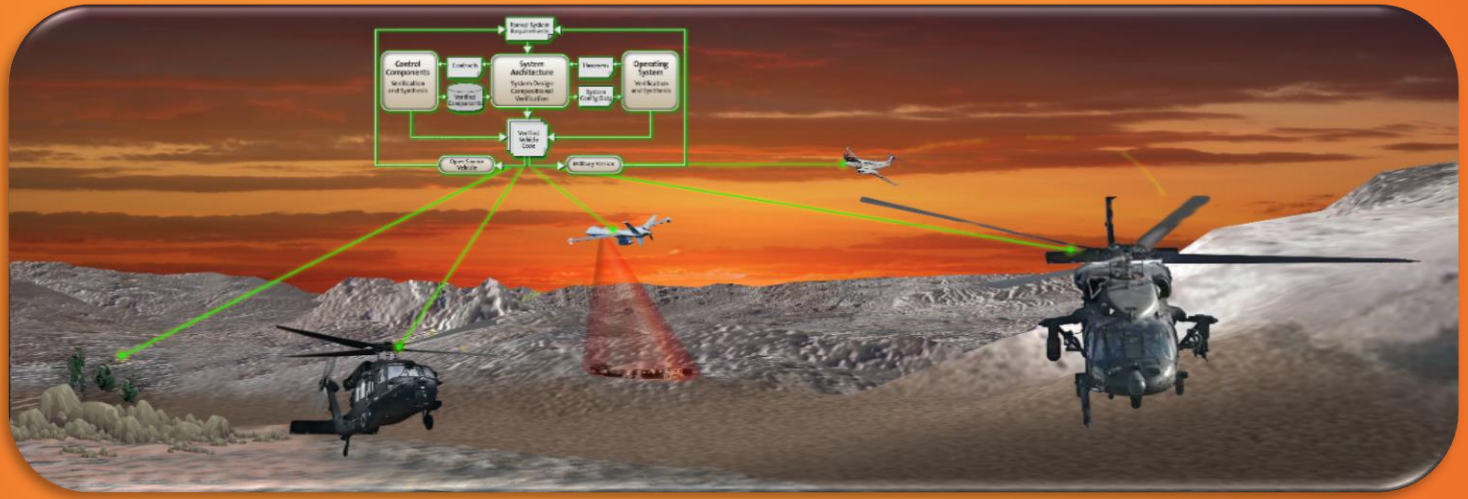


Model Based Systems Engineering with Architecture-Driven Assurance
NDIA Systems Engineering Conference

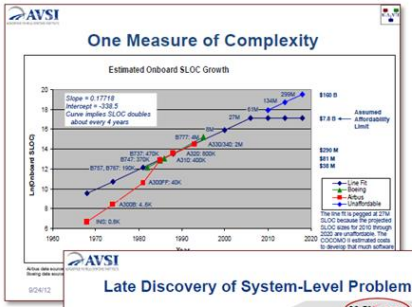
Dan Bliek – Principal Systems Engineer

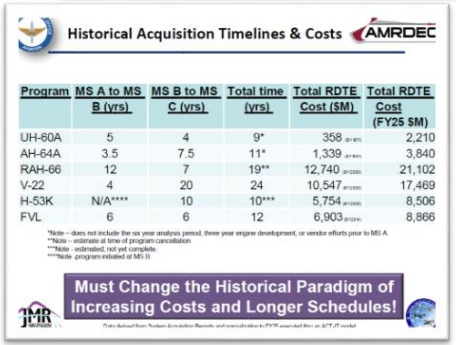
Rockwell Collins
Building trust every day

Introduction - Change Drivers

- System Size and Complexity Continue to Grow
- Late Discovery of System-Level Errors Cause Major Cost and Schedule Impacts
- Fielding Times Have Become Unacceptably Long
- Increased Emphasis On:
  - Operational flexibility and technical superiority with rapidly composable heterogeneous systems
  - Dramatic reductions in system fielding times
  - Increased focus on efficient integration and verification

New systems development challenges with familiar overarching theme: "Better, Faster, Cheaper"





Program	MS A to MS B (yrs)	MS B to MS C (yrs)	Total time (yrs)	Total RDTE Cost ($M)	Total RDTE Cost (FY25 $M)
UH-60A	5	4	9*	358	2,210
AH-64A	3.5	7.5	11*	1,339	3,840
RAH-66	12	7	19**	12,740	21,102
V-22	4	20	24	10,547	17,469
H-53K	N/A****	10	10***	5,754	8,506
FVL	6	6	12	6,903	8,866

*Note – does not include the six year analysis period, three year engine development, or vendor efforts prior to MS A
**Note – estimate at time of program cancellation
***Note - estimated, not yet complete.
****Note -program initiated at MS B

Rockwell Collins

Transformational Change To System Engineering Processes And Tools

- The Goal
  - Rapidly ensure functionally correct, verifiably safe, and cyber-resilent components and systems
- Architecture-Driven Assurance - Simple Definition
  - Representing system structure (architecture) and formally expressed system behaviors (requirements) in analyzable models
  - Enabling early virtual analysis and integration of systems
- Requires Tools That
  - Express system architecture using a semantically rich, precise and standard notation
  - Enable formally expressing and analyzing system behaviors
  - Allow formalized requirements to be attached to system hierarchy

Five Precepts of Architecture-Driven Assurance

- Provably Correct Requirements
  - Behavioral properties formally expressed and analyzable
  - Annotate system model components with assume/guarantee contracts
  - Compete, correct and necessary
- Architectural Model Is Correct
  - Identifies system components, interfaces and interactions
  - Ability to verify structural properties of the system
- Components Are Correct
  - Contracts are realizable (implementable)
  - Implementation verified with test cases auto-generated from contracts

Five Precepts of Architecture-Driven Assurance

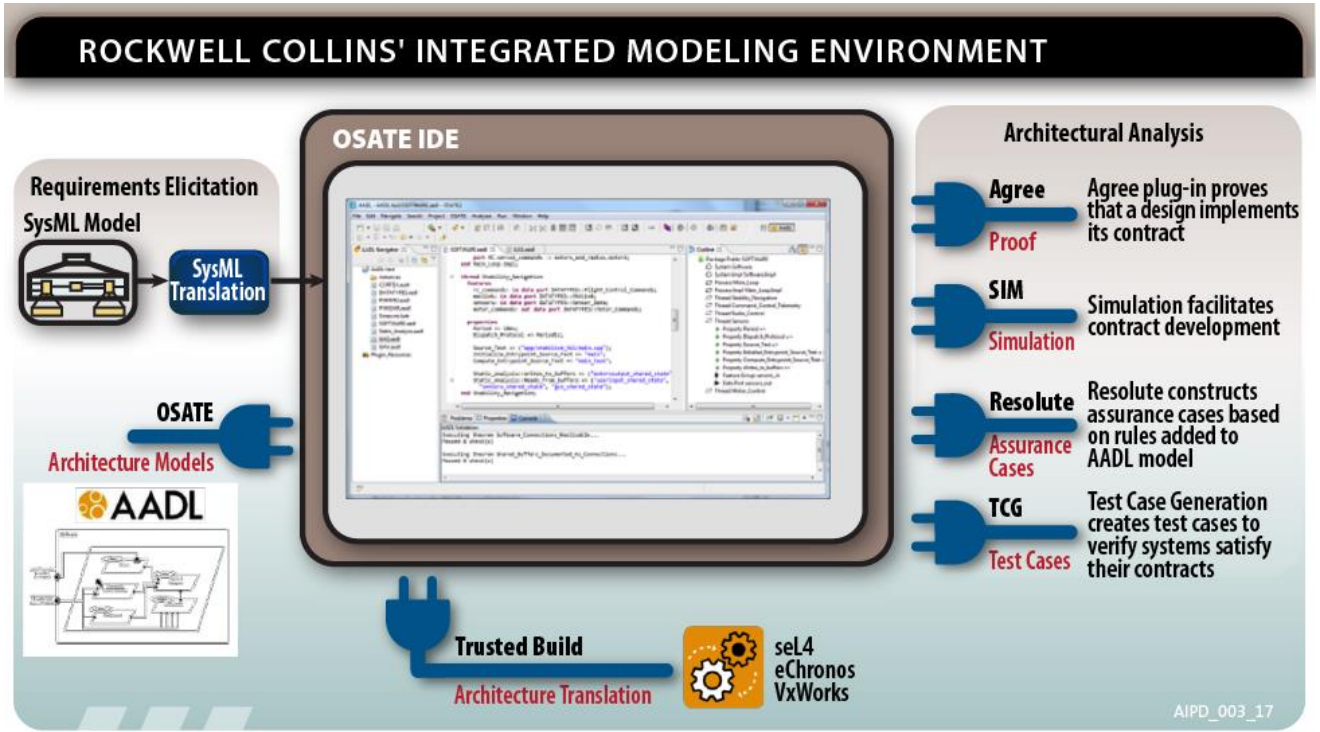
System Implementation Corresponds to the Model

- Build what you analyze
- Generate configuration data and code directly from the model

System Execution Conforms to the Model

- Operating system correctly enforces constructs defined by the architectural model
- Explicit constructs such as execution times, threads and schedules
- Implicit constructs such as no data flow unless explicitly specified

Tools for Architecture Modeling and Analysis



Benefits From Architecture-Driven Assurance

- Early Detection and Correction of Design Errors
  - Design time analysis with virtual integration
- Reduced Requirements Ambiguity with Early Validation
  - Formal expression and analysis of requirements
- Implementation Matches Architecture Models
  - Life-cycle cost savings; model retains value over time
- Hierarchical Models Separating the "What" from the "How" Via Contracts
  - Enabler for 3rd party integration, product-line approaches, and increased reuse
- Improved System/Product Life-Cycle Sustainment
  - Facilitate assessment of component replacement or technology insertions

Conclusions

- Technology Available Now
  - We have the technical capabilities to transform system engineering workflows
- Largest Impediments Are Environmental
  - Procurements based on models
  - Regulatory approvals
  - Inertia within industry to maintain status quo

Maintaining status quo for system engineering tools, methods and procurements will not support demands for increasingly complex systems with decreased fielding times.

Future Work

- Enhance and extend thru ongoing technology programs focused on:
  - Allowing systems engineers to design-in cyber-security throughout the development lifecycle
  - Model-based safety analysis to enable efficient verification and validation of complex safety-critical systems
  - Assurance of autonomous systems and behaviors

- Continue technology transition by applying methods and tools to relevant avionic systems

Questions?

- Contact Information:

Dan Bliek

Rockwell Collins

dan.bliek@rockwellcollins.com

(319) 295-8009

