Innovative Defense Technologies’ Automated Test and ReTest (ATRT) Integrated with an Architecture Analysis and Design Language (AADL) Model

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U.S. Patent Numbers: 8,826,084; 9,135,714; 9,983,965; 10,572,821; 10,678,666; 10,929,258


This work was done under U.S. Army Combat Capabilities Development Command Aviation & Missile Center contract W911W6-19-C-0008.
IDT’s Digital Engineering Thread Capability

**Design**
- Parametric Modeling for Concept Exploration

**Develop**
- Parametric Models Evolved to System Behavior Models
- Automated Test & Analysis Execution

**Test**

**Deliver**
- Integrate Test & Deliver 3rd Party Capabilities with Virtualized Systems

**Operate**
- Continuous Cyber Awareness of Operational Networks

**Sustain**
- Edge Analytics of Operational Data

*Continuum of data and models provide an Authoritative Source of Truth across the lifecycle*

Aligned with OSD’s Digital Engineering Strategy
1. Formalize Development, Integration and Use of Models
2. Provide an Authoritative Source of Truth (AST)
3. Incorporate Technological Innovation
4. Establish Infrastructure and Environments
5. Transform Culture / Workforce
IDT’s Notional U.S. Army System of Systems Ecosystem

- PEO Aviation
- OT&E Communities
- Prime Contractors
- Combat Capability Development Command (DEVCOM)
- Operational bases

**Compelling Value**

- Single Authoritative Source of Truth
- Cloud-based access
- Rapid incremental software updates -- Weeks, not years
- Analytics on the Edge – Move results, not data
- Persistent Configuration Management & cyber awareness

**DevSecOps Development Pipeline**

- Design / Development
- Build

**Secure Cloud**

- CM’d library of AADL decomposed mission behavior models
- Tactical Code

**Virtualized SUT**

- Massively parallel testing
- Automated test
- Automated analysis

**Continuous Integration / Continuous Deployment**

- Results
- Secure / Certification
- Deploy

**Multiple User Access**

- DevSecOps Development Pipeline

**Fleet Performance Analysis**

- Results
- Secure / Certification
- Deploy

- Government SIM/STIM

- Problem Investigation & Resolution

- Edge Analytics AI/ML

- Compelling Value

- Single Authoritative Source of Truth
- Cloud-based access
- Rapid incremental software updates -- Weeks, not years
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- Persistent Configuration Management & cyber awareness

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IDT’s Automated Test and ReTest (ATRT) Enterprise Toolset

- Modeling Tool (MT)
- Persistent Configuration Manager (PCM)
- Cyber Security Manager (CSM)
- ATRT Enterprise Platform Using Digital/Virtual Twins
- Model-Based System Engineering
- Test Manager (TM)
- Analysis Manager (AM)
- Test Strategy Manager (TSM)
IDT’s ATRT Enterprise Tool’s Tactical Value Proposition

• ATRT Enterprise identifies requirement & software faults earlier in the development & test process
  – By decomposing requirements in a mission-based context
  – By applying automated test and analysis
  – By leveraging massively parallel testing using virtualized systems

• ATRT optimizes a cloud-based enterprise digital ecosystem

CAPABILITY DEPLOYED TO WARFIGHTERS FASTER WITH FEWER DEFECTS
Cooperative Engineering of Systems

Key elements of physical system are captured as component abstractions & properties relevant to embedded software system analysis
Benefits of Architecture-centric Engineering

- **Reduce risks**
  - Analyze system early and throughout life cycle
  - Understand system wide impact
  - Validate assumptions across system

- **Increase confidence**
  - Validate models to complement integration testing
  - Validate model assumptions in operational system
  - Evolve system models in increasing fidelity

- **Reduce cost**
  - Fewer system integration problems
  - Fewer validation steps through use of validated generators
ATRT / AADL Model Based Testing

**Requirements**
- Functional
- Timing
- Scheduling
- Safety
- Security

**Artifacts**
- Full Architecture Model (HW & SW)
- Latency / Error Budgets
- Behavioral Use Cases
- Requirements Traceability
- Verification Steps

**Architecture Model**
- AADL
- Generated Code
- ARINC 653 Partition Schedules
- Network Configurations
- Relationships & Metadata from AADL (via API or Plug in Model)

**ATRT Strategy Manager**
- Test Planning
- Test Results
- Behavior Relationships
- Requirements Coverage

**ATRT Analysis Manager**
- Data Management
- Event Reconstruction
- Requirements Verification
- Performance Analysis

**System Under Test**

**Recorded Data**
IDT’s Analysis Manager supports automated test and analysis of multiple platforms including:

- AEGIS (IWS1)
- AEGIS BMD (MDA)
- SPY-6
- MQ-25
- CCS
- LCS SUW MP
- Link-16
- F-16
- F/A-18
- F-35
- Tomahawk
## IDT/SEI ATRT & AADL Summary

Characteristics that can be leveraged from AADL to ATRT elements

<table>
<thead>
<tr>
<th>AADL Feature/Property Implemented</th>
<th>Ph-I with Composite Model</th>
<th>Ph-II with Composite Model</th>
<th>Ph-II UAV Platform/Testbed</th>
</tr>
</thead>
<tbody>
<tr>
<td>End to End flow (of data, events, or both)</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Latency (between/through logical components, execution of threads)</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Modes attached to threads</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Communication bus bandwidth (worst case loads, scheduled loads)</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Power bus capacity (power)</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>System &amp; component weight</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Resource utilization of bound loads (memory, CPU)</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Error flow (ensure error types are handled/mitigated)</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Functional hazard analysis</td>
<td></td>
<td>X</td>
<td>X</td>
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<tr>
<td>Fault tree analysis</td>
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<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Security (confidentiality)</td>
<td></td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Data access &amp; Subprograms</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
ATRT/AADL Project as Demonstrated

• Verification of system requirements
  – SEI built an AADL model of a UAV system
  – Data collected by executing the simulated UAV system
  – Data verified / validated using ATRT tools
    • Analysis is performed by comparing collected data to the AADL Model

• Areas covered during the demo
  – AADL SUT model with three concurrent sensor threads
  – The HW/SW platform & testbed build out of AADL design
  – ATRT Analysis Manager applied to recorded data
  – ATRT TSM dashboard integrates automated test results with model relationships
IDT’s Partners and History

Six Patents Awarded

More than $280M Invested

More than 200 Active/Completed Projects
Including AEGIS, F-16, Minuteman III, F-35, AN/USQ.225, Tomahawk, FA-18, E-2D, SM-6, SM-2, MQ-25, JMPS, TFWC, Link-16, and AADL

No tool licensing fees for the government

Seven Active SBIR Phase III contracts
Questions & Discussion
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