System Architecture Virtual Integration (SAVI)
Overall Concept of Operations

- Design and production based on early and continuous integration (virtual => physical)
- Integrate, then build

Objective

- Shift architecting, design, and production activities to explicitly address integration issues early, reducing program execution risks, cycle time and cost

Approach

- Adopt/develop “integration-based” software and system development processes with emphasis on integrating component-based, model-based and proof-based development
Participants

- **Current**
  - Active – Airbus, BAE, Boeing, DoD (Army), FAA, GE Aerospace (Smiths), Lockheed Martin, Rockwell Collins, SEI/Carnegie Mellon
  - **Joining** – Dassault-Aviation, Honeywell, JPL/NASA

- **Potential**
  - **Current AVSI members** – DoD (Air Force), Goodrich, Hamilton Sundstrand (UTC) {Sikorsky, P&W}
  - **Potential new members** – General Dynamics, Meggitt, Northrup Grumman, Raytheon, Thales, Woodworth
Expanded Objectives

- Integrate system, software, and hardware integration models in one framework
  - Support component-based system assurance through analysis of functionality, performance, safety and security
  - Increase the degree of standardization and commonality for technical data exchanged between airframers, suppliers, and regulatory authorities

- Integrate – then build
  - Predict system behavior through analysis to ensure it is acceptable
  - Build to the requirements determined through the analysis

- Reduce the cost of developing avionic systems
  - Maintain or improve existing levels of safety and security

- Start with the aerospace industry
  - Leverage capabilities developed in related domains
  - Coordinate with related domains when advantageous

- Foster U.S. Government and Aerospace industry Cooperation
  - Complement the large, government/industry funded European R&D efforts
SoS and Systems are Composed Primarily of Components

- **Modules that Encapsulate Both Data and Functionality, and Are Configurable at Run-Time**
- **Requires accurate Modeling and Analysis of Properties, Relationships, Attributes, Associations, Interactions and Dependencies between Components**
  - Control, Data, Timing, Sequencing, Synchronization, Interrupts, Performance, Latency, Jitter, Safety, Security, Reliability, Resources, Fault Tolerance, and other Quality Factors
  - Composable, Reusable Software Modules
- **Requires Two Perspectives**
  - Independent of the context in which they are used
  - Dependent on the context in which they are used
- **Requires Component-Based Model Framework**
Expected Cost / Schedule Impacts

A/C architecture & tradeoffs
Systems specification
Systems design
Systems development
A/C integration
EIS

A/C architecture & tradeoffs
Systems specification
Systems design
Systems development
A/C integration
EIS

Aerospace Vehicle Systems Institute

Plus Production Cost Savings

xx% lead time reduction

xx% cost reduction
Modified Business Model

- System Integrator defines a new product using internal repository of virtual “parts”
- Specifications for virtual subcomponents sent to suppliers
Modified Business Model (continued)

- **Virtual parts returned for virtual integration into a virtual product**
  - *Cost savings realized by finding problems early on virtual parts*

- Once the virtual product is satisfactory, the actual product is developed
  - *Cycle-time reduction realized since re-work on physical parts virtually eliminated*
Single Information and Relationships Repository

Integrate information and relationships in a single repository with a “model bus”

- Better requirements
- Better integration
- Better communication
- Better consistency
Overview of Multi-Aspect Model Repository & Model Bus

Requirements

- Eclipse
- MatLab
- SimuLink
- Rhapsody
- Esterel
- AADL
- DOORS
- SysML

Verification

- OSATE
- SCADE
- TOPCASED
- ?

Design

Inteagation/Deployment

Aerospace Vehicle Systems Institute

Slide 10
Deliverables

- Component-Based Model Framework
  - Multi-Aspect Model Repository Definition
    - Framework for Description of Components
      - Rules for constructing and interconnecting components
      - Rules for property definitions supporting required (integration) analyses
  - Model Bus Definition for Consistent Model to Model Information Interchange

- Virtual Integration Analyses Definitions Catalog
- Parametric Process Definition for achieving Virtual Integration
  - Integrating Component-Based, Model-Based and Proof-Based Development

- Pilot Project(s) Results and Lessons Learned
Why AVSI?

Rapid technological advancement and obsolescence combined with increasingly complex hardware and software evolution present integration problems affecting all of us.

- *It’s not going to get better, it’s only going to get worse*
  - Boeing and Airbus have published data showing doubling of size and complexity every two years.
- *We can’t afford to solve it alone*
- *We can’t afford to solve it multiple times*
- *We can’t afford not to solve it*
Why AVSI?

- We need industry-wide, reusable solutions to be developed, maintained, evolved, and cost-effectively applied to multiple projects by a variety of users
  - Solutions require a combination of research and pragmatic experience (Industry & Academia)
  - Solutions require a balance between development and regulation (Industry & Government)
  - Solutions require broad buy-in (Industry & Standards)

- Partnership Is Only Viable Approach to the Common Problem
Multi-Aspect Models for Model-Centric Development

- Different models, modeling, simulation and analysis tools may be necessary for
  - Different properties
  - Different users
- Compatible modelling tools (open source or commercially available)
  - TOPCASED
  - AADL
  - MATLAB/Simulink
Work Packages (Notional)

WP0: Program Management
- WP1: Acquisition Model
- WP2: Analysis
- WP3: Requirements
- WP4: Language/Collaboration
- WP5: Initial Pilot Project
- WP6: Liaison to Tools and Standards
- WP7: Liaison with Certifying Authorities
- WP5: Final Pilot Project
- WP6: Liaison to Tools and Standards
- WP7: Liaison with Certifying Authorities

Aerospace Vehicle Systems Institute
August 7, 2007
Preliminary Work Products