International Test & Evaluation
LVC Conference

Capability Test Design and Analysis

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# Capability Test Design and Analysis

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**Abstract**:

**Subject Terms**:

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*Standard Form 298 (Rev. 8-98)*  
*Prescribed by ANSI Std Z39-18*
1. Discuss the concept of conducting a capability evaluation strategy refinement process for testing in a joint environment (TIJE)

2. Review the methods and processes for an evaluation strategy refinement process

3. Review potential design of experiment techniques for large number of factors

4. Review tools and techniques for an evaluation strategy refinement process

5. Step through a “case study” example of an evaluation strategy refinement process

6. Review potential issues and insights
JTEM Capability Test Methodology (CTM) v2.0

6 Steps
14 JTEM Processes

0. Develop T&E Strategy
- T&E Strategy (TES)
- T&E Master Plan (TEMP)
  - Develop Capability/SoS Description
  - Develop Joint Operational Context for Test (JOC-T)
  - Develop Evaluation Strategy
  - Develop/Refine Capability Crosswalk

1. Characterize Test
- Program Introduction Document (PID)
- Statement Of Capabilities (SOC)
  - Develop Test Concept
  - Refine Evaluation Strategy
  - Technical Assessment

2. Plan Test
- Test Plan
  - Develop Test Design
  - Perform LVC Distributed Environment Analysis
  - Develop Test Plan

3. Implement LVC-DE
- Integrated Vignettes
  - LVC Distributed Environment Design
  - System Design Document (SDD)
  - Design LVC Distributed Environment Configuration
  - Integrate LVC Distributed Environment

4. Manage Test Execution
- Event Management Plan
  - Client Systems

5. Evaluate Capability
- Joint Capability Evaluation (JCE)
  - Analyze Data
  - Evaluate SoS Performance & Joint Mission Effectiveness

Capability Set Focus

Joint Operational Context for Test
- Test Concept
- Test Data

Capability Subset Focus

Joint Mission Environment
- Joint Mission Environment Design
- Test Control & Monitoring

Event Focus

LVC – Live, Virtual, Constructive
LVC-DE – Live, Virtual, Constructive Distributed Environment
SoS – System of Systems

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JTEM CTM 0.3.3
(Develop Evaluation Strategy)

0. Develop T&E Strategy

- Develop Capability/SoS Description
- Develop Joint Operational Context for Test (JOC-T)
- Develop Evaluation Strategy
- Develop/Refine Capability Crosswalk

1. Characterize Test
- Program Introduction
- Statement of Capability Subset

2. Plan Test
- LVC – Live, Virtual, Constructive
- LVC-DE – Live, Virtual, Constructive Distributed Environment
- SoS – System of Systems

3. Implement
- Design LVC Distributed Environment Configuration
- Integrate LVC Distributed Environment System Design Document (SDD)

4. Manage Test Execution
- Develop Test Concept
- Refine Evaluation Strategy
- Technical Assessment

5. Evaluate Capability
- Develop Capability/SoS Description
- Develop Joint Operational Context for Test (JOC-T)
- Develop Evaluation Strategy
- Develop/Refine Capability Crosswalk

CTM 0.3.3.1 Develop Evaluation Framework

CTM 0.3.3.2 Develop/Refine Exploratory Analysis Plan

CTM 0.3.3.3 Execute Exploratory Data Collection

CTM 0.3.3.4 Conduct Exploratory Analysis

CTM 0.3.3.5 Synthesize Exploratory Results

6. Plan Test Execution

- Analyze Data
- Evaluate SoS Performance & Joint Mission Effectiveness

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Exploratory Analysis Purpose

Purpose is three-fold:

– To explore a wide range of possible factors and levels that might affect joint mission effectiveness (JMe), referred to as the initial JMe factor test space;
– To identify those combinations of factors that have the greatest impact on JMe, referred to as the refined JMe factor test space; and
– To recommend potential factor combinations of interest from the refined JMe factor test space for subsequent test events, referred to as potential test trial sets.
CTM 0.3.3.2: Develop/Refine Exploratory Analysis Plan

- **Develop evaluation strategy**
  - Refine factor space and measure framework
  - Final exploratory analysis strategy outline

- **Models and simulation**
  - Agent based models
  - Other low resolution models
  - Constructive, high resolution models
  - Virtual and human in the loop (HITL) simulation
  - Activity directed networks (ADN)
  - Petri nets
  - Dynamical systems

- **Other techniques**
  - SME input instruments; surveys, interviews, professional military judgment panels (PMJ), etc.
  - Use of prior experimentation or analyses of alternatives (AoA) results to screen the factor space
  - Decision analysis

- **Identify and Assess Potential Tools and Techniques**

- **Identify Appropriate Analytical Methods**

- **Select Analysis Tools and Techniques**

- **Develop M&S Test Scenario and Vignettes**

- **Develop Evaluation Strategy**

- **Choose appropriate DOE based upon:**
  - Types of insights desired
  - Interest in main effects, two- or more-way interactions
  - Number of factors
  - Mix of continuous/discrete/qualitative factors
  - Simulation run times and computational budget

- **Potential types**
  - Full and Fractional Factorial, Central Composite Designs, Latin Hypercubes, Taguchi Robust Designs, etc.
  - Large factor space designs: Nearly Orthogonal Latin Hypercubes (NOLH), Fractional Factorial Confounded Sequential Fractionation (FFCSF), Resolution 5 Fractional Factorials (R5FF), etc.

- **Analysis approach options**
  - Sequentially screen the factor space using a single model
  - Simultaneously screen subsets of the factor space using multiple models
  - Combinations of the above
  - Iterative process.

- M&S scenario and vignette development
  - Developed primarily from JOC-T products
  - Tied to higher level planning guidance
  - Critical that M&S scenarios and vignettes draw from the same sources as test scenario and vignettes
CTM 0.3.3.3: Execute Exploratory Data Collection

• Depending upon tools and methods chosen, configuration of computing resources may be quite involved.
• Other instruments of data collection are also developed here (surveys, interview scripts, PMJ panel planning, etc.).
• Analysts develop model inputs (scenario files, DOE input files, data output specifications, etc.) to execute the data collection.
• Model runs and data collection are executed according to exploratory analysis strategy.
CTM 0.3.3.4: Conduct Exploratory Analysis

- Identify and select appropriate tools and techniques to conduct the analysis.
- Evaluate measure responses from exploratory runs to refine the JMe factor test space.
- Identify factors to explore during next iteration, as required.
- Potential analyses involved in these steps will be discussed in more detail as part of CTM 5, Evaluate Capability, since similar analytic methods will be used as part of both processes.
CTM 0.3.3.5: Synthesize Exploratory Analysis Results

- This set of processes integrates the analyses conducted during the multiple exploratory iterations to draw insights about the “probable” factor space and the measure framework.
- The result should be a final refined factor space consisting of potential test trial sets of interest for subsequent testing.
- Must integrate model related data and qualitative data obtained from SMEs.
- Insights from the analysis will help inform the risk assessment conducted in the next step of the CTM.
  - Potential contributors to risk include the assumptions made during modeling, the capabilities of the models, the measures chosen, etc.
  - Subsequent tests can help validate assumptions made.
Case Study Example
High Level Operational View (OV-1)

System of Systems (SoS)
Develop Evaluation Framework

Case Study Example

Mission Measures of Effectiveness
1. Threat Systems Combat Ineffectiveness
2. Cumulative ineffectiveness time Threat Systems in JOA

Task Measures of Performance
1. Time to C2 indirect fires (IF)
2. Time to get ordnance on target for JCAS
3. Time to get ordnance on target for JFIRES

Measures of System of Systems Attributes
1. Speed of CFF Decisions
2. Speed of CFF Deconfliction

CTM 0.3.3.1 Develop Evaluation Framework

CTM 0.3.3.1.2.1 Identify Mission Measures of Effectiveness (Mission MOE)
CTM 0.3.3.1.2.2 Identify Task Measures of Performance (Task MOP)
CTM 0.3.3.1.2.3 Identify System of System Attributes
CTM 0.3.3.1.2.4 Determine Feasible Levels/Regions for Measures
CTM 0.3.3.1.2.5 Structure the Measures
Agent Based Model

- Visual basic code
- Simple interface
- Models:
  - Agent interactions
  - Airspace deconflictions
  - C2 processes
- 17 materiel and non-materiel factors built in for data farming
## Factor Capability Crosswalk
### SME Estimates

<table>
<thead>
<tr>
<th>Crosswalk Dimension</th>
<th>Crosswalk Sub Dimension</th>
<th>Factor</th>
<th>Levels</th>
<th>Factor Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>System of Systems</strong></td>
<td><strong>Materiel</strong></td>
<td>1. Global Information Grid (GIG)?</td>
<td>Yes/No</td>
<td>Categorical</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Blue Speed</td>
<td>1/2 (Multiplier)</td>
<td>Continuous</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Blue Monitor</td>
<td>1/2 (Multiplier)</td>
<td>Continuous</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Blue Fires</td>
<td>1/2 (Multiplier)</td>
<td>Continuous</td>
</tr>
<tr>
<td></td>
<td><strong>Non-materiel: Doctrine</strong></td>
<td>5. Multiple Trackers?</td>
<td>Yes/No</td>
<td>Categorical</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. Expedited Call For Fire?</td>
<td>Yes/No</td>
<td>Categorical</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7. Call For Fire type Decision</td>
<td>A/C</td>
<td>Categorical</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8. Expedite Move</td>
<td>Yes/No</td>
<td>Categorical</td>
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<tr>
<td></td>
<td></td>
<td>9. Restricted Op. Zone Type</td>
<td>Restrictive/Permissive</td>
<td>Categorical</td>
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<tr>
<td></td>
<td></td>
<td>10. ROZ Size</td>
<td>1/2 (Multiplier)</td>
<td>Continuous</td>
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<tr>
<td></td>
<td></td>
<td>11. ROZ Expiration</td>
<td>Yes/No</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>12. ROZ Slack Time</td>
<td>1/2 (Add. Time Increments)</td>
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<tr>
<td></td>
<td><strong>Condition</strong></td>
<td>14. Adverse Weather?</td>
<td>Yes/No</td>
<td>Categorical</td>
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<tr>
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<td></td>
<td>15. Civilian Zone?</td>
<td>Yes/No</td>
<td>Categorical</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16. Civilian Zone Size</td>
<td>20/40</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>17. Civilian Zone Location</td>
<td>1/2</td>
<td>Categorical</td>
</tr>
</tbody>
</table>

**17 Factors with 3 dependencies**

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Step 1: “Quick Look” Analysis

**Dependent Variable:** Number Threat Kills  
**Independent Variables:** 17 factors (decision & conditional)  
**DOE:** Resolution III Fractional Factorial (80 trials, 20 runs each)  
**Analysis tools:** Stepwise Regression Model

**Findings:**  
- 14 factors significant, 3 factors not significant  
- Adverse weather factor non-intuitive
Step 2: Main Effects Analysis

**Dependent Variable:** Number Threat Kills

**Independent Variables:** 14 factors (decision & conditional)

**DOE:** Resolution V Fractional Factorial (2304 trials, 3 runs each)

**Analysis tools:** Classification and Regression Tree (CART) partitioning

**Findings:**
- Stressing factors (Blue speed, ROZ size, ROZ type)

**Good**
- Blue Speed: 2
- ROZ Size: 1
- ROZ Type: P

**Bad**
- Blue Speed: 1
- ROZ Size: 2

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Step 2: Main Effects Analysis

**Dependent Variable:** Number Threat Kills

**Independent Variables:** 14 factors (decision & conditional)

**DOE:** Resolution V Fractional Factorial (2304 trials, 3 runs each)

**Analysis tools:** Stepwise Regression Model

**Findings:**
- 10 factors significant
- Blue fires no longer significant
- Adverse weather factor intuitive
**Step 2: Main Effects & Two-way Interaction**

**Dependent Variable:** Number Threat Kills  
**Independent Variables:** 14 factors (decision & conditional)  
**DOE:** Resolution V Fractional Factorial (2304 trials, 3 runs each)  
**Analysis tools:** Stepwise Regression Model

### Sorted Parameter Estimates

| Term                                                                 | Estimate | Std Error | t Ratio | Prob>|H| |
|----------------------------------------------------------------------|----------|-----------|---------|-----|---|
| Blue Speed                                                          | 9.8637153 | 0.202016  | 48.83   | 0.0000* |
| ROZ Size                                                            | -7.162326 | 0.202016  | -35.45  | <.0001* |
| ROZ Type[P]                                                         | 2.4657186 | 0.101009  | 24.41   | <.0001* |
| (Blue Fires-1.5)^ROZ Type[P]                                       | -4.063368 | 0.202016  | -20.11  | <.0001* |
| GIG[0ff]                                                            | -1.751302 | 0.101009  | -17.34  | <.0001* |
| Civilian Zone?[Yes40-Yes20&No]                                      | -1.855143 | 0.107136  | -17.32  | <.0001* |
| CFF Type of Decision[A]                                            | -1.508247 | 0.101009  | -14.93  | <.0001* |
| Multiple Trackers?[No]                                             | -1.313802 | 0.101009  | -13.01  | <.0001* |
| Adverse Weather?[No]*ROZ Type[P]                                   | 1.2773438 | 0.101009  | 12.85   | <.0001* |
| (Blue Monitor-1.5)^ROZ Type[P]                                     | 1.7101458 | 0.202016  | 8.49    | <.0001* |
| (Blue Speed-1.5)^ROZ Type[P]                                       | 1.2421875 | 0.202016  | 6.15    | <.0001* |
| GIG[0ff]*ROZ Expiration[No-Yes1]                                    | -0.6875   | 0.123711  | -5.56   | <.0001* |
| (Civilian Zone?[Yes40-Yes20&No]+0.33333)/(ROZ Size-1.5)            | 1.1803366 | 0.214273  | 5.51    | <.0001* |
| (Civilian Zone?[Yes40-Yes20&No]+0.33333)^ROZ Type[P]               | -0.57194  | 0.107136  | -5.34   | <.0001* |
| CFF Type of Decision[A]*ROZ Type[P]                                | 0.531664  | 0.101009  | 5.26    | <.0001* |
| Adverse Weather?[No]/CFF Type of Decision[A]                       | 0.5098626 | 0.101009  | 5.05    | <.0001* |

**Findings:**  
- 6 main effect factors significant  
- 5 additional factors significant in two-way interactions  
- Blue fires & adverse weather part of two-way interactions
Step 3: Aggregated Conditional Factors

Dependent Variable: Number Threat Kills
Independent Variables: 10 factors (9 decision, 1 conditional)
DOE: Resolution V Fractional Factorial (128 trials, 3 runs each)
Analysis tools: Classification and Regression Tree (CART) partitioning

**Case Study Example**

**Bad**
Stressing Factor: Most
Blue Speed: 1
GIG?: Off

**Good**
Stressing Factor: Least
Blue Speed: 2
CFF Type Decision: C
ROZ Type: P

**Example (5 Factor Least Stressing Levels)**

- **Count**: 64
- **LogWorth Difference**: Mean 84.78125, Std Dev 22.64017

<table>
<thead>
<tr>
<th>Blue Speed: 1</th>
<th>Blue Speed: 2</th>
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<tbody>
<tr>
<td>Count</td>
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<tr>
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<td>Std Dev</td>
<td>26.11036</td>
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<table>
<thead>
<tr>
<th>GIG? (Off)</th>
<th>GIG? (On)</th>
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</thead>
<tbody>
<tr>
<td>Count</td>
<td>16</td>
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<tr>
<td>Mean</td>
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<tr>
<td>Std Dev</td>
<td>10.3624</td>
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<table>
<thead>
<tr>
<th>CFF Type of Decision (A)</th>
<th>CFF Type of Decision (B)</th>
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<tr>
<td>Mean</td>
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<tr>
<td>Std Dev</td>
<td>14.28621</td>
</tr>
</tbody>
</table>

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## Step 3: Aggregated Conditional Factors Results

### Sorted Parameter Estimates

| Term                                      | Estimate | Std Error | t Ratio | Prob>|t| |
|-------------------------------------------|----------|-----------|---------|------|---|
| System of Systems                         |          |           |         |      |---|
| Materiel                                 |          |           |         |      |---|
| 1. Blue Speed                             | 17.59375 | 1.122227  | 15.68   | <.0001* |---|
| 2. Blue Fires                             | 30.8125  | 2.244455  | 13.73   | <.0001* |---|
| 5. Global Information Grid (GIG)?         | -15.8125 | 2.244455  | -7.05   | <.0001* |---|
| 3. Restricted Op. Zone Type               | 6.375    | 1.122227  | 5.68    | <.0001* |---|
| 4. Call For Fire type Decision            | -6.296875| 1.122227  | -5.61   | <.0001* |---|
| 1/2 (Multiplier)                          | 1.122227 | 1.122227  | 1.00    | <.0001* |---|
| 1/2 (Multiplier)                          | 1.122227 | 1.122227  | 1.00    | <.0001* |---|
| Yes/No                                    | 1.122227 | 1.122227  | 1.00    | <.0001* |---|
| Restrictive/Permissive                    | 1.122227 | 1.122227  | 1.00    | <.0001* |---|
| A/C                                       | 1.122227 | 1.122227  | 1.00    | <.0001* |---|
| Yes/No                                    | 1.122227 | 1.122227  | 1.00    | <.0001* |---|
| Continuous                                | 1.122227 | 1.122227  | 1.00    | <.0001* |---|
| Categorical                               | 1.122227 | 1.122227  | 1.00    | <.0001* |---|
| Continuous                                | 1.122227 | 1.122227  | 1.00    | <.0001* |---|
| Categorical                               | 1.122227 | 1.122227  | 1.00    | <.0001* |---|
| Continuous                                | 1.122227 | 1.122227  | 1.00    | <.0001* |---|

### Findings:
- One aggregated condition factor significant
- Six decisional factors significant
**Step 1: Measures Relationship Table**

**Green: Direct relationship**  
**Red: Indirect relationship**  
**No color: No relationship**

### Findings (Direct and Indirect relationships):
- Direct relationship for all measures: Blue Monitor, Multiple Trackers, ROZ Slack Time  
- Indirect relationship for MMOEs and TMOPs/MOSAs: CFF Type of Decision, ROZ Expiration  
- Direct relationship across both MMOEs

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| Factors                        | Values          | M | M | T | T | T | M | M | M | M | M | M | M | M | M | M | M | M | M | T | T | T | T | T | T | T | T | T | T |
| GIG                           | Off or On       | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
| Blue Speed                    | 1 or 2          | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Blue Monitor                  | 1 or 2          | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Blue Fires                    | 1 or 2          | 1 | 1 | 0 | -1 | 0 | 1 | -1 | -1 | 0 | 1 | -1 | -1 | 1 | -1 | 0 | 1 | 0 | 0 | -1 | -1 | 1 | 0 | 0 |
| Civilian Zone                 | Off or On       | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| Civilian Zone Size            | Small or Large  | -1 | -1 | -1 | 0 | 0 | -1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| Multiple Trackers             | No or Yes       | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Adverse Weather               | No or Yes       | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| Expedited CFF                 | No or Yes       | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| CFF Type of Decision          | Closest or Available | -1 | -1 | 1 | 1 | 1 | 1 | 1 | 1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| Expedite Move                 | No or Yes       | 1 | 1 | 1 | -1 | 0 | 1 | 0 | 1 | -1 | 0 | 1 | -1 | 0 | 1 | 0 | 1 | 0 | -1 | 0 | 1 | 0 | 1 |
| ROZ Type                      | Restrictive or Permissive | 1 | 1 | 1 | 1 | 1 | -1 | 1 | 1 | 1 | 1 | 1 | -1 | 1 | 1 | 1 | -1 | 1 | -1 | 1 | -1 | 1 | 1 |
| ROZ Size                      | 1 or 2          | -1 | -1 | 0 | 0 | -1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Multi-service Wait time       | 1 or 2          | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ROZ Expiration                | No or Yes       | 1 | 1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| ROZ Slack Time                | 1 or 2          | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Civilian Zone Location        | 1 or 2          | 0 | 0 | -1 | 0 | -1 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 |

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**MMOE** – Mission Measure of Effectiveness  
**MOSA** – Measure of System of Systems Attributes  
**TMOP** – Task Measure of Performance
Insights into Exploratory Analysis

• Resolution V DOE needed for assessing two-way interactions
  – Resolution III does not confound main effects with one another, but does confound main effects with 2-factor interactions
  – Resolution V does not confound main effects and 2-factor interactions, but confounds main with 4-factor and 2-factor with 3-factor

• Factor prioritization is an iterative process
  – Initial DOE and data farming may provide first insights into significant measures
  – May require further exploration to validate initial findings
  – May differ across multiple measures and require retaining uncertain factors in the second design
  – Iterative farming can provide additional prioritization of factors

• Factors with more than two discrete levels requires additional farming to assess their impact
  – Requires crossing with additional factors
  – May wish to assume two levels for initial design

• Multiple measures (dependent variables) adds significant complexity to determining factors with highest impact
  – Requires evaluation of factors across measures
  – Constructing relationship tables provides insights on measure impacts
Summary

- Exploratory analysis requires an iterative process for prioritizing factors
- Factors can be analyzed across multiple dependent variables (measures)
- Automated tools for DOE and modeling can help to simplify the exploratory analysis process
- Non-materiel factors can be equally important to testing a System of Systems
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Serving the testing, acquisition, and warfighting communities
Abstract

The Joint Test and Evaluation Methodology (JTEM) project has been collaborating with various government organizations and academia to develop enhanced Design of Experiment (DOE) modeling and analysis approaches for Testing in a Joint Environment (TIJE). This paper discusses the applied research that has been conducted in this area over the past three years, as well as its application to JTEM test events. Discoveries involving enhanced data farming techniques and technology applications have proven to be catalysts for test and evaluation of complex adaptive systems. Hybrid DOE models for large factor test designs (e.g., Fractional Factorial Controlled Sequential Bifurcation, Resolution Five Fractional Factorial, Nearly Orthogonal Latin Hypercube) have demonstrated success in refining robust Joint test spaces. Innovative application of analytical models and methodologies (e.g., Advanced Response Surface Methodology, Classification and Regression Tree) have improved our ability to analyze Critical Capability Issues (CCI) involving multiple responses. Agent based model simulation prototypes (e.g., Tester, MANA, Pythagoras) have been modified and/or developed by our academic and government partners to enable enhanced test design and evaluation of capabilities in a Joint environment. Proof of concept efforts in this collaboration has included International Data Farming Workshop (IDFW) events, where various techniques and tools have been explored for use in Testing in a Joint Environment (TIJE). Key research techniques and selected results are presented in the context of a use case that is based upon JTEM test events.