Capability Test Methodology (CTM) Measures Framework

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Overview

• TiJE
• JTEM Overview
• Why Measures Framework?
• CJI Construct
• CEM
• Measure Framework
  – Examples
• Way Ahead
Why Test in a Joint Environment?

It is the right thing to do . . .
- Early discovery of problems, reduced rework costs
- Improved test data for milestone decision authorities
- Improved system characterization and limitations for Service and combatant commander planning
- Field proven joint capabilities to the combatant commander

Test like we fight

Hey, this stuff passed its interoperability certs! How come it doesn’t work in the AOR?

ENABLING THE JOINT FORCE

Interoperability Test/Certification

“. . . any resultant materiel solution will be verified through testing in the expected joint operational environment to demonstrate joint interoperability . . .”

CJCSI 3170.01F, B.3 [May 2007]

DoDi 5000.2, E.5 [Draft, August 2007]

Joint

Army Forces
Naval Forces
SOF
Air Forces
Marine Forces

Interdependent

Integrated

Deconflicted

Army Forces
Naval Forces
Air Forces
Marine Forces

The warfighter demands it!

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Testing in a Joint Environment (TiJE) Methods and Processes Approach

- Best practices
- Consistent approach to joint mission environment (JME)
- Consistent joint capability assessments and evaluations
- Application across the acquisition life cycle
Why Measures Framework?

• For consistent answers on SoS, need standard methodologies across:
  – Services
  – Domains
• Need standard instrumentation
• Need joint tasks measured by test organizations
• Need measures rooted in JCIDS, AA, etc.
Relationship between CEM and CTM

Capability Test Methodology (CTM) Lexicon

provides underlying conceptual definitions

Capability Evaluation Metamodel (CEM)

provides underlying business rule relationships

LVC-DE – Live, Virtual, Constructive Distributed Environment

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Capability Evaluation Metamodel (CEM)

- JTEM is designing a Capability Evaluation Metamodel (CEM)
  - Metamodel definition
    - An explicit model of the constructs and rules needed to build specific models within a domain of interest
    - A meta-model can be viewed from three different perspectives:
      - as a set of building blocks and rules used to build models
      - as a model of a domain of interest, and
      - as an instance of another model
  - CEM purpose
    - Provide an underlying structure for CTM evaluation methods and processes (for example, CTM evaluation-related template content and relationships)
    - Provide business rule relationships for the CTM evaluation thread
Joint Mission Desired Effects

- Disrupt Red Combat forces moving in battle area.
- Attrite Red Combat forces in the battle area.
- Support Blue maneuver in the battle area.
- Protect Blue forces in the battle area.

Mission MOEs

Joint Tasks

SN 1, “Conduct Strategic Deployment and Redeployment”

OP 1, “Conduct Operational Movement and Maneuver”

TA 1, “Deploy/Conduct Maneuver”

Task MOPs

CEM Key Relationships

CTM establishes the M&P to test SoS ability to provide the means and ways to perform a set of tasks in order to achieve the set of desired effects that lead to mission success

CEM – Capability Evaluation Metamodel
JCIDS – Joint Capabilities Integration and Development System
MOP – Measure of Performance

CTM – Capability Test Methodology
M&P – Methods and Processes
SoS – System of Systems

JCA – Joint Capability Area
MOE – Measure of Effectiveness
UJTL – Universal Joint Task List

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Capability Evaluation Metamodel (CEM): Test Plan Design

Legend

- **Joint Operational Context for Test (JOC-T)**
- **CEM Measures Framework**
- **CEM Evaluation Concepts**
Capability Evaluation Metamodel (CEM): DOD Context for CEM JOC-T

Legend

- **DOD Context for CEM**
- **Joint Operational Context for Test (JOC-T)**
Capability Evaluation Metamodel (CEM): Global View
Evaluation Strategy Overview

• Critical Joint Issue (CJI) Checklist
  – Is the CJI:
    • Used to assess performance as it pertains to capabilities supporting joint missions?
    • Structured as a question addressing joint capability areas described in Joint Capability Documentation?
    • Addressing the system of systems ability to perform joint operational tasks and/or the system of systems, system, or service attribute performance?
  – Does the CJI phrasing include SoS contribution to achieving the desired mission end state outcomes in terms of mission desired effects?
  – CJIs should be of primary importance to the decision authority in reaching a decision to allow the system of systems to advance into the next phase of development.

• CJI Example Template:
  Can the Capability perform Task X by SoS Configuration Y under Condition A to achieve Mission Desired Effect Z?
Critical joint issues assess system and task performance pertaining to capabilities which support joint missions.

Measures Framework

Service-acquired capabilities

that perform joint tasks

CJI: Can JBD2 perform to enable close air support by near-term networked fires SoS under a hostile threat environment to achieve destroyed or neutralized Threat Forces (in Zone, moving into Zone, indirect fires, ADA)?

to accomplish a joint mission

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CJI: Can JBD2 perform to enable close air support by near-term networked fires SoS under a hostile threat environment to achieve destroyed or neutralized Threat Forces (in Zone, moving into Zone, indirect fires, ADA)?

- Systems measure critical technical parameters (CTP) (attributes, that when achieved, allow attainment of desired operational capabilities) to resolve critical operational issues (COI) regarding task accomplishment.

The program manager/OTA need to know if the SUT can accomplish the required task in the Joint Operational Context for Test.
CJI: Can JBD2 perform to enable close air support by near-term networked fires SoS under a hostile threat environment to achieve destroyed or neutralized Threat Forces (in Zone, moving into Zone, indirect fires, ADA)?

- Systems are combined to accomplish Universal Joint Tasks which are measured at the System of Systems level (Services acting in concert to achieve a task)

Joint tasks are measured by a Task Measure of Performance derived from UJTL references (after Joint Capability Area analysis).
Measures Framework

Mission Measure of Effectiveness (MMOE) measures desired end state(s) (desired effects) that result from task performance.

- One or more tasks contribute to desired effect(s)/end state

CJI: Can JBD2 perform to enable close air support by near-term networked fires SoS under a hostile threat environment to achieve destroyed or neutralized Threat Forces (in Zone, moving into Zone, indirect fires, ADA)?

System/System of Systems

System/System of Systems

Joint Task(s) Accomplishment (TMOP)

Mission Desired Effect (MMOE)
Mission Statement
Blue Forces conduct Joint Forcible Entry Operations to expand lodgment and control key infrastructure in order to facilitate rapid force build-up in the Joint Operations Area (JOA).

End State
- Expand lodgment and control key infrastructure to facilitate rapid force build-up
- Preserve key infrastructure and prevent environmental contamination
- Secure LOCs to facilitate flow of forces needed to conduct regime change operations

Desired Effects
- Destroyed or neutralized Threat Forces (in Zone, moving into Zone, indirect fires, ADA)
- Blue unhindered in maneuver within the JOA
- Blue force survivability in the JOA

Integrated Fires System of Systems

Networked Fires
- Detect
- Fuse
- Allocate
- Engage
- Assess

Air Maneuver/Ops
- Monitor
- Coordinate
- Redirect

Air & Missile Defense
- Detect
- Fuse
- Allocate
- Engage
- Assess

Provides the ability to perform
Mission Statement
Blue forces conduct joint forcible entry operations to expand lodgment and control key infrastructure in order to facilitate rapid force build-up in the joint operations area (JOA).

End State
Expand lodgment and control key infrastructure to facilitate rapid force build-up

Desired Mission Effect
Destroyed or neutralized threat forces (in zone, moving into zone, indirect fires, ADA)

Sequence of Events
1. Mission start at time $t_0$. Threat forces in JOA or moving into JOA. Blue forces conducting joint forcible entry operations.
2. Blue forces employ Networked Fires task thread to prosecute threat targets.
3. Threat systems killed, damaged, or dislocated.
4. Mission complete at time $t_n$
Mission MOE: Threat Systems Combat Ineffectiveness
(Percentage of threat systems rendered ineffective [killed, damaged, dislocated] compared to Blue desired value)

**Data Elements**

1. Blue Desired Fraction of Threat Systems in JOA Combat Ineffective at Mission End State (threshold value)
2. Cumulative count Threat Systems in zone over time (System Type, Time, Location)
3. Cumulative count Threat Systems Killed (System Type, Time, Location)
4. Cumulative count Threat Systems Combat Damaged (System Type, Damage Type, Time, Location)
5. Cumulative count Threat Systems Dislocated (System Type, Dislocation Type, Time, Location)

**Key Terms**

1. **Threat Mounted Systems**: Those threat mounted systems that either are in the JOA at trial start or enter the JOA during the trial period. System does not have to still be in JOA at trial end to be counted. A system will also not be counted more than once (if enters JOA more than once). (System Type: identifying type; Time: Time at which entered JOA; Location: Positioning data at time which entered the JOA. If in JOA at trial start, then position at trial start time)
2. **Threat Mounted System kill**: Those threat systems that can no longer move, shoot, and sense. System no longer possesses a capability. Assumes cannot be fixed and remains a kill until trial end. (System Type: identifying type; Time: Time at which killed; Location: Positioning data at time which killed)
3. **Threat Mounted System damaged**: Those threat systems that can no longer shoot but are not killed. System is combat ineffective but still retains some capability to move or sense. (System Type: identifying type; Damage type: S – unable to shoot, SM – unable to shoot and move, SS – unable to shoot and sense; Time: Time at which entered damaged state. Must remain in damaged state to trial end to be counted. If later attacked and killed, then counted as a kill. If moves out of JOA or goes into hiding, still considered damaged and not dislocate; Location: Positioning data at time which entered damaged state)
4. **Threat Mounted System dislocated**: Those threat systems that are not combat effective in the JOA at trial end. System either leaves the JOA and remains outside the JOA until trial end, or system is in the JOA and hiding at trial end to avoid attack. Hiding assumes it is unable to move, shoot, or sense. A system is only counted as dislocated if in that state at trial end. (System Type: identifying type; Dislocation type: departed, denied, hidden; Time: Time at which entered dislocated state. Reset if system goes out of dislocated state before trial end; Location: Positioning data at time which entered dislocated state. Assumes does not move if remains in dislocated state until trial end)

**Calculation**

\[
\frac{\sum \text{Threat Systems Combat Ineffective (killed \lor damaged \lor dislocated) in JOA at trial end}}{\sum \text{Threat Systems in/newly entered JOA by trial end}} \]

(Blue Desired Fraction of Threat Systems Combat Ineffective in JOA at Mission End State)

**Success Criteria**

\[ \text{MMOE} \geq 1.0 \]
Task MOP: Percentage targets attacked IAW requests for fires
(Number of targets attacked compared to total number of requests for fires)

**Mission Statement**
Blue Forces conduct Joint Forcible Entry Operations to expand lodgment and control key infrastructure in order to facilitate rapid force build-up in the Joint Operations Area (JOA)

**Joint Task**
TA 3.2.1 Conduct Joint Fires:
Employ Fires that support land, maritime, amphibious, and special operation forces to engage enemy forces, combat formations, and facilities in pursuit of tactical and operational objectives.

**MOP (M1)**
Percentage targets attacked IAW requests for fires

**Sequence of Events**
1. JTF SOF soldier detects 2S19 Battery at start time $t_d$
2. JTF SOF soldier reports 2S19 target information to the FEC to populate the COP.
3. Decision is made to engage the 2S19s with PAM. Request for fires is made.
4. NLOS-LS receives fire mission
5. NLOS-LS processes the target acquisition information and is prepared to fire PAM.
6. NLOS-LS fires PAM at time $t_f$
7. Class III UAV detects effects.
8. BDA report is sent to FEC for COP update and potential re-targeting/re-attack.
9. Ground truth of target effects.

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Data Elements

1. Blue Target Engagement Objective Value
2. Number of requests for fire
6. Number threat systems attacked from requests for fire

Key Terms

1. Threat Systems (TS_d) detected in JOA: Those threat systems (TS_d) that are detected in the JOA and a request for fires is executed. (System Type: identifying type; Detection time: Time at which TS was first detected (t_d); Request for Fires time: Time at which request for fires on TS was executed (t_r))

6. Threat Systems (TS_k) targeted in JOA: Those threat systems (TS_k) that are targeted and attacked in the JOA during the trial period. (System Type: identifying type; Fires time: Time at which TMP was fired on (t_k))

Calculation

\[ TMOP = \frac{\sum \text{Threat Systems Attacked from Requests for Fire}}{\sum \text{Requests for Fire}} \]

Success Criteria

\[ TMOP \geq 1.0 \]
Sequence of Events

1. JTF SOF soldier detects 2S19 Battery at start time $t_d$
2. JTF SOF soldier reports 2S19 target information to the FEC to populate the COP.
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Mission Statement
Blue Forces conduct joint forcible entry operations to expand lodgment and control key infrastructure in order to facilitate rapid force build-up in the joint operations area (JOA)

System of Systems (SoS) Networked Fires

SoS Performance Areas
Doctrine
Organization
Training
Materiel
Leadership
Personnel

SoS Attribute: Rapid Fires Engagement
(Average time to engage targets from networked fires)
SoS Attribute: Rapid Fires Engagement
(Average time to engage targets from networked fires)

**Data Elements**

1. **BlueDesiredEngagementTime**
2. **Cumulative Count Threat Systems Engaged**
3. **Threat System detection time** \( (t_d) \)
4. **Threat System fires time** \( (t_f) \)

**Key Terms**

1. **Threat Systems** \( (T_{S_d}) \) **detected in JOA**: Those threat systems \( (T_{S_d}) \) that are detected in the JOA and a request for fires is executed. (System Type: identifying type; Detection time: Time at which TS was first detected \( (t_d) \), Request for Fires time: Time at which request for fires on TS was executed \( (t_f) \))

6. **Threat Systems** \( (T_{S_k}) \) **targeted in JOA**: Those threat systems \( (T_{S_k}) \) that are targeted and attacked in the JOA during the trial period. (System Type: identifying type; Fires time: Time at which TMP was fired on \( (t_f) \))

**Calculation**

\[
BET = \frac{\sum (\text{Threat System Fires Time} \ t_f - \text{Threat System Detection Time} \ t_d)}{\text{Cumulative Count Threat Systems Engaged}} \quad \forall \ T_{S_k} \text{ and Engaged}
\]

**Success Criteria**

\[
BET \geq 1.0
\]
Path Forward

• Need Analysis Framework
• Need regular tests in JCAs
• Need CONUS virtual range stood up
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