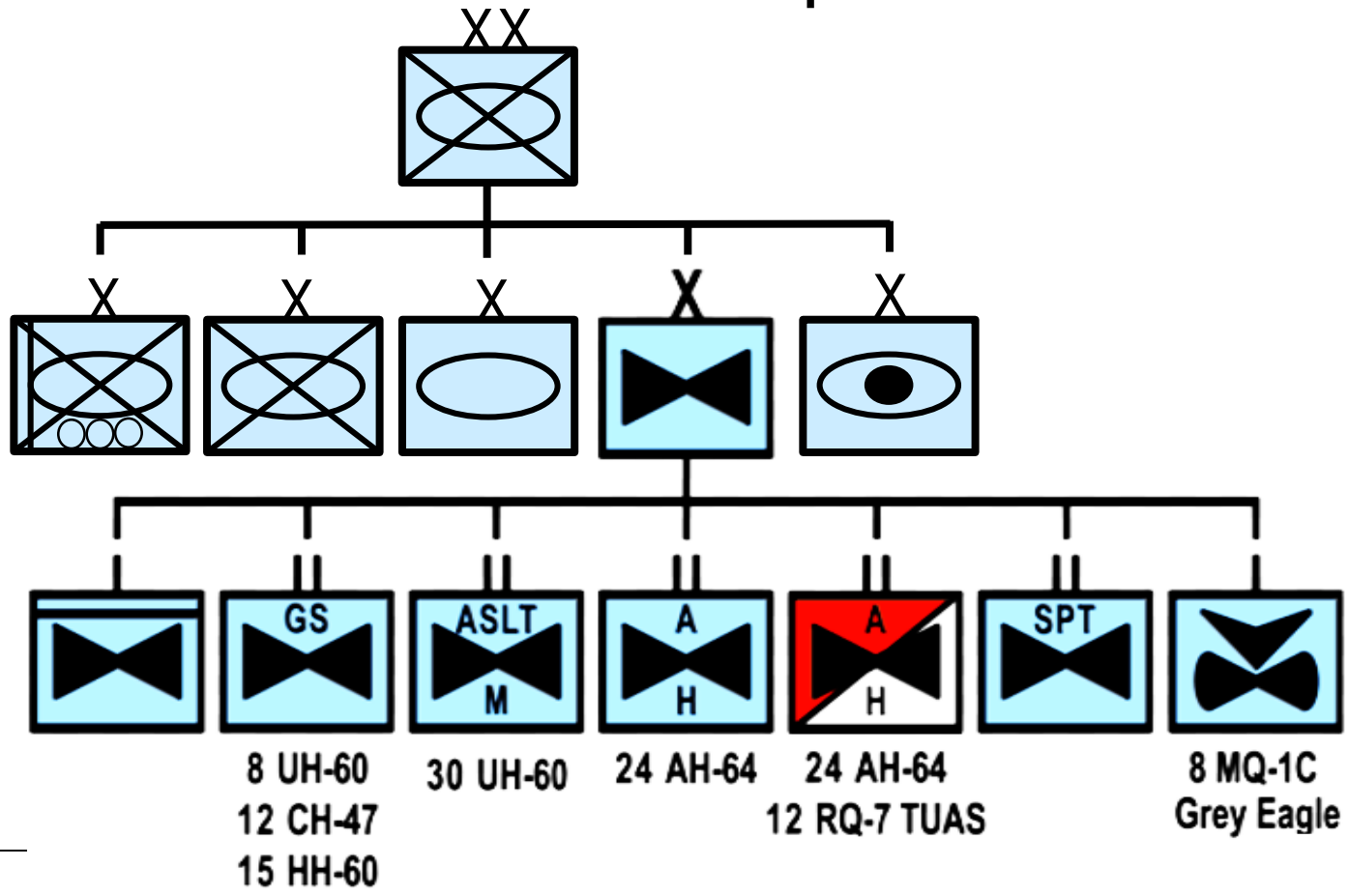
- **Need to find a way to combine the two in a meaningful quantitative way**
  - There is no one size fits all approach
  - Creating objective, quantitative metrics is hard!!!

Inputs to the Thought Process

Unit Equipped with the system	System	Capability
Artillery platoon	 Excalibur	Improved miss distance
Unmanned Aerial Vehicle Company	 Gray Eagle UAV	New payload and improved endurance
Infantry platoon	 Raven UAV	New program and capability provide intel to ground units
Infantry company(s)	  Bradley A4 & Abrams M1A2 SEPv3	Upgraded radios and mission command

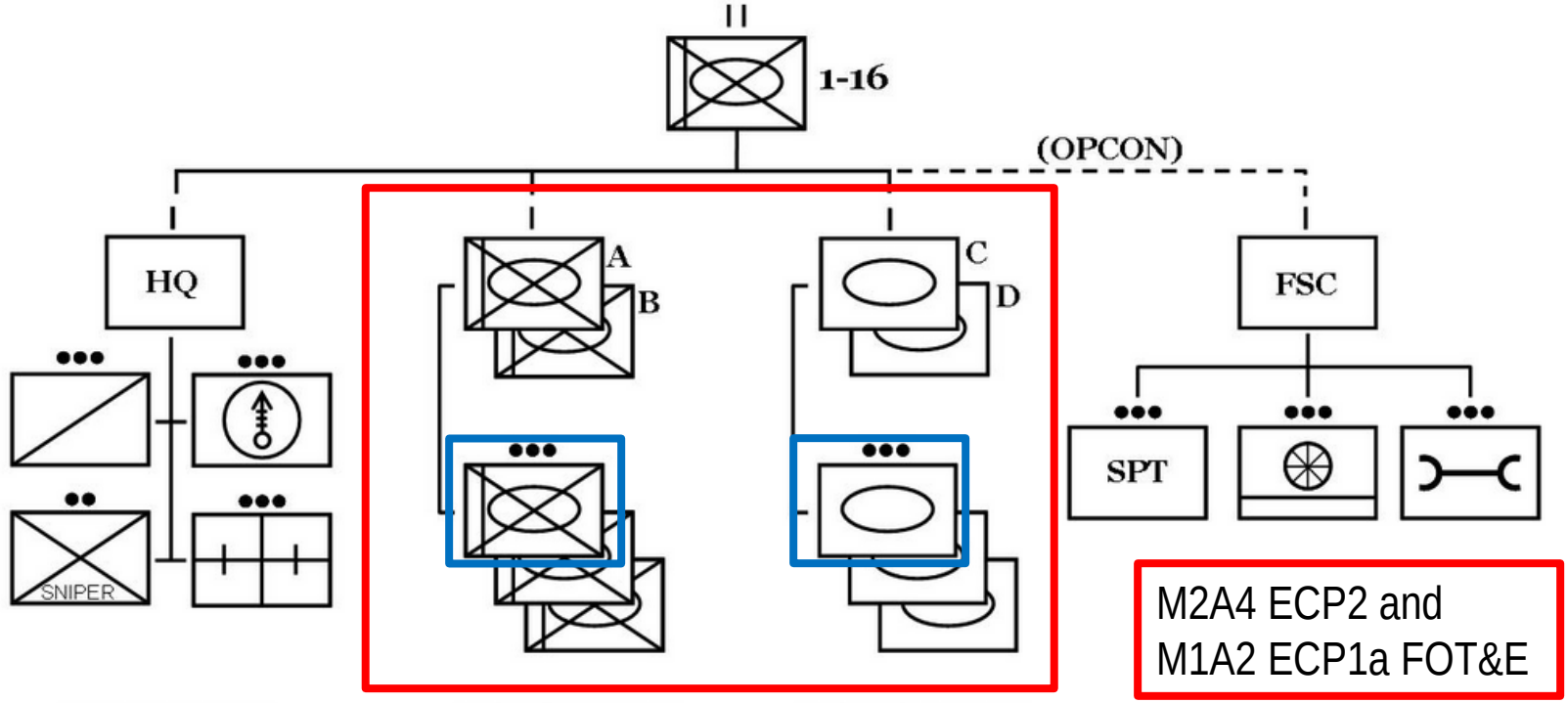
Where Do We Draw the Box?
(Gray Eagle UAV)

- **Gray Eagle is organized as a company in the Combat Aviation Brigade and a Division asset, but it usually pushed down to the maneuver Brigades**
- **Who is the end user of the information provided?**



Where Do We Draw the Box?
(M2A4 Bradley and M1A2 SEP v3 Abrams)

- **Ground Combat Systems are typically organized in units from squads/crews up to brigades**
- **What is the scope of the capability being tested?**



HQ & HQ Company

28 Officers (includes Bn Staff
201 EM

3 M3A2 CFV (Scouts)
5 LRAS3 (Scouts)
4 M1064 Mortar Carriers
4 120 mm Mortars
1 M1068 Fire Direction Ctr
2 M577 Aid Stations
8 M113A3 Ambulances
1 LMTV (Medics)
17 HMMWVs
1 Raven UAS (Scouts

Each Rifle Company:

5 Officers
131 EM

9 Rifle Squads
14 M2A2 BFV
2 HMMWVs
2 MTVs
1 M113A3
1 Raven UAS

Each Tank Company:

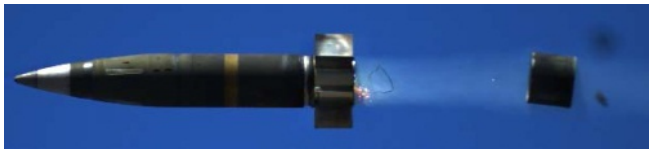
5 Officers
59 EM

14 M1A2 Abrams
2 HMMWVs
1 MTVs
1 M113A3

M2A4 ECP2 and
M1A2 ECP1a FOT&E

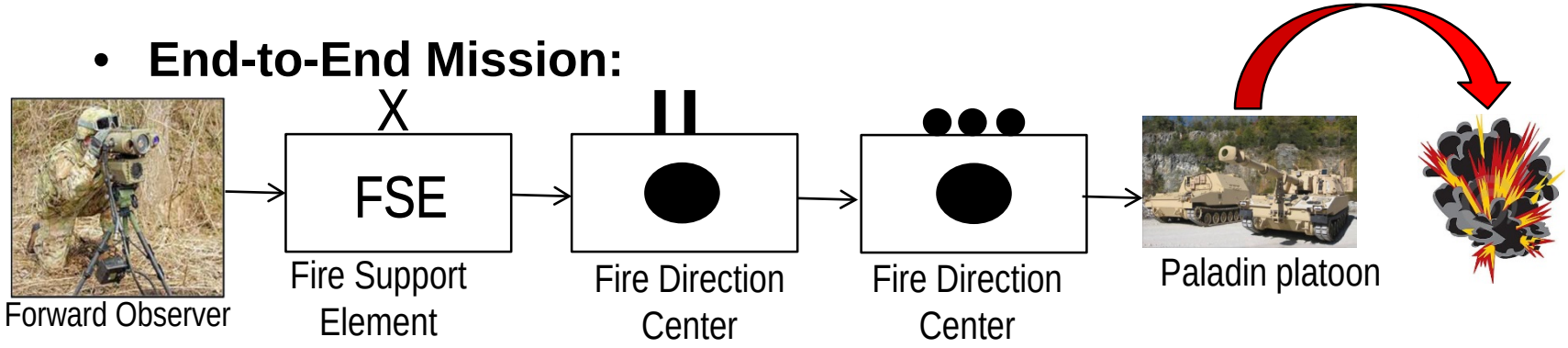
Improved FLIR
Limited User Test

Example 1: Excalibur Unitary Projectile



Easy

- **Test: Initial Operational Test and Evaluation**
- **Requirements: Mission Effects, accuracy and timeliness**
- **End-to-End Mission:**

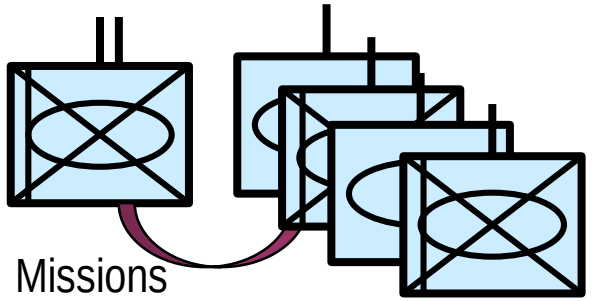


- **Metrics**
  - Did Excalibur achieve desired effects on target? (binary)
  - What is the accuracy? (continuous)
  - What is the timeliness; how long did it take to execute a mission? (continuous)

Example 2: M2A4 Bradley and M1A2 SEPv3 ECP 1a Abrams

Moderate

- **Test: Follow-on Test and Evaluation**
- **Requirements: Mitigate size, weight, and power limitations, integrate C2 upgrades but do not degrade existing capabilities**
- **End-to-End Mission: Combat arms missions, i.e., assault, breach, screen, etc.**

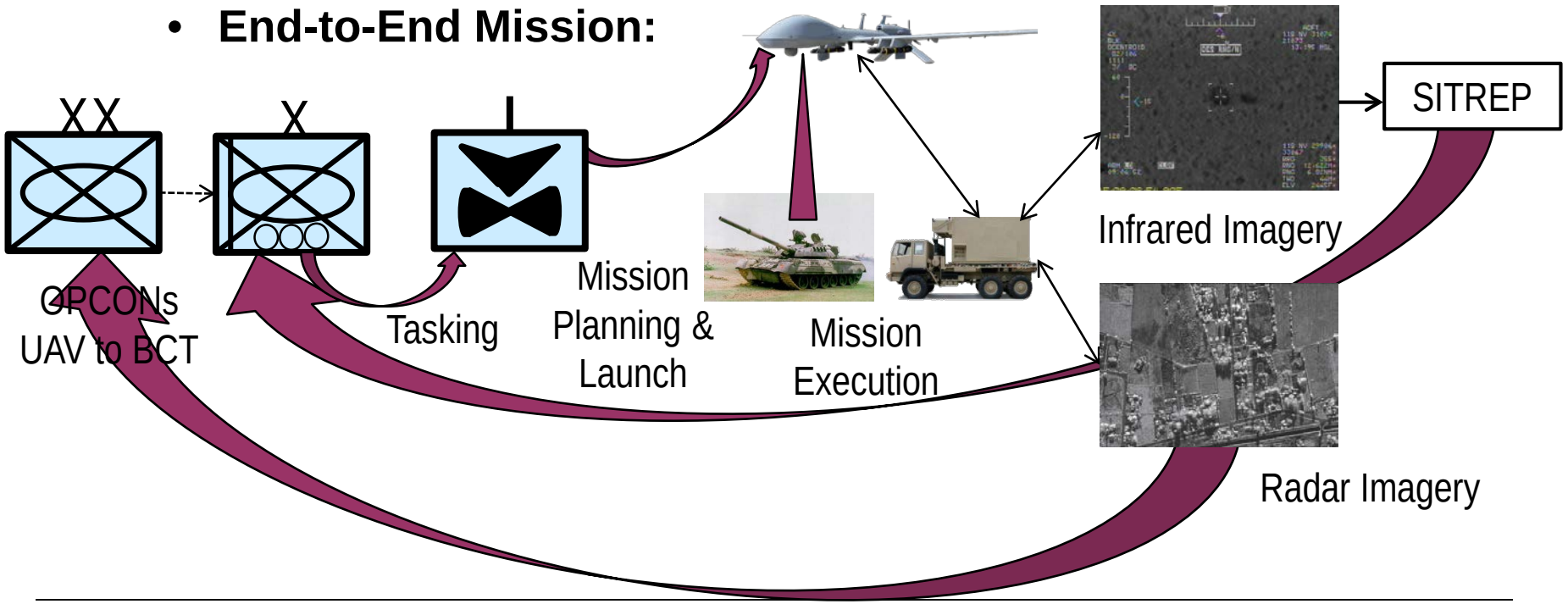


- **Metrics**
  - Mission accomplishment (task and purpose based on unit order)
    - » Likert Scale to evaluate both task/mission accomplishment and purpose/commander's intent
    - » Contribution of system to unit mission accomplishment
  - Blue losses – vehicles, soldiers.
  - Red losses – vehicles, soldiers.
  - Fratricide/Civilian/non-combatant losses.

Example 3: Gray Eagle UAV

Moderate

- **Test: Follow-on Operational Test and Evaluation**
- **Requirements: Target location error, sensor performance, flight performance**
- **End-to-End Mission:**



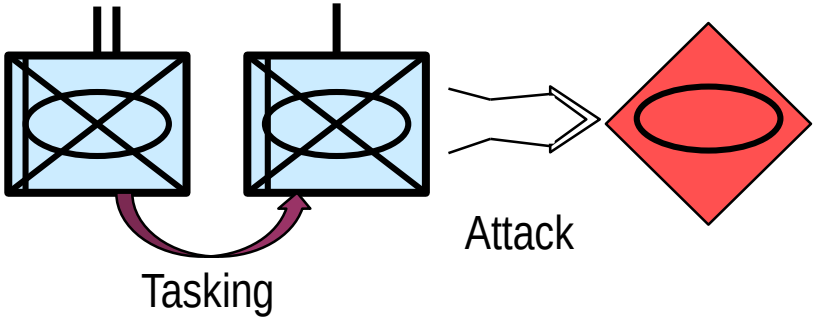
Example 3: Gray Eagle UAV, continued

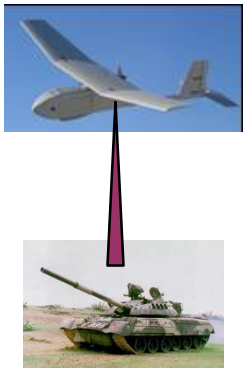
- **Metrics:**
  - Was the information provided in the SITREP timely?
    - » Measured in terms of the what the requester would deem as actionable
  - Was the information provided in the SITREP accurate?
    - » Measured in terms of the target location error
  - Was the information provided in the SITREP complete?
    - » Did the report contain sufficient essential elements of information to correctly determine the composition of the target? (sensor performance)
  - Did the report contribute to answering the commander's intelligence requirements?

Example 4: Raven UAV

Difficult

- **Test: Initial Operational Test and Evaluation**
- **Requirements: Target location error, sensor performance, flight performance**
- **End-to-End Mission:**





- **Metrics:**
  - Does the information provided by the SUAV enhance the likelihood of Mission Success?
  - Does the information provided by the SUAV reduce blue casualties?
  - Does the information provided by the SUAV increase red casualties?
  - Does the information provided by the SUAV help avoid or reduce fratricide?

Conclusions

- **Mission-based metrics aren't usually found in the requirements**
- **Developing mission-based metrics can be challenging**
- **Focus on the unit equipped with the system**