Engineered Resilient Systems Architecture

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ERS Architecture – Integrating Capabilities

• Provide a cohesive, integrating capability for ERS tools, technologies and products
• Develop reference architecture
• Promote reuse and common infrastructure
• Develop guidance and standards
• Work closely with application and development teams

- Architecture artifacts evolve and are refined over time
- Development cycles are aligned with product deliveries
# ERS User Groups

<table>
<thead>
<tr>
<th>STRATEGIC PLANNERS</th>
<th>OPERATING COMMANDS</th>
<th>PROGRAM MANAGEMENT</th>
<th>DOD SYSTEM DESIGNERS</th>
<th>DOD T&amp;E</th>
<th>INDUSTRY</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Satisfy national security objectives</td>
<td>• Analyze operational situation</td>
<td>• Program Execution</td>
<td>• Identify designs that meet performance &amp; mission objectives</td>
<td>• Identifies early knowledge of developmental &amp; operational issues</td>
<td>• Identify design alternatives</td>
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<tr>
<td></td>
<td>• Identify capability gaps &amp; strengths</td>
<td>• Delivered on time within cost</td>
<td></td>
<td></td>
<td>• Proposal devt &amp; production</td>
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<td></td>
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<td>• Meet warfighters’ requirements</td>
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<td>• Better understanding of requirements</td>
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- **DOD M&S**
- **DOD HPC**
- **ERS ANALYTICS**
Architecture Drivers

- Improve impact of ERS through early, continuous delivery of products
- Focus: Building early user acceptance and adding capabilities as needed/wanted
- Enable “Open” computing framework to support cross-community (DoD-Industry)
- Apply advanced computing methods to improve accuracy, depth, and breadth of tradespace studies

Integration with Industry is key to success. Participation in Architecture Working Group kicks off: Nov 2015

Working products are the primary measure of progress.
ERS Overview - NDIA SE Conference - October 2015

Distribution Statement A – Approved for public release by DOPSR. Distribution is unlimited.

Advanced Tradespace Analysis tools are at the core of the ERS capability.

ERS focuses on improving decision-making by integrating computational resources that increase accuracy and depth of analysis.

Decision-makers refine the system by trading cost, performance, schedule, and risk.

Advanced Tradespace Analysis

- DESIRED PERFORMANCE
- PROGRAM CONSTRAINTS
- MODELS & DATA
- POSSIBLE ALTERNATIVES
- ADVANCED COMPUTING ASSETS
- PHYSICS-BASED DESIGNS
- MISSION-LEVEL SIMULATIONS
- M&S CAPABILITIES

M&S CAPABILITIES
ERS Building Blocks (Reference Architecture)
ERS Open Architecture

• Modular back-end in Node.js using REST services.
• Project data structures in easily read MongoDB JSON.
• Front-end tools added through AngularJS directives.
• Projects and Data accessible through REST API.
• High performance low-level API for tradespaces.
• “R” Analytics tool allows for custom analysis.
• SAML-based 2 factor identity services for federated user management
ERS Infrastructure

END USERS

INDUSTRY PARTNERS

DREN

EXTERNAL ERSNet

INTERNAL ERSNet

HPC

SDREN HPC

EXTERNAL ERSNet

INTERNAL ERSNet

HPC
TradeStudio Processes

MODELING PHASE

TRADESPACE CREATION

- Existing Codes
- Domain models
- Spreadsheet
- Python/R Wrappers
- Jupyter Notebooks

TRADESPACE

- HDFS Format
- Metadata included
- Stats
- Low-level API (c/c++)

ANALYSIS PHASE

TRADESPACE ANALYSIS

- Open Architecture
  - Tradespace API (REST)
  - GUI Modules
  - REST Services
  - R. Modules
ERS Tradespace Assembly Toolkit (ERSTAT)

- Introduce DoD Conceptual Design Teams to the Cloud Computing Environment (CCE)/HC
- Introduce DoD Conceptual Design Teams to R Language
- Enhance Collaboration
- Gather and distribute cross-cutting functionality
- Examine, profile and improve model assembly pipelines

ERSTAT is a computational environment that connects legacy M&S to the ERS Workflow
Computational Notebooks

**TEXT, DIAGRAMS, EQUATIONS, EXPLANATIONS**

**HIGH-LEVEL CODE DIRECTLY EXECUTABLE ON ERS HPC**

**RESULTS, TABLES, GRAPHS, STATISTICS**

**COMPUTATIONAL NOTEBOOK: PIPELINE OF ACTIVITIES**

**EASE OF USE EASILY SHARED**

**NOTEBOOKS ARE DESIGNED TO BE SHARED**

**ERS Common Computing Environment (CCE)**

**NOTEBOOKS CAN RUN ON ANY ERS PLATFORM**
ERSTAT Architecture

ERSTAT NOTEBOOK

ERS TRADESTUDIO

PROXY SERVER

PNG AUTHENTICATION

ERS PORTAL

PHOENIX LOGIN NODE

RESULTS PUSHED

BRIDGE DIRECTLY TO TRADESTUDIO

ERSTAT BACKEND RUNNING ON CCE HPC PHOENIX
Data Management and Transformation Tools

Managing data: Projects and Tradespace

Projects:
- Top-level data container
- Full security through permissions
- Shared Workspace

Tradespace:
- Standalone – immutable dataset
- HDF5 format
- Metadata
- Statistics

Transforming data: Tools

- Appropriate tools surround the tradespace
- Tools can create subsets
Data Reduction Tools

- Operates on very large tradespaces (up to 10 million designs)
- User selects attributes of interest, conducts scoring process that allows exclusion of designs by attribute value
- Each attribute assigned a weight
- Cumulative score is displayed in real time
- Results saved as a new sub-tradeset with added “score” attribute
Data Visualization Tool

- 2D/3D visualizer
- Use color, size and opacity or a fourth attribute
Data Analysis Tools

- Select attributes to show plot matrix with histograms
- Select any graph for close-up
- Assign parameter colors
Data Analysis Tools

- Select “Analyze Points” to run analysis tool
- Select objective attributes
- Change objective values
- Tool calculates score for each design
“R” Analytics

- “R” script tool allows upload of new, custom analytics
- ERS “R” packages inform what GUI inputs should be
- “R” scripts output plots or new subsets
“R” Analytics

“R” script output is stored in the project relative to the tradeset used to generate it.
Questions & Answers

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