

Basswood

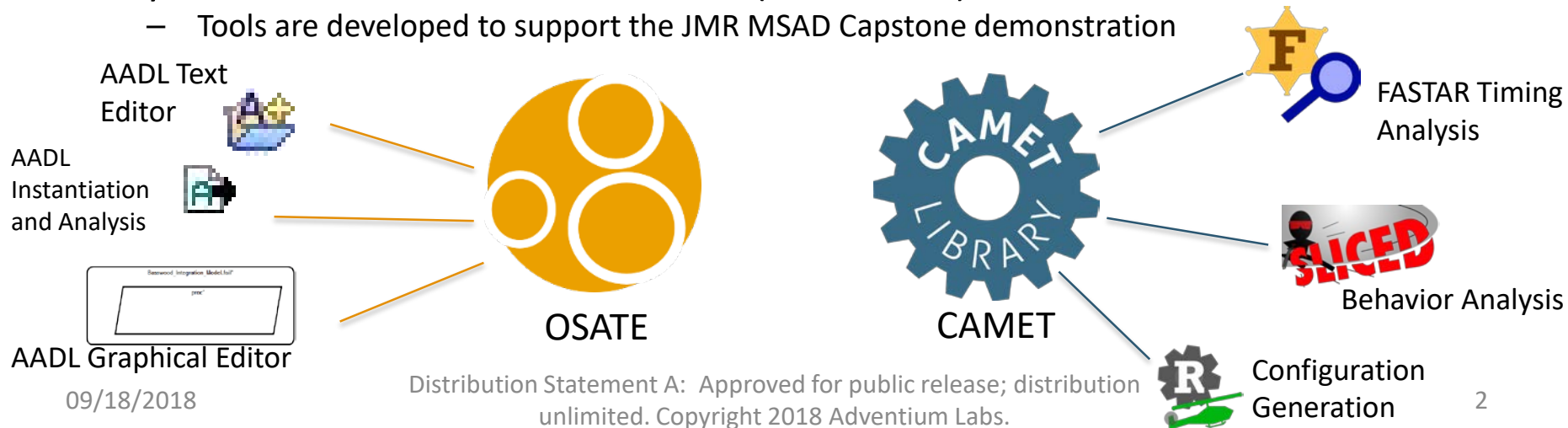
BALSA inspired real-time analysis and model based system engineering

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Who are we?

- **Adventium Labs**
 - Tyler Smith and Dr. Rob Edman
 - Adventium solves hard problems in cyber security, systems engineering, and automated reasoning.
 - Adventium is a member of the FACE Consortium and Adventium's Bruce Lewis is the chair of the AADL Standards Committee.
 - Authors of the AADL Annex for the FACE Technical Standard
- **Carnegie Mellon Software Engineering Institute (SEI)**
 - Joe Seibel
 - The SEI is a Federally Funded Research and Development Center (FFRDC).
 - The SEI develops the Open Source AADL Tool Environment (OSATE), a leading AADL development environment.
 - Creators of the FACE Data Model to AADL Translator
- **Work done in conjunction with U.S. Army AMRDEC Joint Multi-Role Mission System Architecture Demonstration (JMR MSAD)**
 - Tools are developed to support the JMR MSAD Capstone demonstration

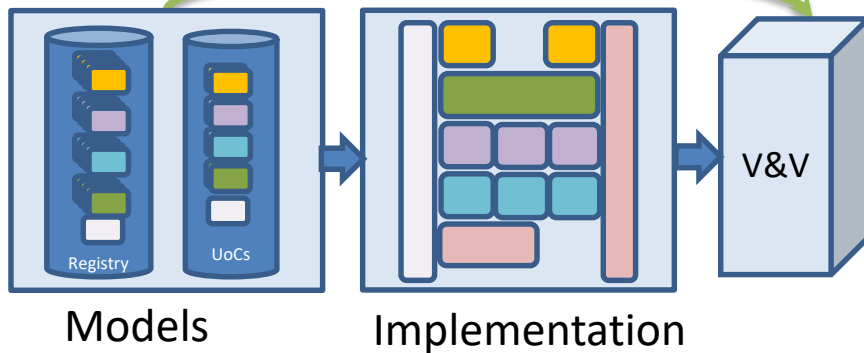


Basswood Demonstrates Virtual Integration

CONCEPT

Practical Demonstration of Virtual Integration

Virtual Integration Analysis



APPROACH

- Create an example for FACE users, to illustrate FACE aligned components running in a real-time environment with hard real-time constraints.
- Use model-based analysis to co-validate the Basswood implementation and Basswood models.
- Demonstrate application of free and low-cost model-based analysis tools.

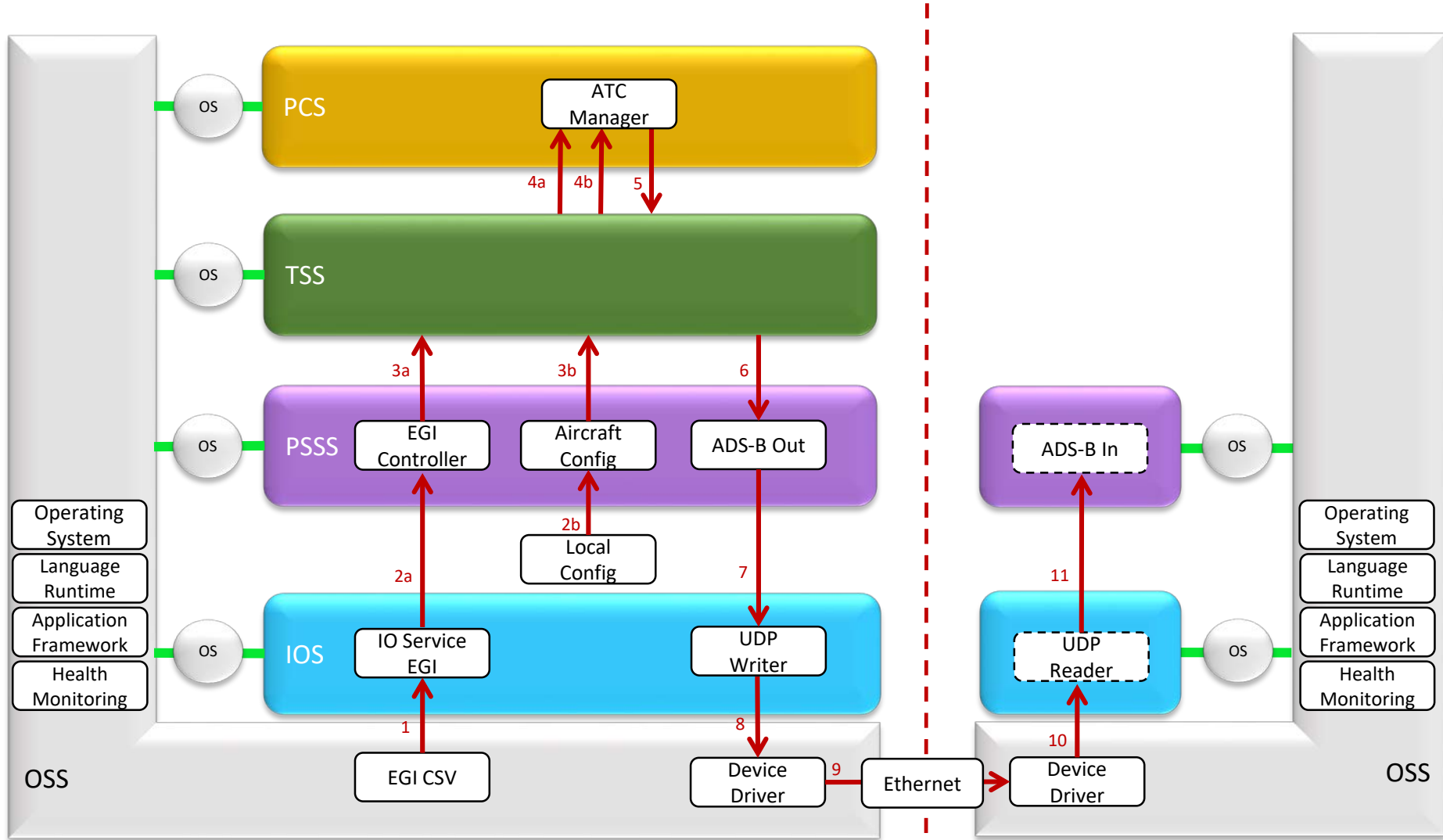
Impact

- Low barrier to entry by building tools around open environment and free/low cost tools.
- Align the FACE and AADL communities to foster virtual integration methods for FACE UoCs.
- Basswood demonstrates discovery of emergent timing behaviors using virtual integration.

Context

- The Basic Avionics Lightweight Source Archetype (BALSA) provides a collection of UoCs, backed by a FACE aligned Shared Data Model that run standard desktop environment.
- Real-time performance is a critical aspect of avionics computing.
- Virtual integration allows design-phase detection real-time defects such as missed deadlines and latency bounds.

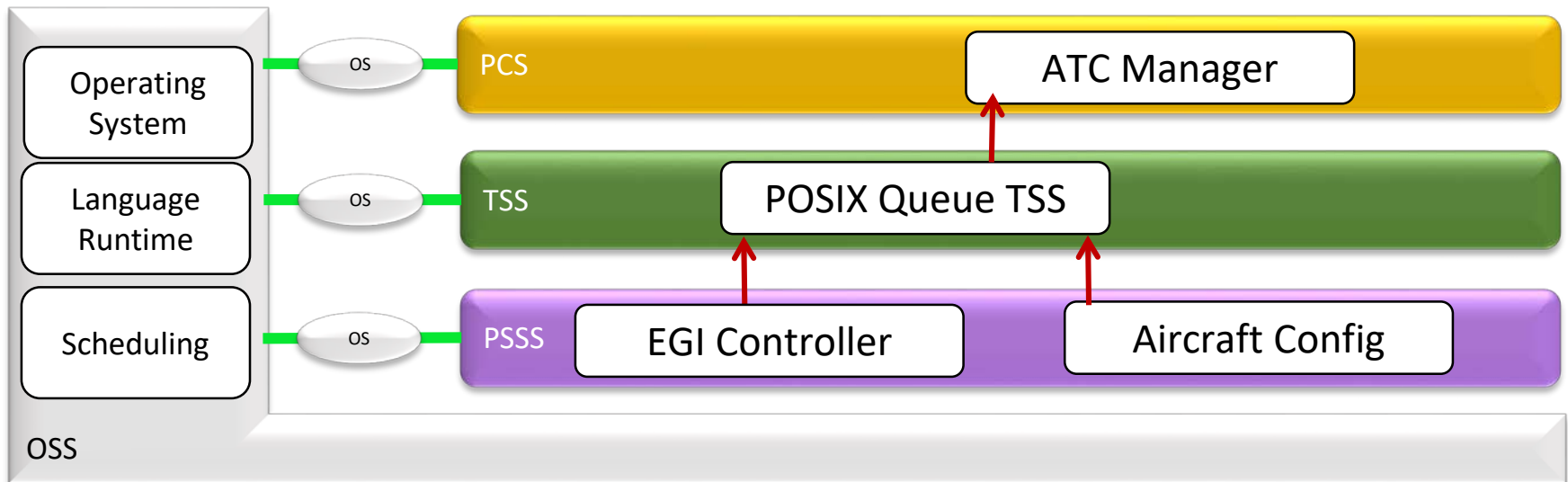
BALSA



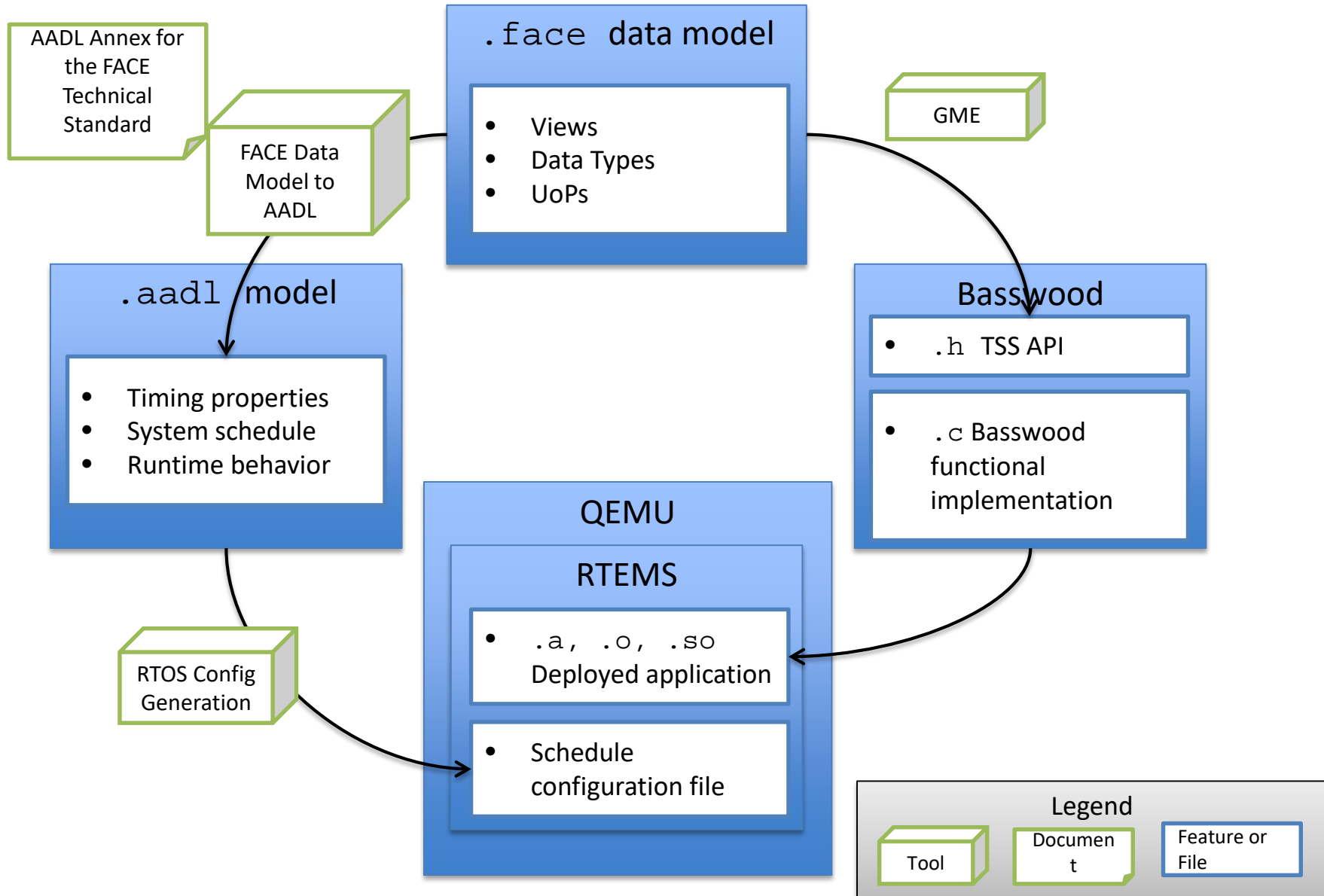
From the September, 2016 Pilot BITS Event

Basswood

- Basswood runs on Real-Time Executive for Multiprocessor Systems (RTEMS), an open source RTOS.
- Using real-time Fixed Priority Preemptive Scheduler
- Example of multiple UoCs sharing memory space
- Basswood exercises FACE C language bindings



Basswood Training



Architecture Analysis & Design Language (AADL) Use Cases

Availability & Reliability

- MTBF
- FMEA
- Hazard analysis

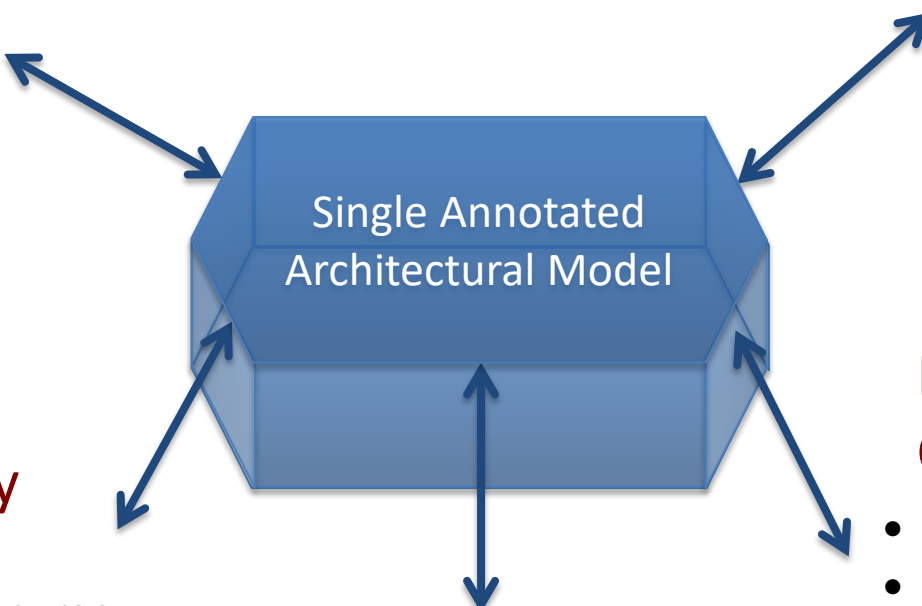
Security

- Intrusion
- Integrity
- Confidentiality

Data Quality

- Data precision/accuracy
- Temporal correctness
- Confidence

Single Annotated
Architectural Model



Real-time Performance

- Execution time/Deadline
- Deadlock/starvation
- Latency

Resource Consumption

- Bandwidth
- CPU time
- Power consumption
- Weight
- Heat production

From <http://www.aadl.info/aadl/currentsite>

Benefits

Consortium Contributions

- Basswood source code
- Getting started guide for AADL and the FACE Standard
- TIM Paper with additional details

No Cost Public Release

- Source Code & Documentation
- Sample AADL Models

Ecosystem contributions

- FACE Annex for AADL
- Open source translator
 - Supported by open analysis tools

Lessons Learned

- Object Constraint Language (OCL) is a precise way to interpret the standard
- Tool vendors have expectations for the standard
 - Meaningful example snippets
 - Example coverage
- Virtual integration detects system specific integration issues in real-time systems.
- Open discussion and early tool helps unify support across both commercial and open vendors.

Demonstration

- Basswood development virtual machine
 - VirtualBox Ubuntu VM
 - RTEMS development environment
 - Emulated execution with QEMU
- FACE Data Model to AADL Translator
 - BALS Data Model to AADL
 - AADL Graphical BALS Model
- Integrated AADL Analysis Lesson Six
 - Add schedulability properties to the Basswood model
 - Run FASTAR schedule analysis*
 - Demonstrate schedulability failure

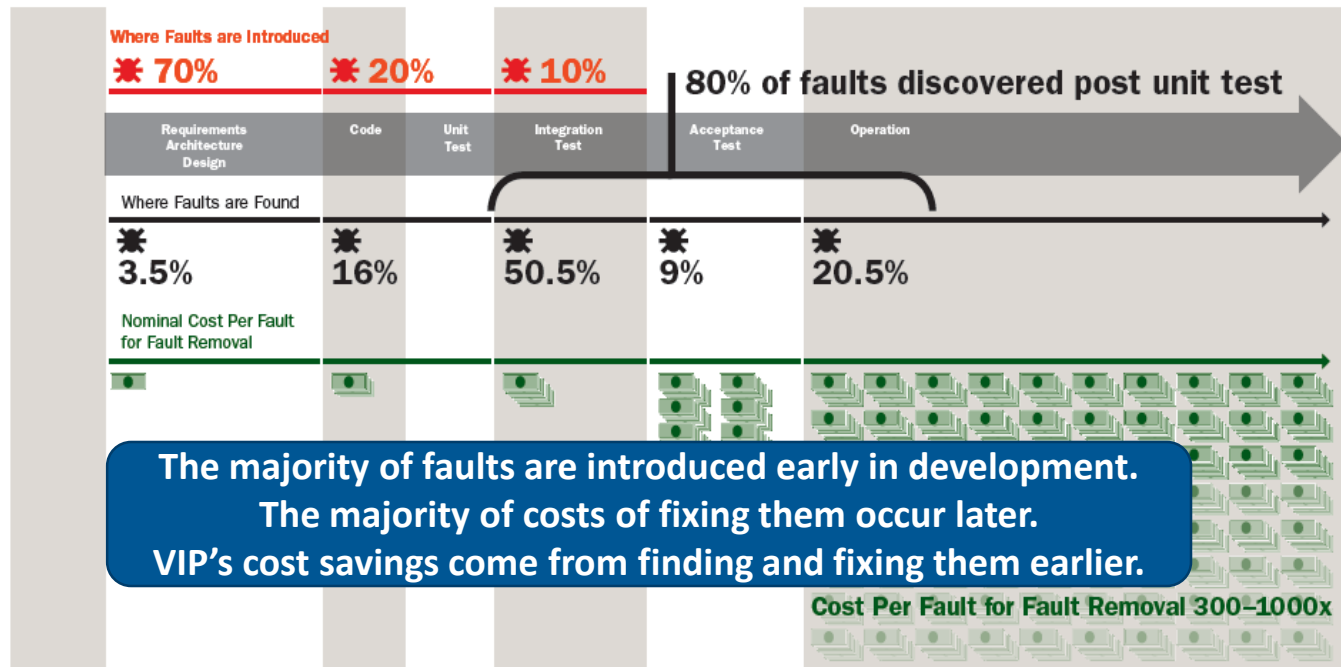
*Requires CAMET Sponsorship

To Learn More

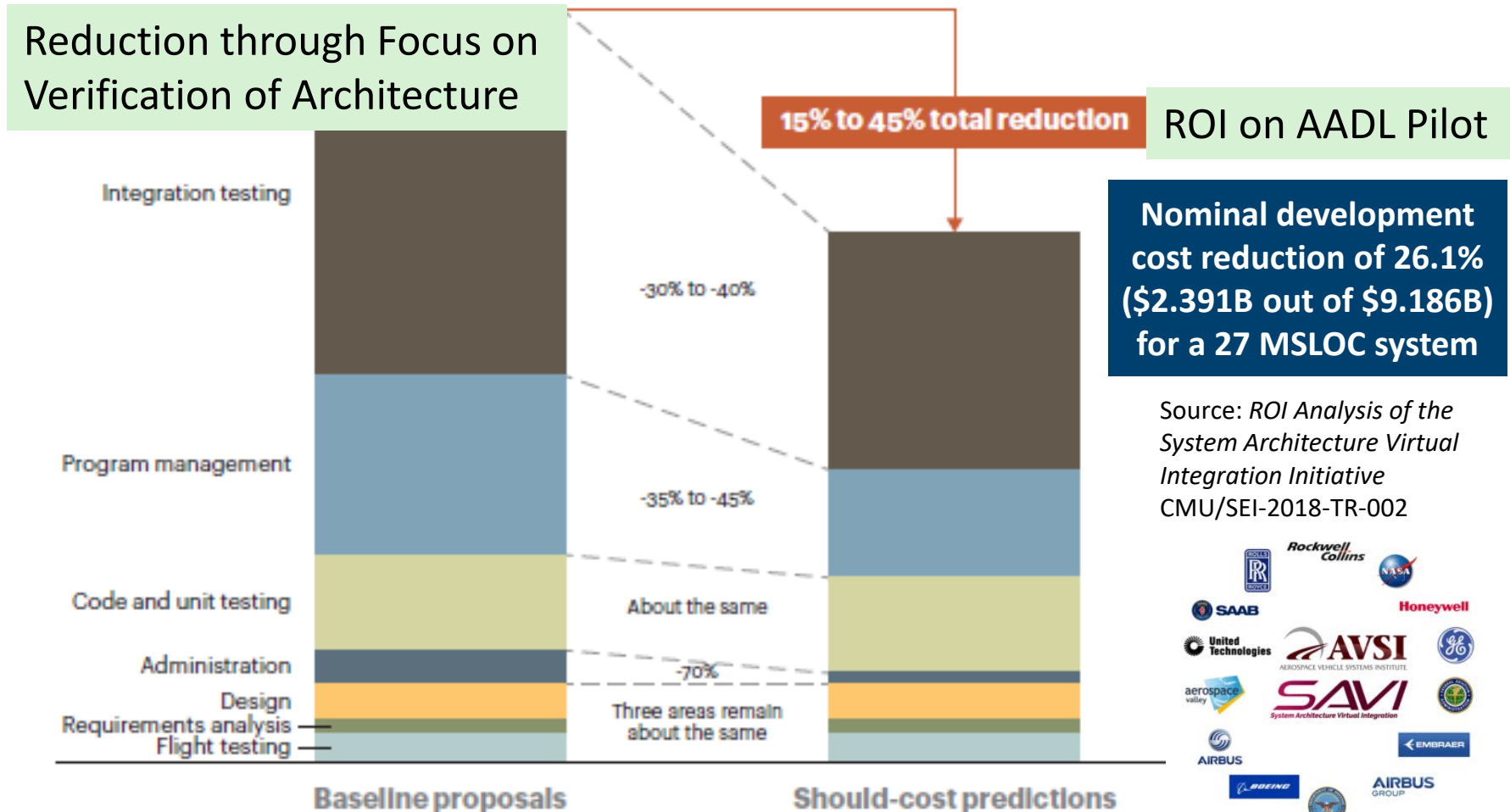
- adventiumlabs.com/camet/face
 - Download Basswood source code
 - Download Basswood-based tutorials
 - Review the AADL Annex for the FACE Technical Standard
 - Review the Introduction to AADL Analysis and Modeling with FACE Units of Conformance
- osate.org
 - Download OSATE
 - Install the FACE Data Model to AADL Translator

Backup

Finding and fixing faults early saves money



Cost Reduction Potential through Virtual Integration of Embedded Software Systems



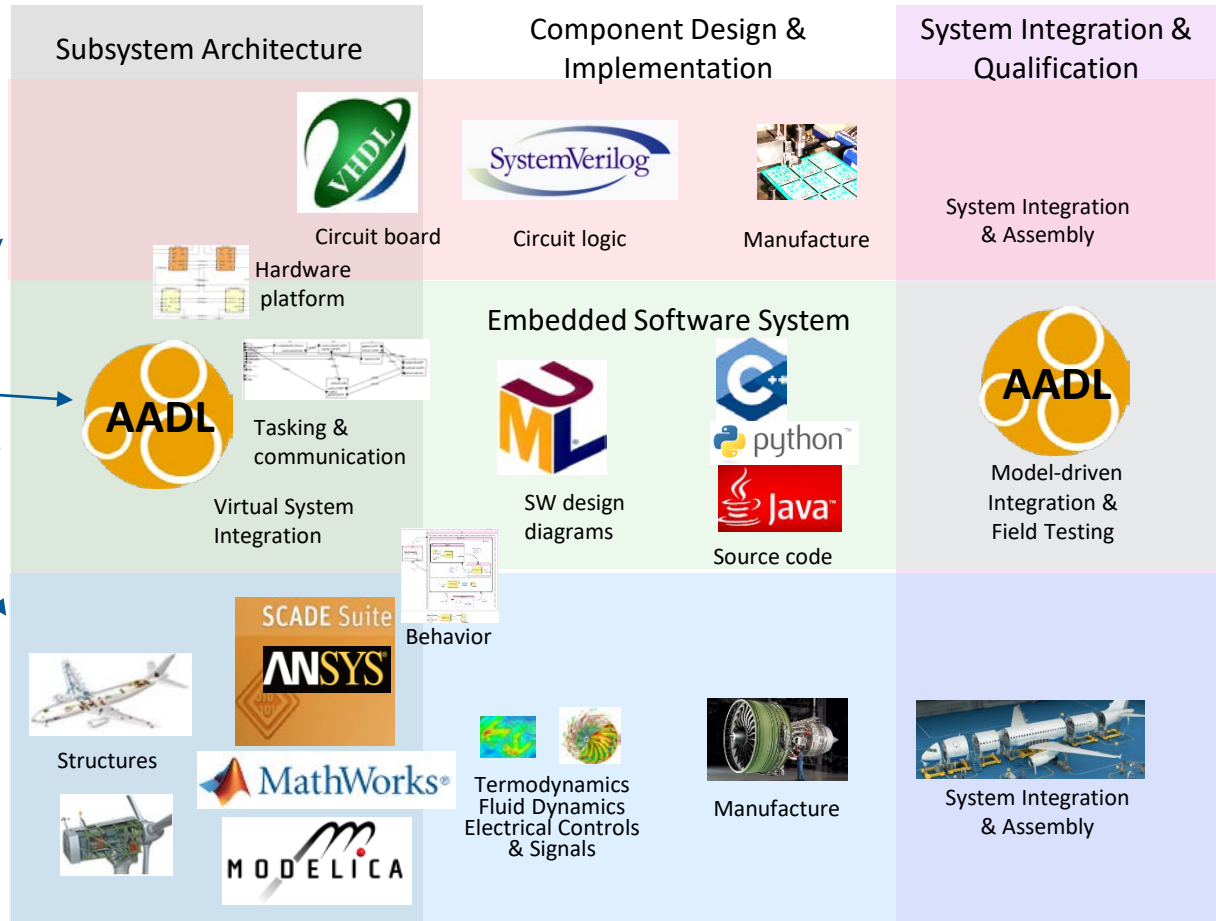
AT Kearney "Software: The Brains Behind U.S. Defense Systems"

Multiple Languages and Tools to Meet Users Needs

Mission System Requirements System Concepts & Functions

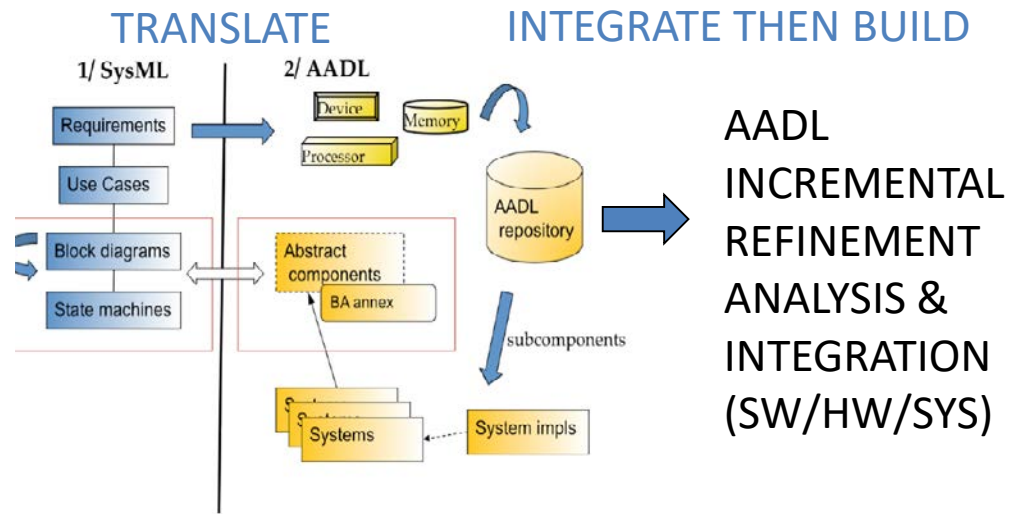
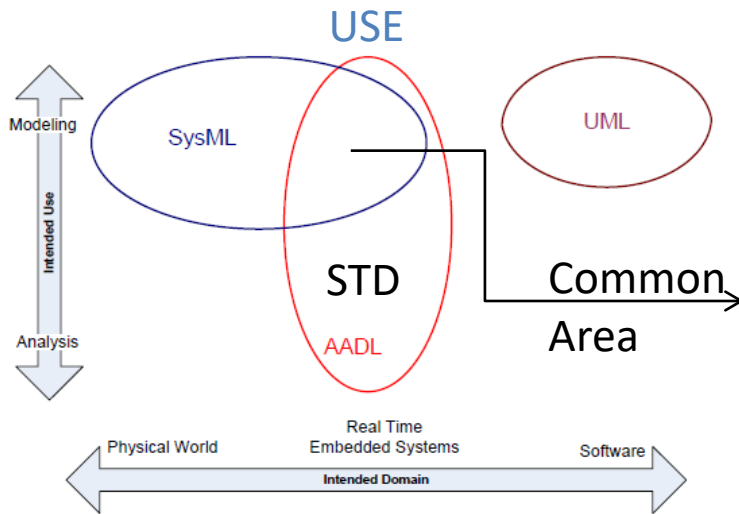


Computer Hardware
Embedded Software System
Physical System



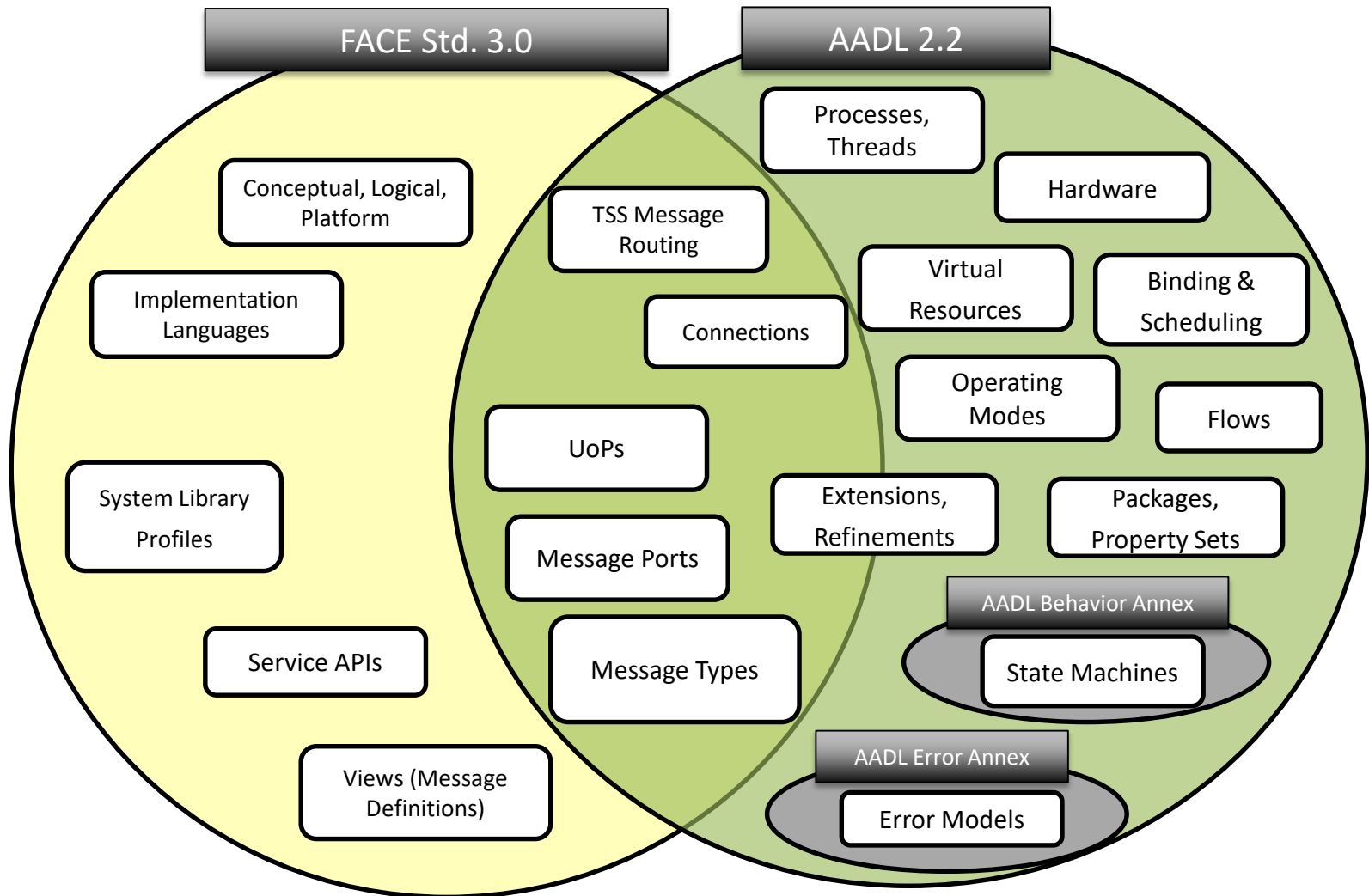
**Filling the Modeling and Analysis Gap
for Embedded Software System**

SysML & AADL Comparison



Modeling Language	UML	SysML	AADL
Standards Org	OMG	OMG	SAE International AS 5506
Purpose	Object Oriented Program Modeling	Larger Systems Modeling & Analysis	Embedded Software Systems Modeling & Analysis
Constructs/ Views	Class Diagram, Block Diagram, Sequence, Activity, State Machine	Use-Case, Block Diagrams, Internal Block Diagrams, Rqmts, Sequence, Activity, State Machine, Parametric	Real-Time Embedded Systems Components (Abstract, Processor, Memory, Bus, System, Threads...) State Machines (Modes, Behavior, Error) Flows, Bindings, connections
Practice / Methodology	Object Oriented	OOSEM	Virtual System Integration, ACVIP
Tools (Examples)	IBM Rhapsody, ANSYS SCADE, Sparx EA, NoMagic, MagicDraw, etc.	IBM Rhapsody, ANSYS SCADE, SPARX EA, NoMagic MagicDraw, Papyrus, etc.	OSATE, Adventium, ANSYS SCADE, ElliDiss, Dassault, WW Technology Group, IDT, POC
Practitioners	Commercialized	Commercialized	R&D platform, S&T, commercial tools available

FACE Standard and AADL Overlap



Adventium Projects and Tools using AADL

- AFFMAD Fault Management Analysis (NASA)
- AMCAT Simulation Verification (Army)
- CASPIAN Simulation Orchestration (Army)
- FASTAR Timing Analysis (Army)
- FASTAR Schedule Generation (Army)
- ISOSCELES Reference Architecture for Medical Devices (DHS)
- MILS Analysis (Army)
- RTOS Configuration Generation (Army)
- SLICED Behavior Analysis (Navy)



FASTAR Schedule Generation



ISOSCELES™

Safety • Security • Flexibility

Architecture-Centric Virtual System Integration with AADL

Investment Highlights

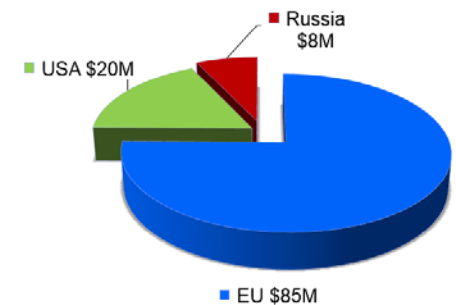
- SEI & AMRDEC SED long term strategy for maturing architecture-centric virtual system integration
- International commercial aerospace industry AVSI SAVI
- D-MILS Euro-MILS: Design of Secure Systems
- Multiple projects in DARPA META & HACMS programs
- NASA research by University Minnesota & Rockwell Collins
- 10+ Chinese patents based on papers written by others*

Spreading the Word

- 5000+ OSATE Downloads per release
- 53,000 separate visitors to AADL website
- AADL Book by Feiler/Gluch
- 20+ SEI blog posts, 40+ podcasts, 1 webinar
- 60+ SEI publications
- 1000+ publications by others

Workbenches

- OSATE: Open source by SEI
- AADL Inspector: commercial
- TASTE: European Space Agency
- MASIW: Russian aerospace
- ANSYS: Commercial Tool Suite



Army Pilot Projects with AADL

Common Avionics Architecture System (CAAS) 2004

- Modeling and analysis of reference architecture

Comparative study of 6 CAAS based helicopter systems 2007

- Single AADL model identifies commonalities and differences

Apache Block III Model-based Architecture Evaluation (ATAM) 2008

- AADL modeling during ATAM uncovers additional issues

ASSIP Real-time System State-of-the-Art 2009

- Virtual system integration as emerging technology

Virtual Upgrade Validation Method (VUV) 2010

- Codifies software system root cause areas

Apache Mission Processor Upgrade Study 2011

- Application of VUV method

Reliability Improvement Framework Study for Aviation Engineering Directorate 2011

- Four pillars of a qualification improvement strategy

Apache Flight Management System 2012

- Analyzed 3100 page requirement document with 7500 global Boolean flags

CH47-F Health Monitoring System Upgrade study 2012

- Pre-CDR discovery of system issues

AMRDEC JMR program 2014-2020

- Technology roadmap & ACVIP shadow project (FY14/15), MSAD (FY16/17), Capstone (FY18-19)

Acronyms

- **AADL**: Architecture Analysis & Design Language
- **AFFMAD**: Architecture Framework for Fault Management Assessment And Design
- **FASTAR**: Framework for Analysis of Schedulability, Timing, and Resources
- **IDE**: Integrated Development Environment
- **ISOSCELES**: Intrinsically Secure, Open, and Safe Cyber-physical Enabled, Life-critical Essential Services
- **RTEMS**: Real-Time Executive for Multiprocessor Systems
- **SLICED**: State Linked Interface Compliance Engine for Data
- **OSATE**: Open Source AADL Tool Environment
- **MILS**: Multiple Independent Levels of Security