Verification and Validation of DTRA’s Unified EM Design

Robert F. Gray
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Approved for public release
### Verification and Validation of DTRAs Unified EM Design

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Overview

• Unified EM Design Background
• Unified EM Design Software Architecture
• V & V Approach
• V&V Results
• Conclusion
Background

- JCS memo on combined battlefield environmental effects initiative, c. 1994
  - Unified Protection Concept
  - Allocation Methodology
  - Evaluated Military and Commercial Standards
  - Prototype Unified EM Design Tool
- Unified EM Design & Test Protocols Program, 1999 - 2004
  - Unified EM Design Tool
  - Evaluation of potential for unified test methods
- Advanced Unified EM Design Program, 2005 - Present
  - Prototype DETES development
  - NuCS Capabilities integration
  - Verification and Validation
Application of UEM

<table>
<thead>
<tr>
<th>Phase 1 Concept Definition</th>
<th>Phase 2 Engineering Development</th>
<th>Phase 3 Production</th>
<th>Phase 4 Deployment</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Define System Concept to Meet Mission Needs</td>
<td>• Develop Cost Effective and Producible System Design</td>
<td>• Produce System</td>
<td>• Ensure Fielded Systems Operate to Requirements</td>
</tr>
</tbody>
</table>

Unified EM Design provides:
- Access to EM Standards (Left)
- System modeling (Bottom)
- Unified Barrier Performance Requirements for enclosure and penetration ports (Right)
Software Architecture

- Runs under all current Windows operating systems
- Major elements are:
  - User Interface
  - Analytical Models
  - Databases
- Databases have common structure
- Data in the UEM Design information database is protected

Diagram:
- Operating System
  - Windows XP
- User Interface
  - Visual Basic
  - SQL
- Analytical Models
  - Visual Basic
- System Information
  - MS Access DB Tables
  - SQL
- UEMD Information
  - MS Access DB Tables
  - SQL
- User Information
  - MS Access DB Tables
  - SQL
V & V Approach

- Based on DTRA V&V Guide
- Assumes Level II Accreditation

<table>
<thead>
<tr>
<th>V&amp;V Activity</th>
<th>Accreditation Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM Assessment</td>
<td>I +</td>
</tr>
<tr>
<td>Documentation Assessment</td>
<td>I +</td>
</tr>
<tr>
<td>Software Quality Assessment</td>
<td>I +</td>
</tr>
<tr>
<td>Security Requirements Assessment (Not Required)</td>
<td>I +</td>
</tr>
<tr>
<td>Sensitivity Analysis</td>
<td>II +</td>
</tr>
<tr>
<td>Uncertainty Analysis</td>
<td>II +</td>
</tr>
<tr>
<td>Data V&amp;V</td>
<td>II +</td>
</tr>
<tr>
<td>SME V&amp;V (Conceptual Model, Logical, Face, &amp; Results)</td>
<td>II +</td>
</tr>
<tr>
<td>Detailed V&amp;V (Requirements, Design, &amp; Code)</td>
<td>III</td>
</tr>
</tbody>
</table>
Results for Level I+ Activities

- CM Assessment looked at controls on software for maintenance and releases
- Documentation review
  - Independent review performed on V1.6
  - Verified current version documents consistent with V1.6
  - Verified new EM Quantity documentation
- SQA focused on outstanding program trouble reports (PTRs) and operational stability
Example Sensitivity Analysis

- Barrier performance requirements calculation utilizes a non-linear bounding process.
- Outputs will not vary linearly with input parameters in the large scale.
- Sensitivity analysis over a limited range.
- Example shows agreement within 0.2%.
## Uncertainty Analysis Overview

<table>
<thead>
<tr>
<th>Uncertainty</th>
<th>Risk Level</th>
<th>Discussion</th>
<th>Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environments</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radiated</td>
<td>Low</td>
<td>Based on Standards. Very low sensitivity study result.</td>
<td></td>
</tr>
<tr>
<td>Conducted</td>
<td>Low to Moderate</td>
<td>Based on Standards or Worst Case Estimates. Low to moderate sensitivity study result.</td>
<td>Mitigators include use of test data or results from more accurate models and specifications.</td>
</tr>
<tr>
<td>Immunities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radiated</td>
<td>Low</td>
<td>Based on Standards. Very low sensitivity study result.</td>
<td></td>
</tr>
<tr>
<td>Conducted</td>
<td>Low to Moderate</td>
<td>Depends on fidelity of model for conversion of standard’s specified test procedure to penetration current. Low to moderate sensitivity study result.</td>
<td>Mitigators include use of actual test data and margin.</td>
</tr>
<tr>
<td>Margins</td>
<td>Low</td>
<td>Based on QSTAG 1051 procedures. User selectable to manage risk. Very low sensitivity study result.</td>
<td></td>
</tr>
<tr>
<td>Topology</td>
<td>Low</td>
<td>Based on QSTAG 1051 procedures. No restrictions in Unified EM Design. Extensive user training also conducted.</td>
<td></td>
</tr>
<tr>
<td>Barrier Performance</td>
<td>Very low to Moderate</td>
<td>Based on QSTAG 1051 procedures. Very low sensitivity study result.</td>
<td>Mitigators include Shielding Effectiveness testing, Current Injection testing, and System Level testing.</td>
</tr>
</tbody>
</table>
Data V & V Analysis

- **Producer Quality**
  - Vast majority of the data comes from commercial and military standards
  - Verification approach
    - 857 EM Quantity descriptions in UEM V2.3
    - Randomly selected 60 descriptions & verified them against the standards
    - Accuracy of 90% or greater with 95% confidence
      - Complete review recommend
      - Review will be completed before release of V2.3

- **User Quality established by CBEE**
  - Instructional information in QSTAG 1051
Methodology was codified as part of the American, British, Canadian, and Australian Armies’ Standardization Program - QSTAG 1051

QSTAG 1051 includes:

- Step-by-step procedures for the barrier performance requirements calculations
- Logical verification of UEM processing
- Example results
Summary

- V & V approach based on DTRA guide
- Some of the V & V tasks completed as part of original development
- All V&V activities completed
- Draft V & V report available
  - V2.3 recommendations include complete data audit
  - Long term recommendations recommendations relate to maintainability and operation under new Operating Systems