The Four-Element Framework: Progress Towards an Integrated Mission-Based T&E Strategy

Christopher Wilcox

U.S. Army Evaluation Center
Aberdeen Proving Ground, MD

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Agenda

- Accomplishments
- Four-Element Framework (4-EF) Overview
- Improvements made to the:
  - Mission Element
  - System Element
  - Mission to System Interface
  - Evaluation Element
  - Test Element
- Detailed Development of the 4-EF Execution
- Mission-Based Test and Evaluation Strategy
- Summary

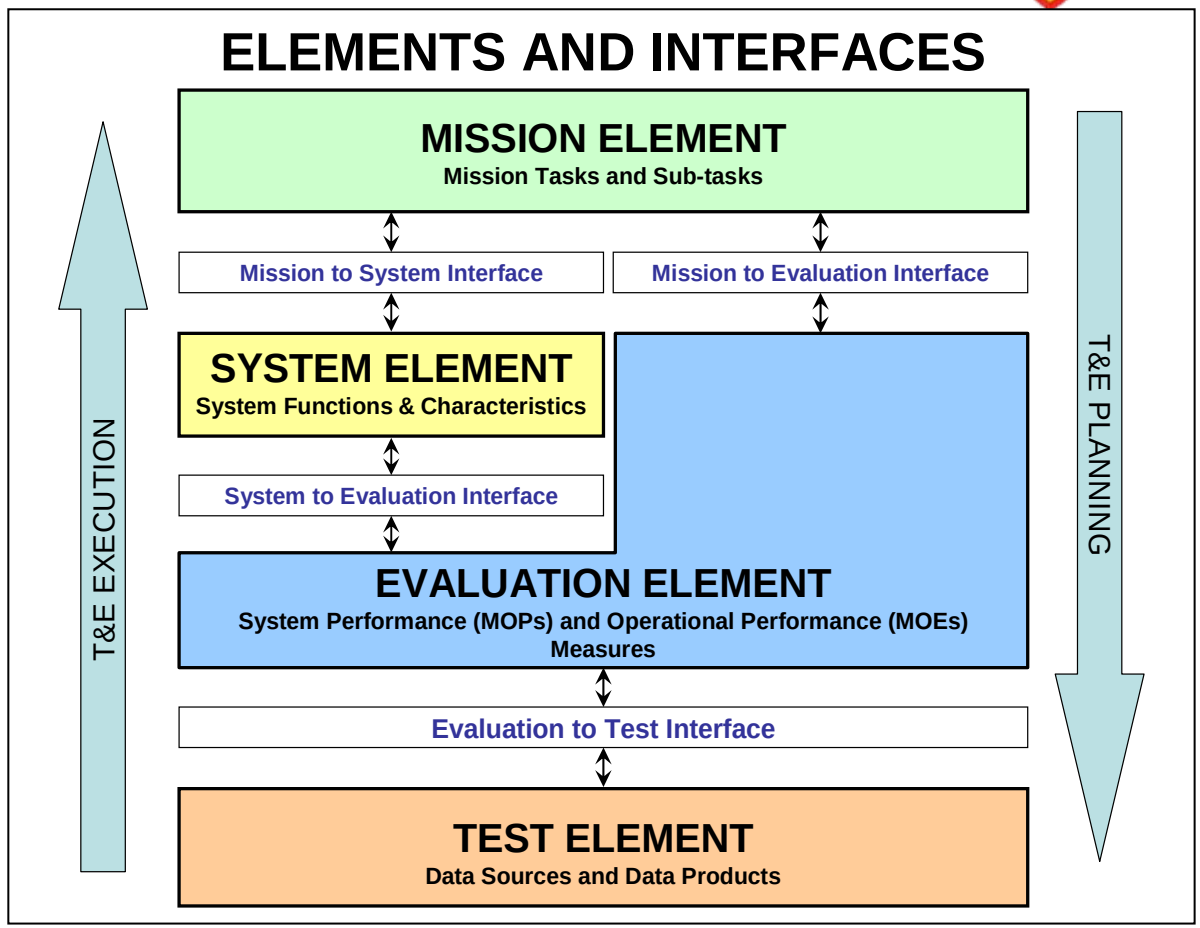
Accomplishments

- Briefed at 23rd NDIA National T&E Conference, 13 March 2007
- CH-47F Case Study (completed)
  - Applied 4-EF to the evaluation of the CH-47F.
  - Modified the construct of the all four elements (mission, system, evaluation and test).
  - Verified the modified element designs by producing a 4-EF designed System Evaluation Plan (SEP).
- Joint Cargo Aircraft Case Study (ongoing)
  - Started application of 4-EF to the evaluation of the JCA.
  - Validated design of the mission and system elements by producing them .
  - Continuing to develop evaluation and test elements on road to producing 4-EF designed SEP.
- Held Mission-Based T&E Strategy Summit (5th-6th Feb 08)
  - Path Ahead: Integrate – Demonstrate - Coordinate

4-EF Overview

Elements
- Mission
  - Mission tasks and sub-tasks.
- System
  - System items, functions and characteristics.
- Evaluation
  - Evaluation measures.
- Test
  - Data sources and products.

Interfaces
- Mission to System
  - How the system supports the mission tasks.
  - Gives operational conditions and linkages.
- Mission to Evaluation
  - How operational tasks are evaluated.
  - Gives operational conditions.
- System to Evaluation
  - How system performance is evaluated.
- Evaluation to Test
  - How the data supports the evaluation.



Traces
- Planning starts at the mission element, progresses through the system and evaluation elements and ends at the test element.
- Execution of the T&E effort starts at the test element, progresses through the evaluation and system elements and ends at the mission element.

Mission Element

Purpose

- To describe unit mission and tasks required to accomplish that mission.

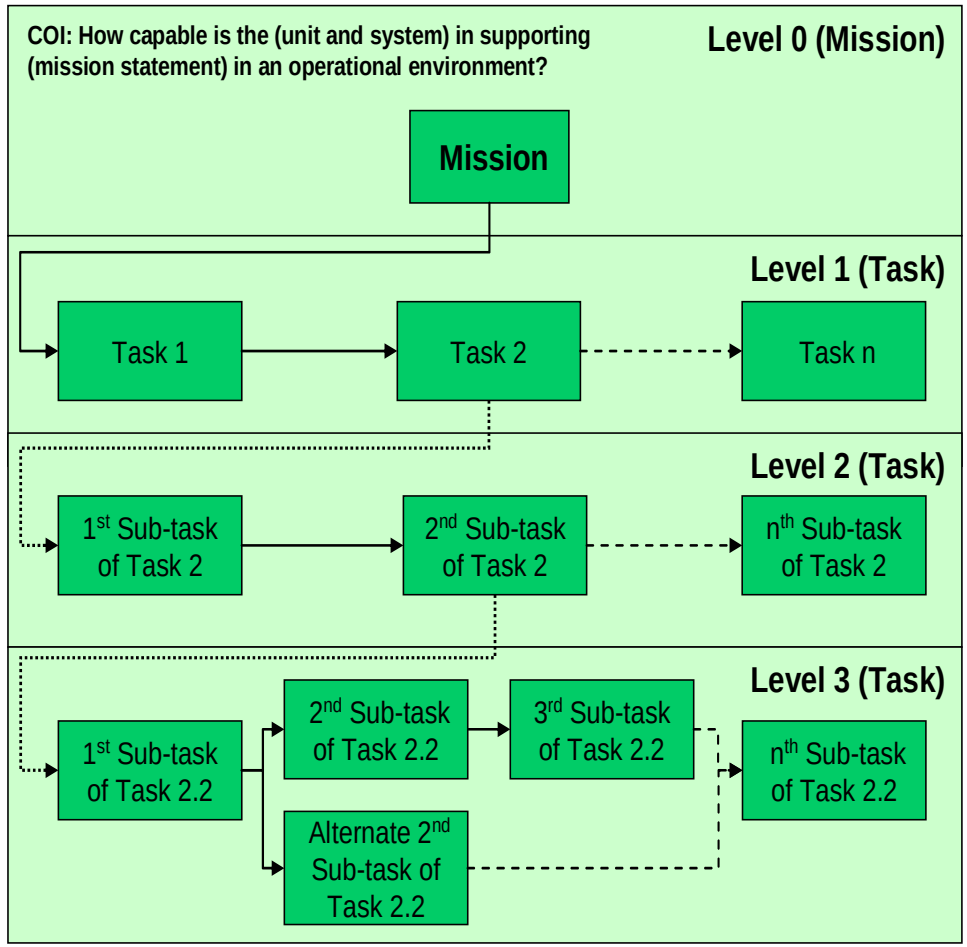
Components

- Task: A task is defined as a discrete action that the unit (system and its operators) must perform in order to accomplish its mission. For example: communicate with ground unit.

- Task Levels: Orderly breakdown of the mission into tasks and sub-tasks.

Three types of tasks were identified in order to assess impact of the task on overall mission performance.

- **Mission Execution Tasks**
- **Conditional Mission Tasks**
- **Mission Enabling Tasks**



Mission Element Task Type Definitions

Mission execution tasks.

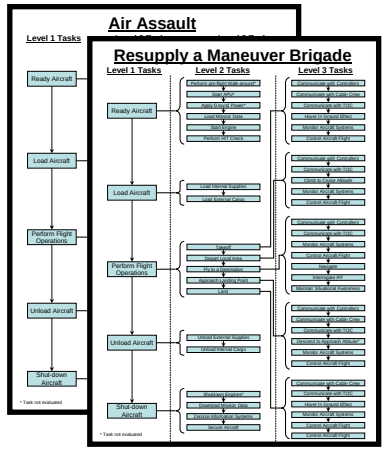
- Tasks that describe a discrete action that the unit (system and its operators) must perform in order to accomplish its main mission.
- Examples: Navigate, ID Target, Send BDA message, etc.

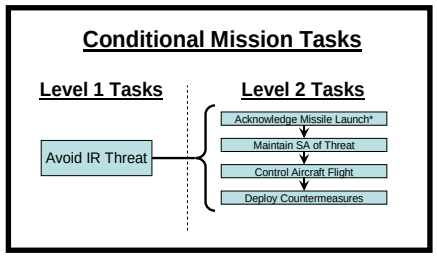
Conditional mission tasks.

- Tasks that are performed during the mission that become required due to some influencing condition. They are not normally required to successfully execute the mission.
- Examples: Avoid threat missile, Extinguish engine fire, etc.

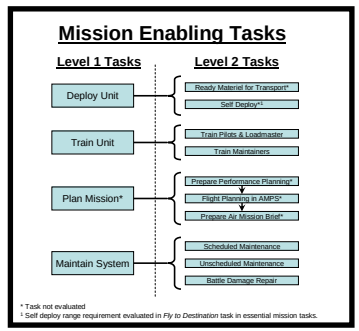
Mission enabling tasks.

- Tasks that enable the mission execution and conditional tasks to be performed. They usually occur before or after the mission.
- Examples: Training, Maintain, etc.





Aggregated into **Effectiveness**



Aggregated into **Suitability**[1]

1. When aggregated along with system enabling characteristics.

System Element

Purpose

- To describe the system and the system functions and characteristics.

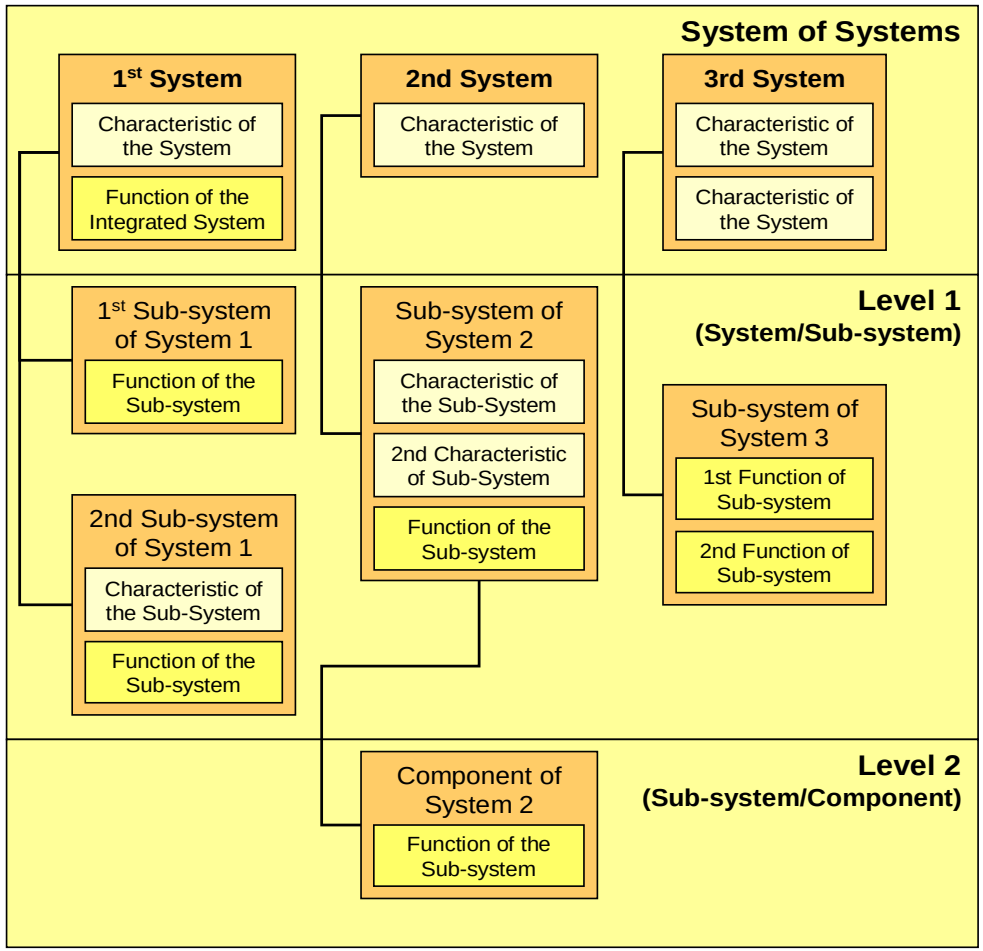
Components

- System Items: Makeup of the system and sub-systems.

- System Functions: Description of the function an item must perform in support of the mission.

Added system "characteristics" to accommodate suitability attributes (reliability, maintainability, etc.).

- **System Characteristics: Description of a particular quality of the system that affects whether the item can perform a function.**



Mission to System Interface

Purpose

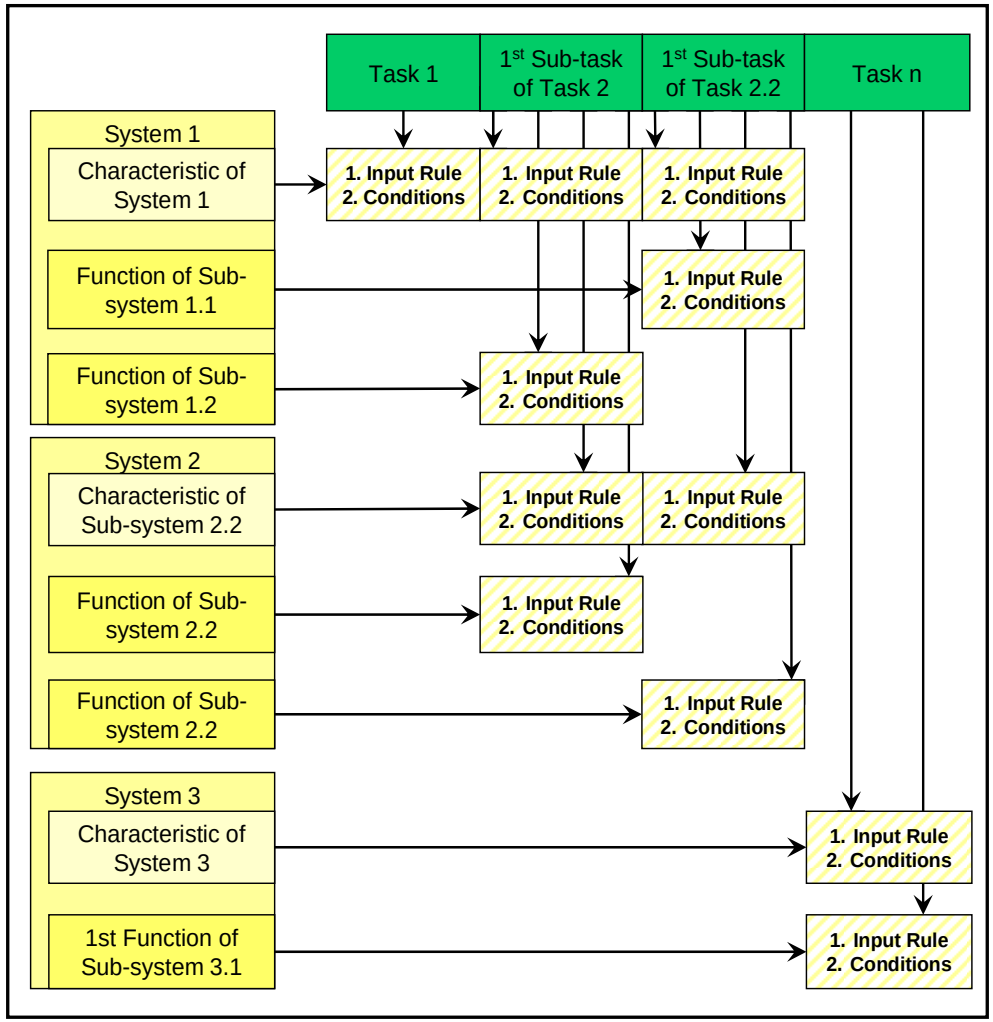
- To describe how the mission tasks relate to the system attributes (functions and characteristics).

Components

- Input Rule: Description of how the system items relate to the mission task. Uses logical input rules, such as AND and OR to describe links to more than one system or function.

- Conditions: Description of the physical, military, and civil variations that affect performance of a task. Comprise the operational test conditions used in DT and OT. For example; weather conditions, countermeasures, urban environment, etc.

Some system characteristics will affect all tasks. These are labeled **"mission enabling characteristics" and are aggregated with mission enabling tasks to assess suitability.**



Evaluation Element

Purpose

- To describe the evaluation measures and how they relate to mission tasks and system attributes.

Components

- Standard: Acceptable performance of the system attribute or mission task in terms of the MOE/MOP.
- Link to System-focused COI/C: Column in the evaluation element that identifies which MOE/Ps are used to evaluate the system-focused COI/C.

Re-aligned evaluation measures to distinguish evaluation of system performance from task capabilities and facilitate planning.

- **Measure of Effectiveness (MOE): Measure used to evaluate operational capability (task capability).**
- **Measure of Performance (MOP): Measure used to evaluate system attribute performance.**

COI: Does the (system) perform (system capability)?				Task 1	1st Sub-task of Task 2	1st Sub-task of Task 2.2
	Standard for MOP	MOP for Characteristic of System 1	Characteristic of System 1	Input Rule Conditions	Input Rule Conditions	Input Rule Conditions
	Standard for MOP	1st MOP for Function of Sub-system 1.1	Function of Sub-system 1.1	Input Rule Conditions		Input Rule Conditions
	Standard for MOP	2nd MOP for Function of Sub-system 1.1				
	Standard for MOP	MOP for Characteristic of System 2	Characteristic of Sub-system 2.2		Input Rule Conditions	Input Rule Conditions
	Standard for MOP	MOP for Function of Sub-system 2.2	Function of Sub-system 2.2		Input Rule Conditions	
	Standard for MOP	MOP for Function of Sub-system 2.2	Function of Sub-system 2.2			Input Rule Conditions
	Standard for MOE	MOE for Sub-task of Task 2			Conditions	
	Standard for MOE	MOE for Sub-task of Task 2.2				Conditions

System Evaluation Plan
Evaluation Planing Construct

Current Evaluation Construct

ESS

- All results aggregated into:
  - is/is not effective,
  - is/is not suitable, and
  - is/is not survivable.

COI/Cs

- ESS evaluation based on **critical issues and criteria**.

MOE

- MOEs are a roll-up of MOPs.
  - Can be operational in nature.
  - Sometimes technical in nature in order to support criterion.
  - Not necessarily "measures" since they are aggregations.

MOP

- MOPs are tested and evaluated.
  - Sometimes technical in nature
  - Sometimes operational in nature. (OT measures).

4-EF Evaluation Construct

Mission

- Capabilities and limitations presented at the mission level.
- **Can be aggregated into ESS**.
  Effectiveness = execution & conditional tasks.
  Suitability = enabling tasks & characteristics.

Level 1 Task

- Mission capabilities and limitations **based on execution of ALL tasks** necessary to accomplish the mission.
- COI/Cs addressed through evaluation of tasks.
  - COIs are a sub-set of tasks or system function/characteristics.

MOE

- MOEs are a measure of task accomplishment.
  - **Always operational in nature**.
  - Truer to DAU definition of a MOE; "Measure designed to correspond to accomplishment of mission objectives and achievement of desired results."

System & Function/ Characteristic

MOP

- MOPs are a measure of system performance.
  - **Always technical in nature**.
  - Truer to DAU definition of a MOP; "Measure of a systems performance expressed as speed, payload, range, time on station, frequency, or other distinctly quantifiable performance features."

Level 2 Task

- Lower level tasks evaluated to determine operational and system performance on overarching task.
  - **Allows T&E at right level of fidelity**.

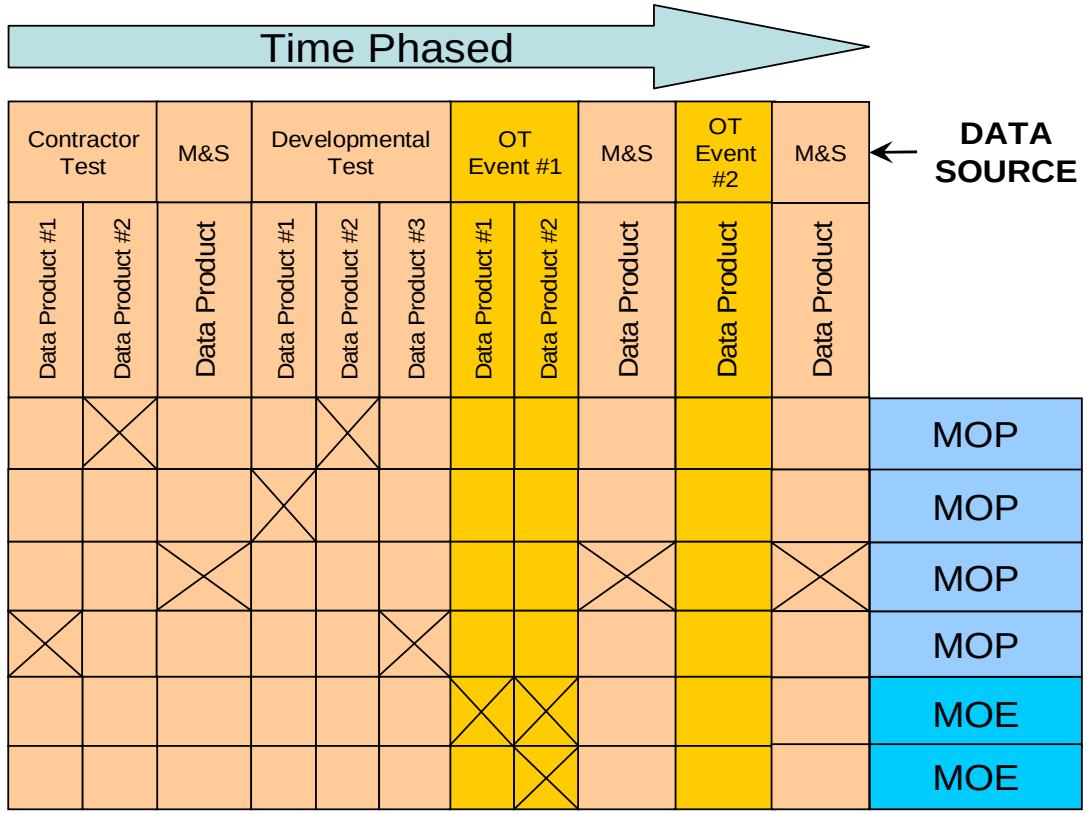
Test Element

Purpose

- To describe the data products, the sources of the data products, and how they relate to the evaluation element's MOPs.

Components

- Link to MOPs: Description of which data products support which MOPs.
- Data Products: Specific data packet obtained though a data source satisfying a MOP data requirement.
- Data Sources: The specific source of a data product.



Test element "time phased" to **facilitate assessment of T&E program** and to describe an integrated T&E plan where the **most appropriate data is used at the most appropriate time**.

System Evaluation Plan

Test Planning Construct

Essential Elements

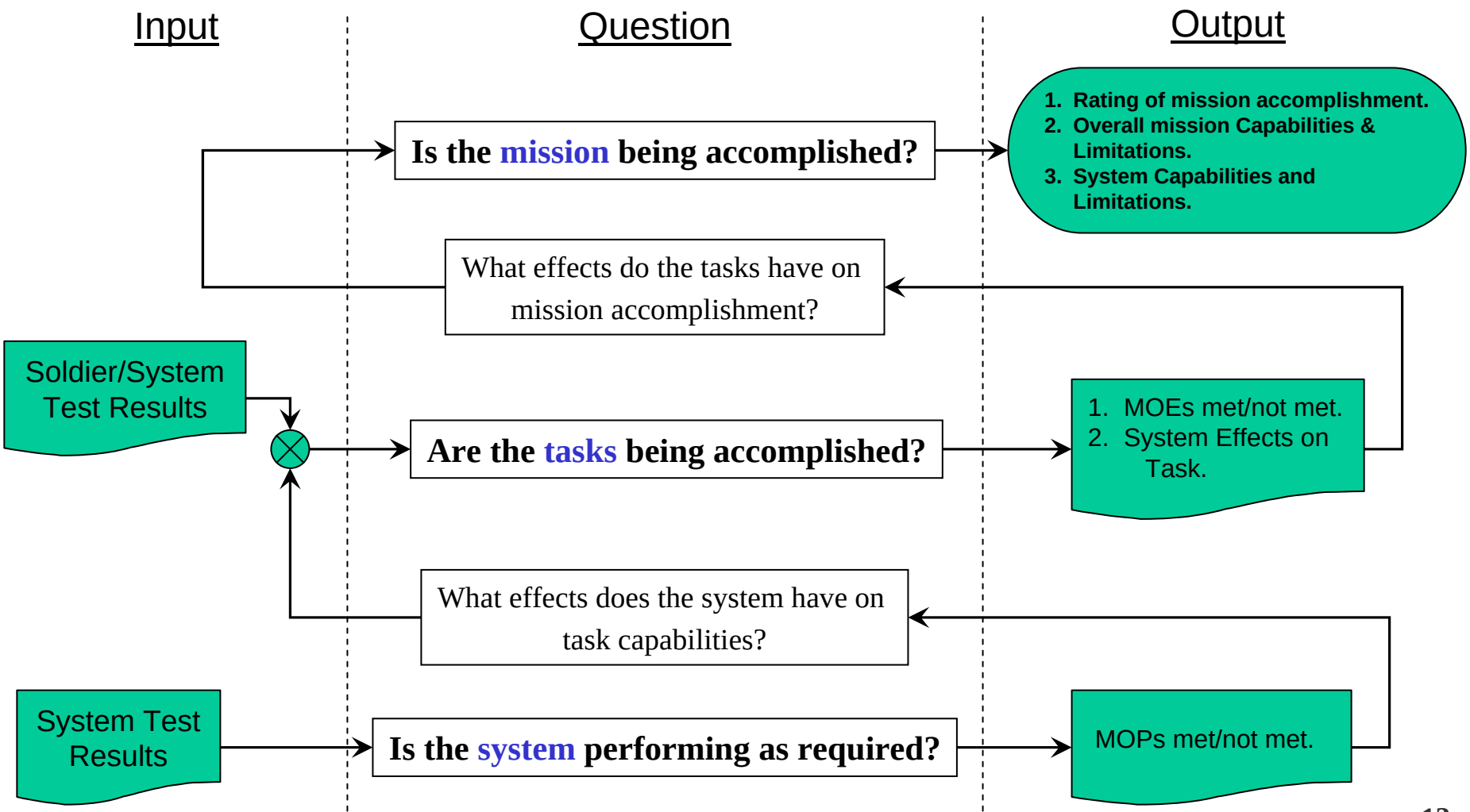
- **Overview**
  - Types of data sources, overall summary & schedule
- **Data Source**
  - Source description (test, analysis, demonstration or inspection).
- **Measures Supported**
  - Measure description, analysis leading to **data elements**, conditions leading to **DOE**.
- **Data Products**
  - Description of deliverables (reports, databases, etc.) supporting delivery of data elements.
- •
- •
- •

4 Basic Types of Data Sources

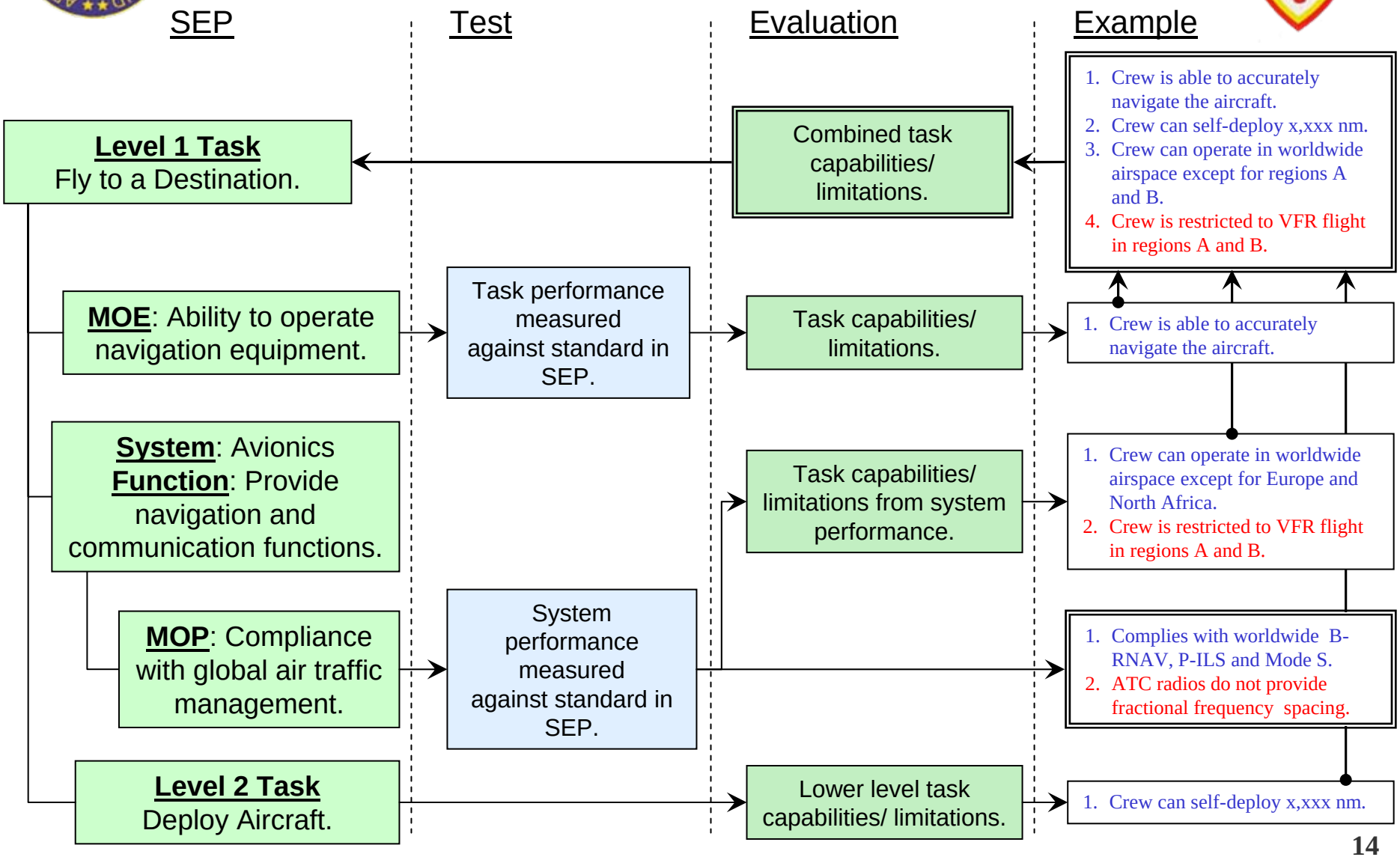
1) Test Events
   - 1a) Developmental Test Events
     - Contractor DT
     - Government DT
   - 1b) Operational Test Events
2) Modeling, Simulation & Analysis
3) Demonstration/Inspection Events
4) Other Agencies' Reports/Certifications

4-EF Execution

(AKA "The 3 Questions")



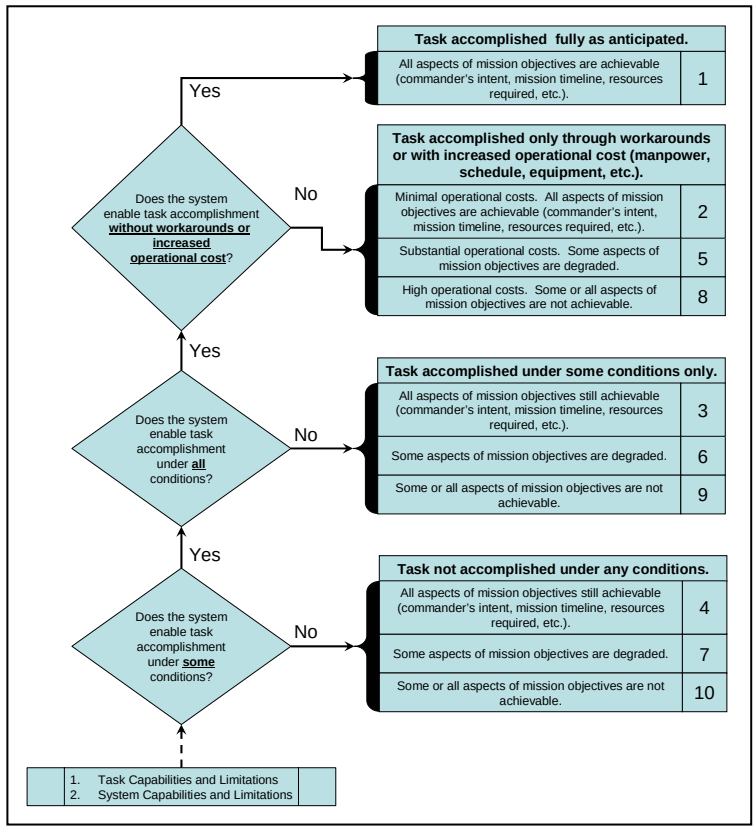
4-EF Execution Example



4-EF Execution

Mission Capability Scale Ongoing Development

- Each mission task is examined in two areas:
  - Does the system support task accomplishment, and
  - Does the task support mission objectives & required capabilities?
- Rating scale is similar to Cooper-Harper or Bedford Workload Scales.
- Rating scale not sequential in order to reflect higher importance of task meeting mission objectives vs. system meeting task requirements.
- Lower the number, the better the mission performance.



Concept being assessed for:

- **<u>Functionality</u>: Can the ATEC system team apply the methodology?**
- **<u>Quality</u>: Are the results repeatable and meaningful?**

Mission-Based T&E Strategy Study Group

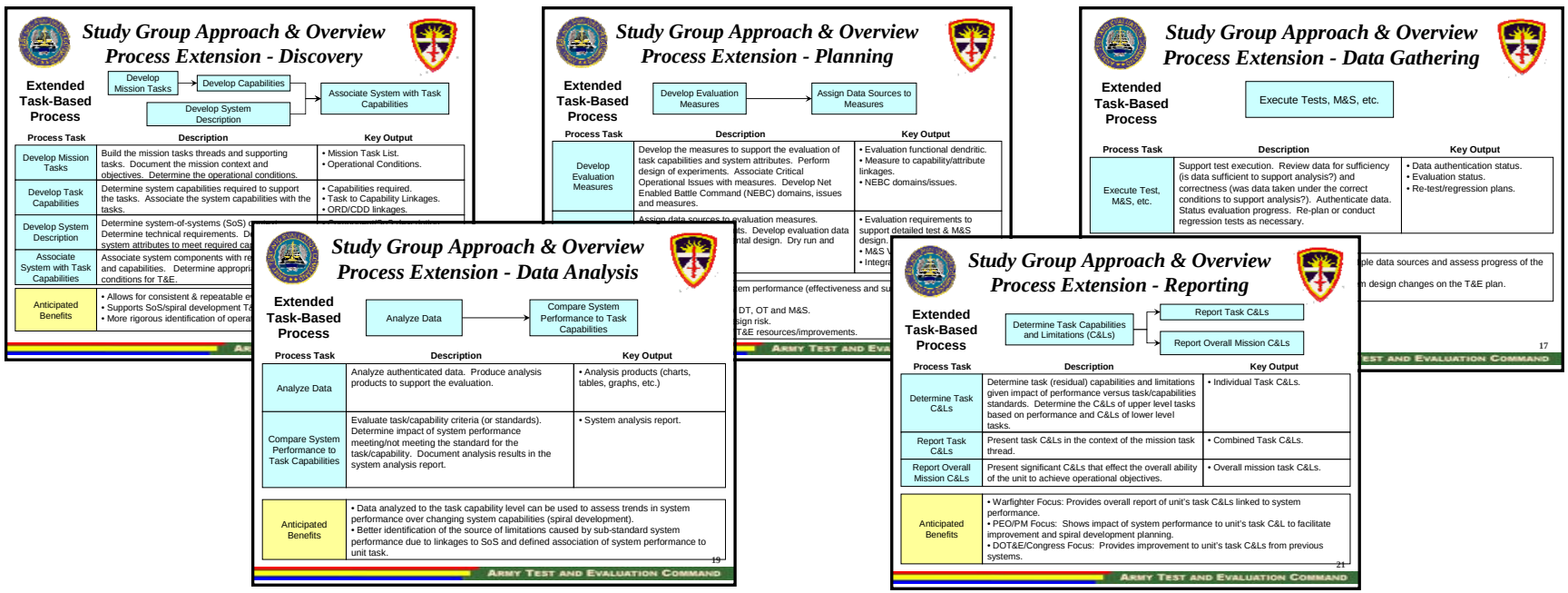
- Study group was formed in early December 2007. Participants included:
  - U.S. Army Test and Evaluation Command,
  - U.S. Army Evaluation Center,
  - U.S. Army Research Laboratory – Survivability/Lethality Analysis Directorate,
  - U.S. Army Research Laboratory – Human Research & Engineering Directorate,
  - U.S. Army Materiel Systems Analysis Activity, and
  - DOT&E, Joint Test and Evaluation Methodology

- The group examined four major efforts in detail: Four Element Framework (AEC), Net Enabled Battle Command (ATEC), Missions and Means Framework (ARL), Capability Test Methodology Measures Framework (JTEM).

- Approach:
  - Integrate the various concepts with the **goal of developing a consistent, repeatable and robust integrated T&E methodology for evaluating the capabilities, limitations and contributions of networked system of systems in improving a U.S. force's ability to accomplish their assigned tasks**.

Mission-Based T&E Strategy
Study Group Results

- Results Achieved
  - Group Consensus: An evaluation focused on the **mission tasks** will show causality of individual system performance on capabilities and limitations provided by the system-of-systems (to include the contribution of the networked-enabled command and control).
  - Group Focus: Development of integrated mission-based T&E process.



Study Group Approach & Overview
Process Extension - Discovery

Extended Task-Based Process: Develop Mission Tasks → Develop Capabilities; Develop System Description → Associate System with Task Capabilities

Process Task	Description	Key Output
Develop Mission Tasks	Build the mission tasks threads and supporting tasks. Document the mission context and objectives. Determine the operational conditions.	• Mission Task List. • Operational Conditions.
Develop Task Capabilities	Determine system capabilities required to support the tasks. Associate the system capabilities with the tasks.	• Capabilities required. • Task to Capability Linkages. • ORD/CDD linkages.
Develop System Description	Determine system-of-systems (SoS) d… Determine technical requirements. D… system attributes to meet required ca…	
Associate System with Task Capabilities	Associate system components with re… and capabilities. Determine appropri… conditions for T&E.	
Anticipated Benefits	• Allows for consistent & repeatable e… • Supports SoS/spiral development T… • More rigorous identification of opera…	

Study Group Approach & Overview
Process Extension - Planning

Extended Task-Based Process: Develop Evaluation Measures → Assign Data Sources to Measures

Process Task	Description	Key Output
Develop Evaluation Measures	Develop the measures to support the evaluation of task capabilities and system attributes. Perform design of experiments. Associate Critical Operational Issues with measures. Develop Net Enabled Battle Command (NEBC) domains, issues and measures.	• Evaluation functional dendritic. • Measure to capability/attribute linkages. • NEBC domains/issues.
	Assign data sources to evaluation measures. …ts. Develop evaluation data …ntal design. Dry run and	• Evaluation requirements to support detailed test & M&S design. • M&S V… • Integra…

…em performance (effectiveness and su…
… DT, OT and M&S.
…ign risk.
…T&E resources/improvements.

Study Group Approach & Overview
Process Extension - Data Gathering

Extended Task-Based Process: Execute Tests, M&S, etc.

Process Task	Description	Key Output
Execute Test, M&S, etc.	Support test execution. Review data for sufficiency (is data sufficient to support analysis?) and correctness (was data taken under the correct conditions to support analysis?). Authenticate data. Status evaluation progress. Re-plan or conduct regression tests as necessary.	• Data authentication status. • Evaluation status. • Re-test/regression plans.

…ple data sources and assess progress of the …
…n design changes on the T&E plan.

17

Study Group Approach & Overview
Process Extension - Data Analysis

Extended Task-Based Process: Analyze Data → Compare System Performance to Task Capabilities

Process Task	Description	Key Output
Analyze Data	Analyze authenticated data. Produce analysis products to support the evaluation.	• Analysis products (charts, tables, graphs, etc.)
Compare System Performance to Task Capabilities	Evaluate task/capability criteria (or standards). Determine impact of system performance meeting/not meeting the standard for the task/capability. Document analysis results in the system analysis report.	• System analysis report.
Anticipated Benefits	• Data analyzed to the task capability level can be used to assess trends in system performance over changing system capabilities (spiral development). • Better identification of the source of limitations caused by sub-standard system performance due to linkages to SoS and defined association of system performance to unit task.	

19

Study Group Approach & Overview
Process Extension - Reporting

Extended Task-Based Process: Determine Task Capabilities and Limitations (C&Ls) → Report Task C&Ls; Report Overall Mission C&Ls

Process Task	Description	Key Output
Determine Task C&Ls	Determine task (residual) capabilities and limitations given impact of performance versus task/capabilities standards. Determine the C&Ls of upper level tasks based on performance and C&Ls of lower level tasks.	• Individual Task C&Ls.
Report Task C&Ls	Present task C&Ls in the context of the mission task thread.	• Combined Task C&Ls.
Report Overall Mission C&Ls	Present significant C&Ls that effect the overall ability of the unit to achieve operational objectives.	• Overall mission task C&Ls.
Anticipated Benefits	• Warfighter Focus: Provides overall report of unit's task C&Ls linked to system performance. • PEO/PM Focus: Shows impact of system performance to unit's task C&L to facilitate improvement and spiral development planning. • DOT&E/Congress Focus: Provides improvement to unit's task C&Ls from previous systems.	

21

Mission-Based T&E Strategy Path Ahead

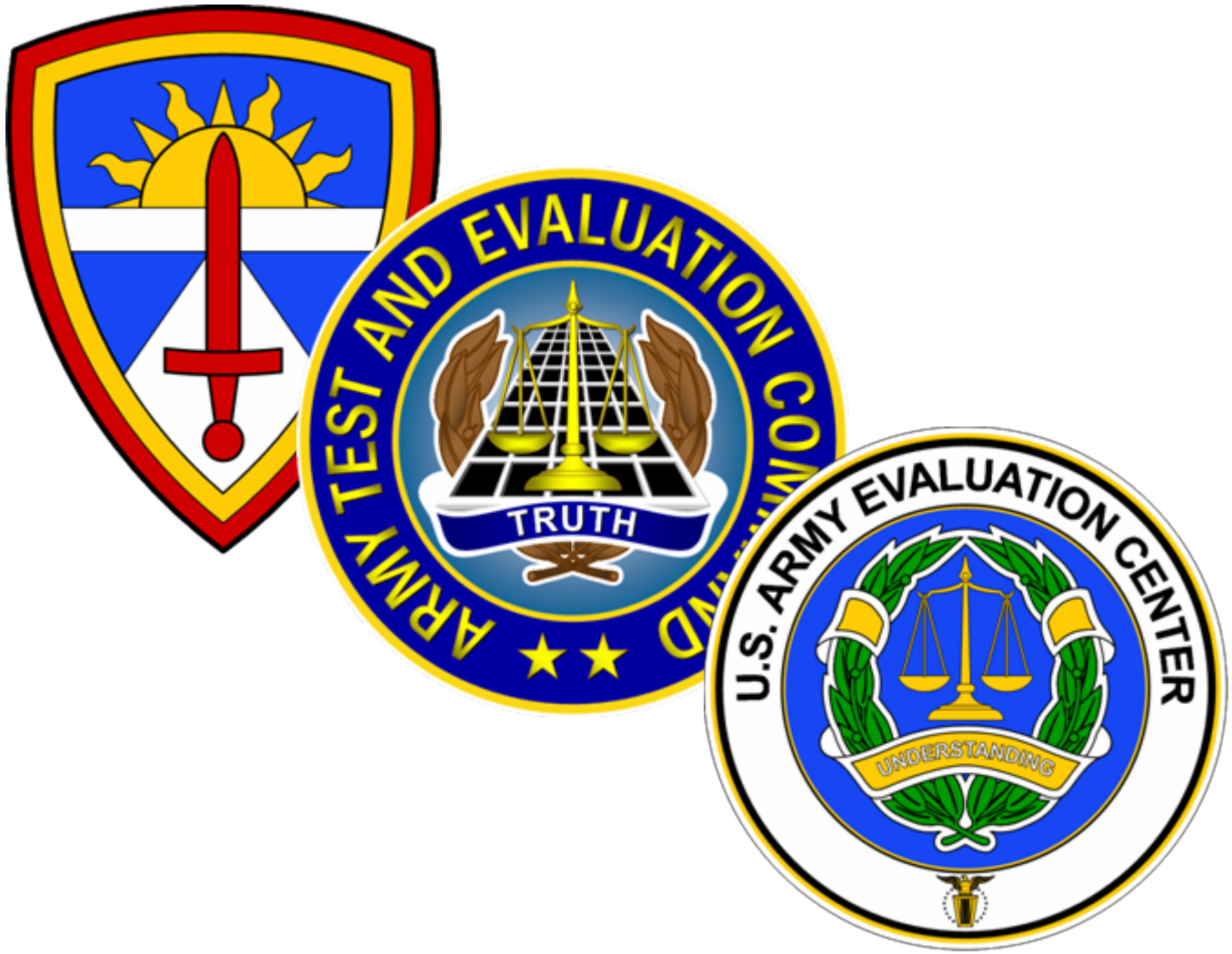
Mission-Based T&E Strategy Summit held 5th-6th Feb 08.

- Briefed out study group results to senior steering group.
- T&E focused on the mission tasks is correct path ahead
- Future efforts should focus on…
  - Development of a common definition of terms: Common language needs to be developed to ensure understanding across organizations.
  - Demonstration of the integrated process: The process needs to be demonstrated to validate the concept and to show that the anticipated benefits can be realized.
  - Coordination of the concept with the rest of the acquisition community: Concept is best executed with a coordinated effort between requirements generator, materiel developer, and T&E Community. Also, lessons learned should be shared with others working similar concepts.

Summary

- Four-Element Framework has evolved through case study application of the methodology.
  - More robust mission element.
  - Suitability attributes addressed.
  - System evaluation plan format developed.
  - Test element re-designed to facilitate assessment of T&E strategies.
  - Methodology for mission task capability roll-up developed.

- Path ahead for mission-based T&E lies in coordination with the acquisition community.
  - Development of common terms.
  - Demonstration of an integrated process.
  - Open discussions with requirement, materiel developer, and T&E community.


ARMY TEST AND EVALUATION COMMAND
TRUTH
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UNDERSTANDING

Author

Christopher M. Wilcox

U.S. Army Evaluation Center

ATTN: TEAE-AV-A

4120 Susquehanna Ave.

APG, MD 21005

(410) 306-0475

chris.wilcox1@us.army.mil

Acronym Chart

AA	Additional Attribute
AKA	Also Known As
ATC	Air Traffic Control
AV	All View (slide 4)
AV	Air Vehicle (slides 11, 13, and15)
CDD	Capabilities Development Document
COI	Critical Operational Issue
CPD	Capabilities Production Document
DAG	Data Authentication Group
DoD	Department of Defense
DT	Developmental Test
GCS	Ground Control Station
JCIDS	Joint Capabilities Integration and Development System
KPP	Key Performance Parameter
MER	Mission Evaluation Report
METT-TC	Mission, Enemy, Terrain, Troops, Time and Civil
MOE	Measure of Effectiveness
MOP	Measure of Performance
OA	Operational Area
OT	Operational Test
OT&E	Operational Test and Evaluation
OV	Operational View
RSTA	Reconnaissance, Surveillance & Target Acquisition
RT	Remote Terminal
SATCOM	Satellite Communications
SV	Systems View
T&E	Test and Evaluation
T/O	Takeoff
TM	Telemetry
TV	Technical View
UAS	Unmanned Aerial System
UAV	Unmanned Aerial Vehicle
VFR	Visual Flight Rules