

Research Review 2021

Collaboration Conversation Scalable Assurance of Safety-Critical Systems

Sholom Cohen, Jerome Hugues, Sam Procter
Moderated by SuZ Miller

Document Markings

Copyright 2021 Carnegie Mellon University.

This material is based upon work funded and supported by the Department of Defense under Contract No. FA8702-15-D-0002 with Carnegie Mellon University for the operation of the Software Engineering Institute, a federally funded research and development center.

The view, opinions, and/or findings contained in this material are those of the author(s) and should not be construed as an official Government position, policy, or decision, unless designated by other documentation.

NO WARRANTY. THIS CARNEGIE MELLON UNIVERSITY AND SOFTWARE ENGINEERING INSTITUTE MATERIAL IS FURNISHED ON AN "AS-IS" BASIS. CARNEGIE MELLON UNIVERSITY MAKES NO WARRANTIES OF ANY KIND, EITHER EXPRESSED OR IMPLIED, AS TO ANY MATTER INCLUDING, BUT NOT LIMITED TO, WARRANTY OF FITNESS FOR PURPOSE OR MERCHANTABILITY, EXCLUSIVITY, OR RESULTS OBTAINED FROM USE OF THE MATERIAL. CARNEGIE MELLON UNIVERSITY DOES NOT MAKE ANY WARRANTY OF ANY KIND WITH RESPECT TO FREEDOM FROM PATENT, TRADEMARK, OR COPYRIGHT INFRINGEMENT.

[DISTRIBUTION STATEMENT A] This material has been approved for public release and unlimited distribution. Please see Copyright notice for non-US Government use and distribution.

This material may be reproduced in its entirety, without modification, and freely distributed in written or electronic form without requesting formal permission. Permission is required for any other use. Requests for permission should be directed to the Software Engineering Institute at permission@sei.cmu.edu.

DM21-1007

Model-Based Engineering for Cyber-Physical Systems



Create the best design
that holds up over time
as the system evolves.



Test the design
without having to
write any code.



Build a single model to assess
hardware and embedded software
before the system is built.

SAE AADL / ACVIP

Standardized language and
process for the engineering
safety-critical systems.

OSATE

Open Source AADL toolset
for performing verification
and validation (V&V).

DoD Transitioning

Maturity increased through
pilot projects and trainings.

AADL Standard Suite (AS-5506 series)

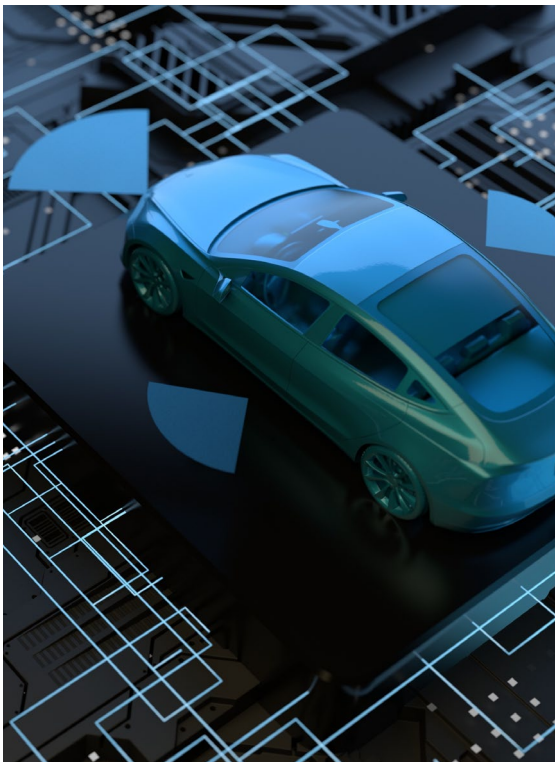
Core AADL language standard [v1 2004, v2 2012, ... **v2.3 2022Q1**]

- focused on *embedded system architecture: modeling, analysis, and generation*
- strongly typed language with well-defined semantics, rich property sets for capturing performance, safety, and security
- annexes: safety, avionics (ARINC653, FACE), behavior, code generation

AADLv2.3: minor revision to address new architecture needs

- patterns for multicore systems, updates to ARINC653
- clarification of semantics of threads (core), operation on errors (EMV2)

SAFIR: Assuring AI/Autonomous Cyber-Physical Systems



An autonomous car is both

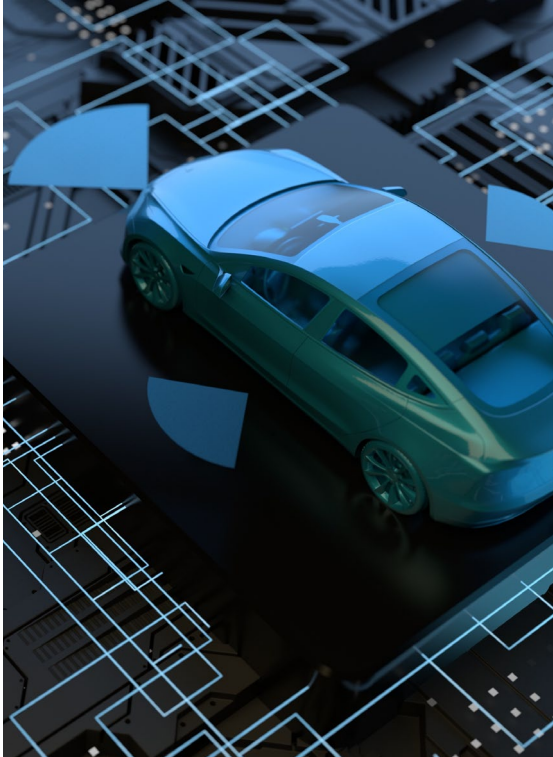
A car with CPUs inside
for navigation, engine control, etc.

A “car and its environment” inside CPUs
to make informed decision for driving, braking, etc.

How to assess system safety?

What is the contribution of architecture to AI safety?

SAFIR: Assuring AI/Autonomous Cyber-Physical Systems



context

This autonomous CPS is **safe** because

- It does reqs ; it is implemented by arch+code .
- V&V activities demonstrate strict conformance.
- It is operated **safely** and **hazards or threats** are monitored and mitigated by FDIR .

} Design
time

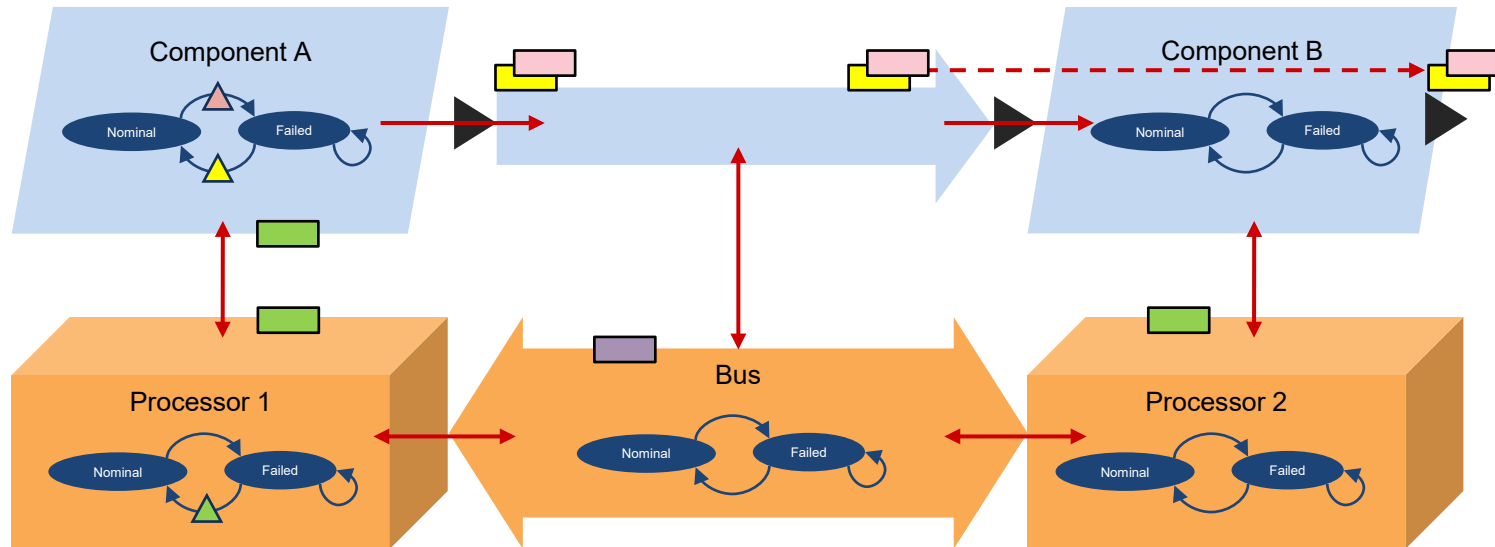
} Run
time

SAFIR is building a comprehensive approach to support both systems engineering and safety assessment processes *through*

- tool-support, architectural patterns at both model and runtime levels, new analysis capabilities, *and*
- an argument the above are self-consistent

Model-Based Systems Engineering & Safety

- **Core Idea:** Embed information where it's relevant
- Language features useful to variety of stakeholders
 - Used by tooling to automate common tasks / generate reports



Architecture Centric Virtual Integration Process (ACVIP) Research Objectives

- Integrate ACSVIP into MBSE across the lifecycle—emphasis on addressing risk to program goals (cost, schedule, performance).
- Emphasize modeling with analysis as the goal not “Architecture as Artwork” (Phil Zimmerman).
- Move modeling and analysis to the left.

Application of Modeling and Analysis

Example

Make tradeoffs

Reuse of proven modeling and analysis results

Refine specifications

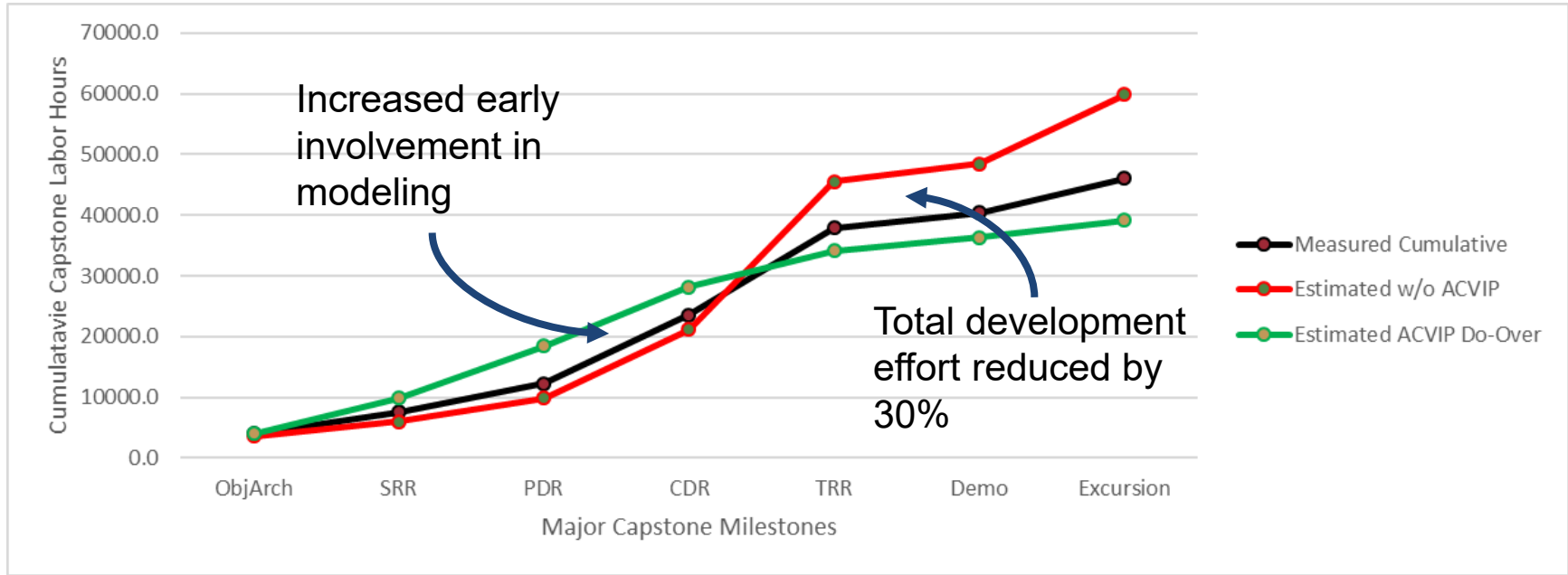
Scenario based acquisition support for specification refinement

Early discovery of defects

“Ubiquitous testing”

Effort Invested vs. Effort Saved During S&T

Apply research to transition from Science & Technology (S&T) to operation.



The Panel



SuZ Miller

Moderator, Principal Researcher



Sholom Cohen

Principal Engineer



Dr. Jérôme Hugues

Principal Investigator, Senior
Architecture Researcher



Dr. Sam Procter

Senior Architecture Researcher

Research Team



Dr. Jérôme Hugues
Principal Investigator,
Senior Architecture
Researcher



Dr. David Gluch
Software Architecture
Researcher



Dr. Aaron Greenhouse
Senior Architecture
Researcher



Keaton Hanna
Assistant Software Engineer



John Hudak
MTS, Principal Engineer



Dr. Sam Procter
Senior Architecture
Researcher



Dr. Chuck Weinstock
Principal Researcher



Lutz Wrage
Senior Member of the
Technical Staff