Powering Innovation That Drives Human Advancement

# Scade One Introduction

INCOSE SE Lab – Dec 2nd 2024

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# Ansys Embedded Software

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# Embedded Software Challenges

## ENGINEERING CHALLENGES

### *Create safe & reliable software*

Develop embedded software that complies with safety standards and regulations.

Create reliable software to reduce risks.

### *Reduce time to market*

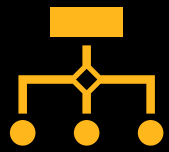
Develop with more agility, shorter cycles and supporting continuous integration / delivery (CI/CD).

Reduce validation time and cost.

### *Break down silos between engineering teams*

Better connect system engineering and software development teams, with a smooth workflow from requirements and system architecture to software implementation.

### *Embrace digital engineering*



Manage integration of various processes, tooled solutions, software/hardware components.

Ensure digital continuity.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# What is Ansys Embedded Software?

## The gold standard model-based solution for safety-critical embedded software

Ansys EMBEDDED SOFTWARE

- Develop safe and reliable embedded software
- Reduce your development time
- Secure your certification journey

## APPLICATIONS

### Embedded Control Software

Aerospace & Defense

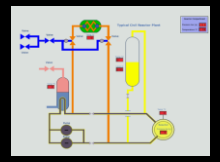
Rail

Automotive

Energy & industry

### Embedded Human Machine Interface (HMI) Software

Cockpit Displays

Industrial Controls 

Simulators & training

### Embedded Mission Software

Autonomy

ADAS

Mission Systems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# Why is Ansys Embedded Software the solution

## / RELIABLE

- Built from the ground-up for safety
- Produces safe, high-quality software aligned with the highest-level safety standards across industries

## / EFFICIENT

- Shift-left your development cycle
- Catch bugs early before they become expensive
- Supports agile and collaborative development

## / SEAMLESS

- System engineers and developers can jointly produce high-quality embedded applications
- Integrated in a comprehensive MBSE approach

## / OPEN

- Integrates easily into any HW/SW environment
- Open ecosystem integration / tool agnostic
- Rich APIs based on Python offer limitless extension capabilities

**2x**
TIME TO MARKET SPEED-UP

**50%**
REDUCTION IN DEV COST AND TIME

**200+**
EMBEDDED SYSTEMS CERTIFIED

**25+**
YEARS OF EXPERIENCE IN SAFETY CERTIFICATION


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# SCADE / The reference for Safety-critical Embedded Software

System & Software Requirements

System & SW Architecture

*Embedded Systems & Software Architecture*
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SCADE ARCHITECT

System Architecture

**System Safety Analysis**
Ansys
MEDINI

**System Simulation & Digital Twins**
Ansys AVXCELERATE *& driving simulators*
Ansys TWIN BUILDER

Auto Auto

SW Design

Prototyping & control laws

*Critical Embedded Control Software*
Ansys
SCADE SUITE

Auto

*Critical Embedded HMI Software*
Ansys
SCADE DISPLAY

SW Components / MiL / PiL / HiL

*Simulation*

*Test / MiL*

Auto Auto

*Certified Automatic Code Generation*

EN 50716 SIL 3/4 · DO-178C DAL A · ISO 26262 ASIL D · C code · IEC 61508 SIL 4

Auto

*Embedded Control & HMI Software Testing*
Ansys
SCADE TEST

*Platform Integration*
*RTOS & HW*
*Multi-rate / Multi-core*

System Level
Application | Application | Application
Task Management | Task Management | Task Management
System Services | System Services | System Services
Micro-kernel | Micro-kernel | Micro-kernel

HW
Core 0 | Core 1 | Core *n*

*Test / PiL / HiL*


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# Scade One overview

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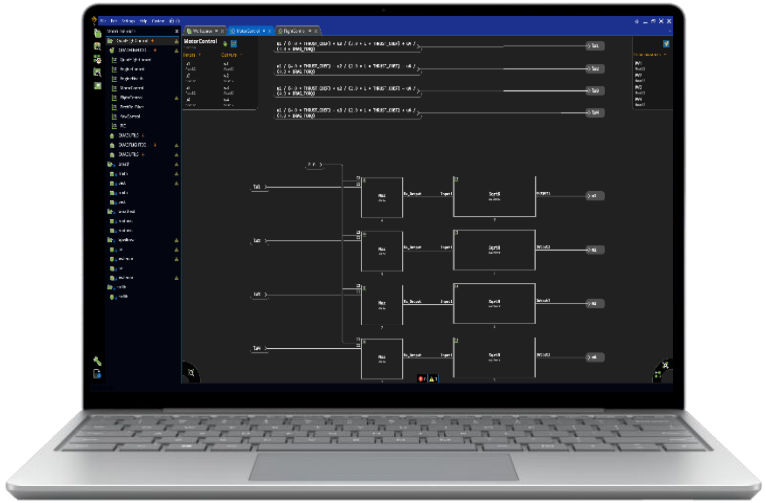
# Scade One / The next generation of SCADE

Ansys
SCADE ONE



## / A unified environment, for all activities

Design | Debug | Generate | Test | Integrate

## / A visual coding experience

Efficient modeling | Auto-layout | On-the-fly-checks | User assistance

## / Improved modeling and testing capabilities

Better scalability | Simpler handling of array/matrices | Tests as models

## / Democratizing model-based development

Scade One Essential , a dedicated offering for non-certified embedded software

## A Wider Scope of Applications!

**In Every Mission / Safety / Cost Critical Embedded System**

## … and many more innovations to come

Collaboration | Full V&V workflow | Qualification | Unified HMI/Logic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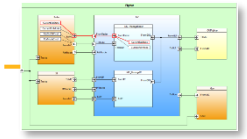
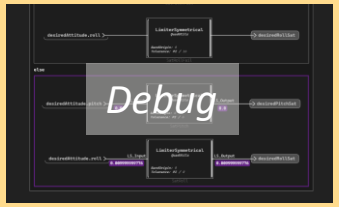
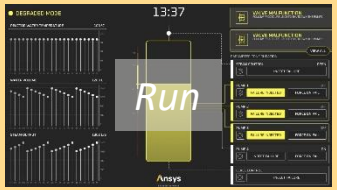
# A model-based development environment

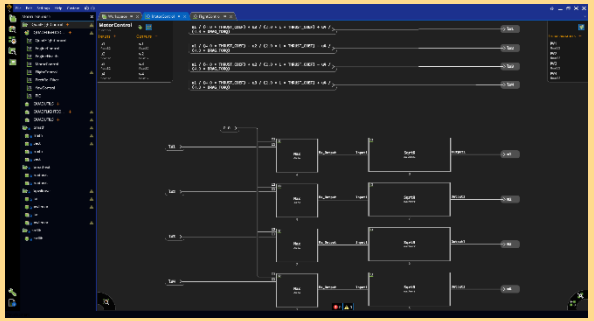
Ansys / SYSTEM ARCHITECTURE MODELER



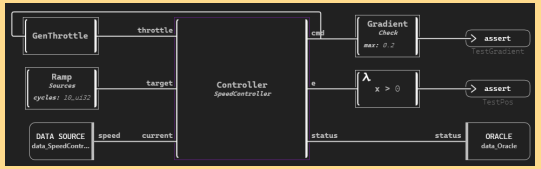
*System architecture*



*Design models*




*Manage test cases*

fmi

*System simulation*

Generate

Test

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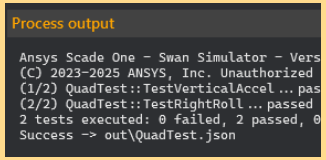
SCADE ONE



*Extend / Customize*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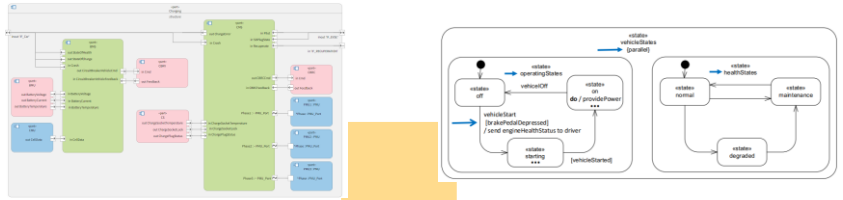
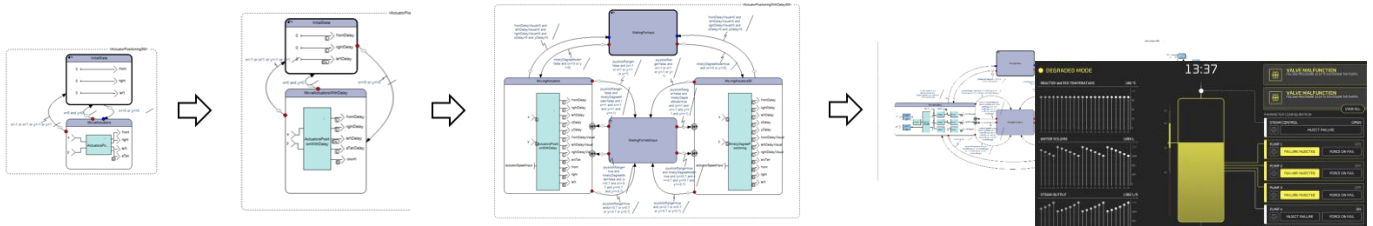
# Scade One for software prototyping

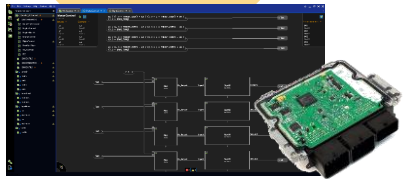
Ansys / SYSTEM ARCHITECTURE MODELER



*System architecture*



*Software models*



*Embedded software*

Ansys
SCADE ONE

*Software prototyping often consists in building **successive refinements**, of increasing complexity*

- Smooth transition from system to software
- Visual programming & debugging
- Graphical simulation panels
- Easily integrate in system-level simulation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# Packaging

**Scade One Essential**
*All-in-one*

**An all-in-one solution for software prototyping & non-certified embedded software development, from design to code generation**

**Scade One Studio**
*IDE*

**A complete Integrated Development Environment (IDE) for safety-critical embedded software, including advanced productivity features**

**Scade One Code Gen**
*Batch*

**Code generator, ready to be qualified and offering full configurability and traceability**

**Scade One V&V**
*Batch*

**Batch tools for V&V activities (test execution, coverage, test harness generation)**

**Scade One Cert Kit**
*Documents*

**Certification data for Code Gen and V&V tools**

\+

**PyScadeOne**
*API*

**Open-source Python APIs**

*Gray: feature planned for future release*


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# Modeling

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# Model-based development / Catch bugs early

## Perform most activities at model-level

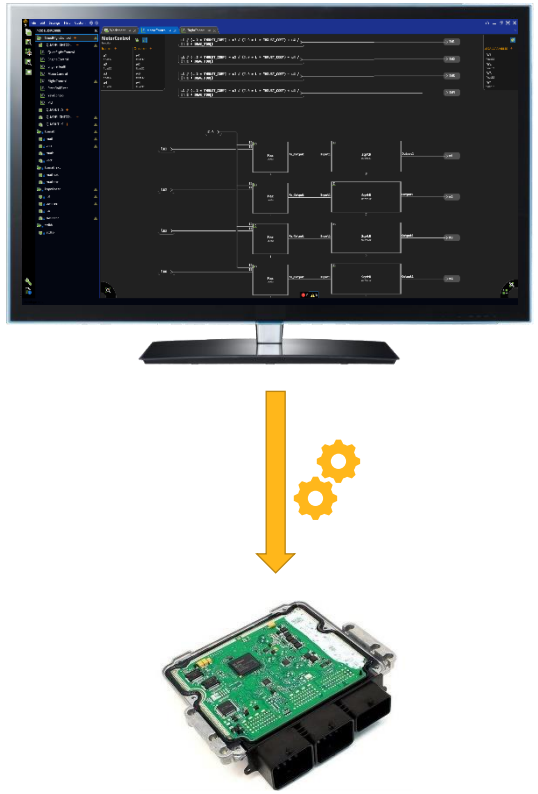
- Design *high-level* models, using a domain-specific programming language
- Debug, Testing, review on the model

## Generate code automatically

- With confidence that behavior on target is the same
- As efficient as hand-written code

## Reduce development cost and time

- Avoid late reworks of design and specification
- Reduce costly target verification activities

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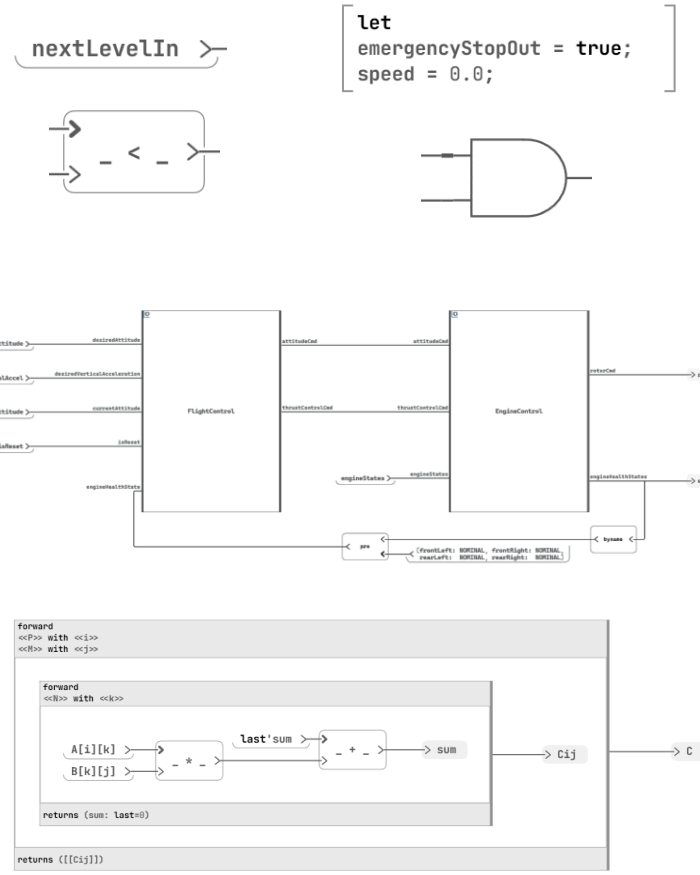
# Swan, a domain-specific language for control software

- **Easy to use for non-programmers** (control engineers, system engineers)
- **Well-defined** behavior Designed for **safe real-time embedded applicative software**
  - **Avoid pitfalls** of low-level, general-purpose programming languages like C
  - Guarantees properties *by construction*: **safe**, **deterministic**
  - No safe subset or modeling rules
- From **control software** to **more complex applications**
  - Manage data structures (arrays, structures, variants)
  - *Modularity*, *genericity*





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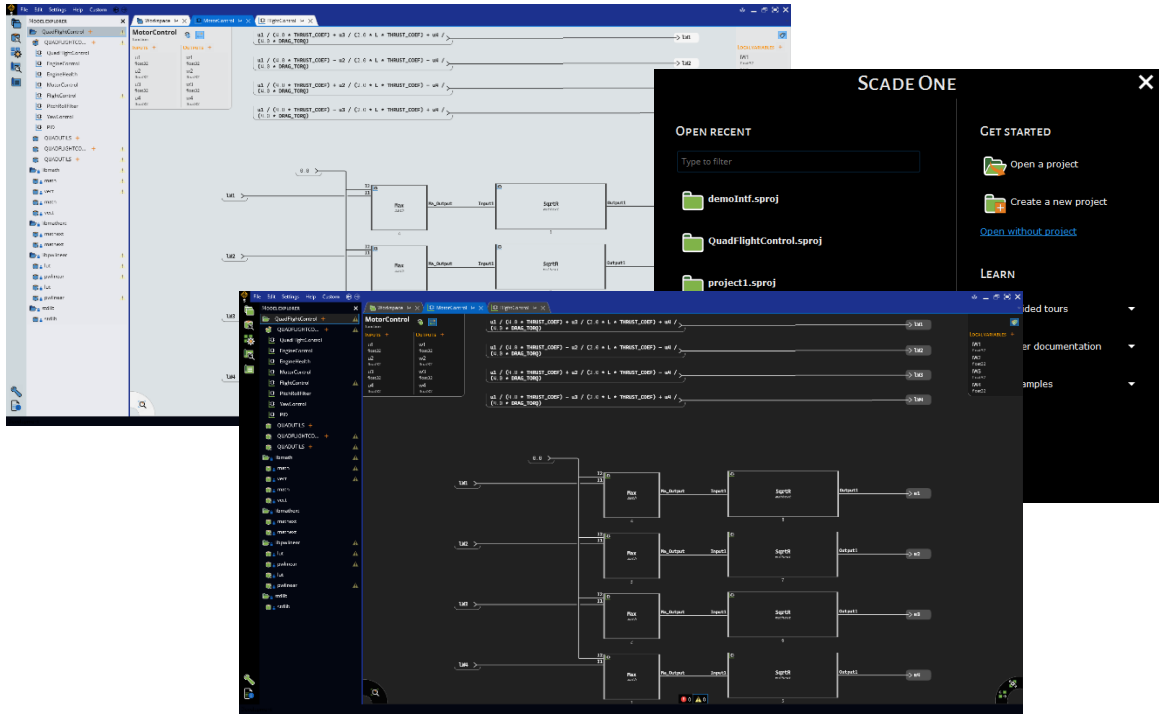
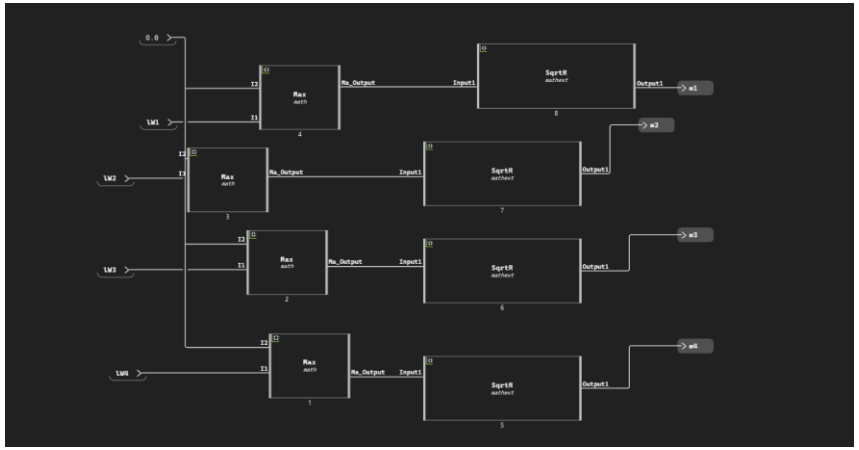
# Create models easily with a visual coding experience

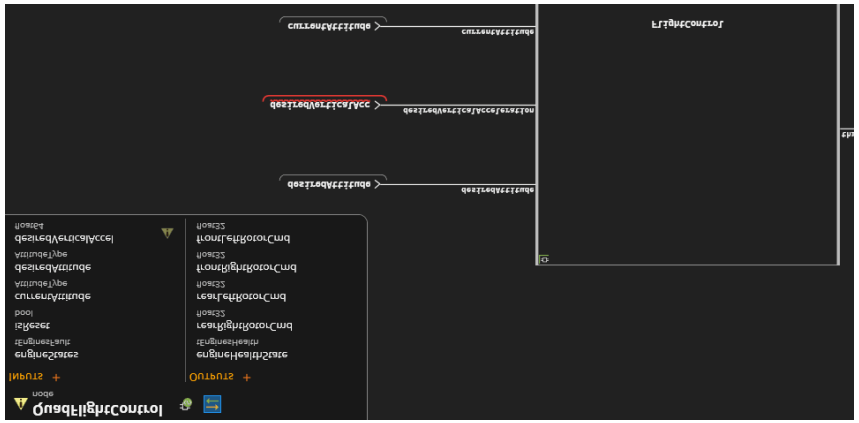



***Modern UI/UX***



***Efficient modeling***

*Smart guides, Auto-layout*



***Smart services***

*On-the-fly checks*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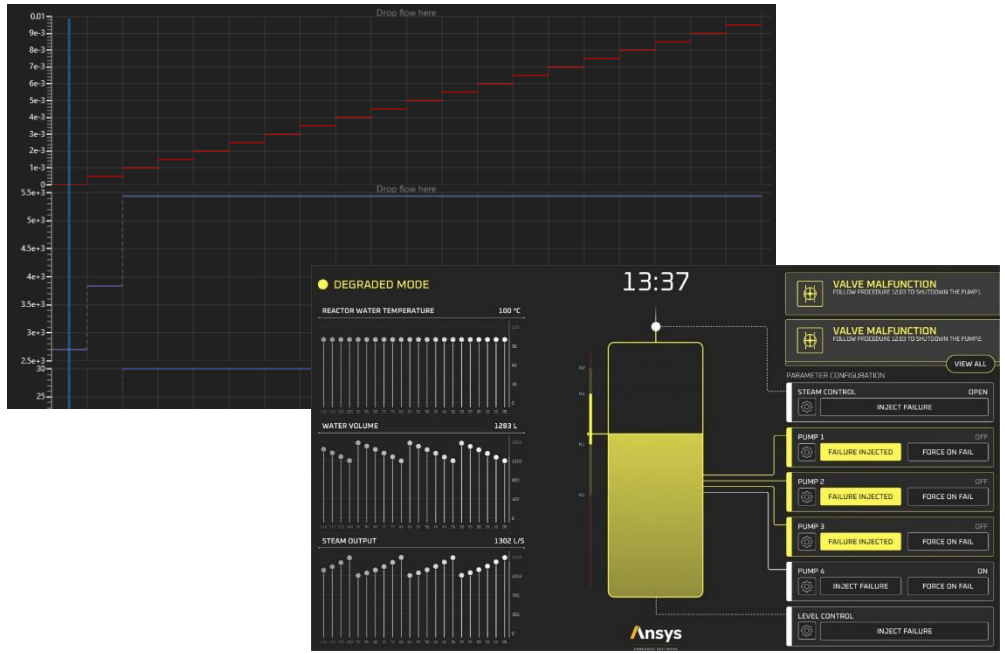
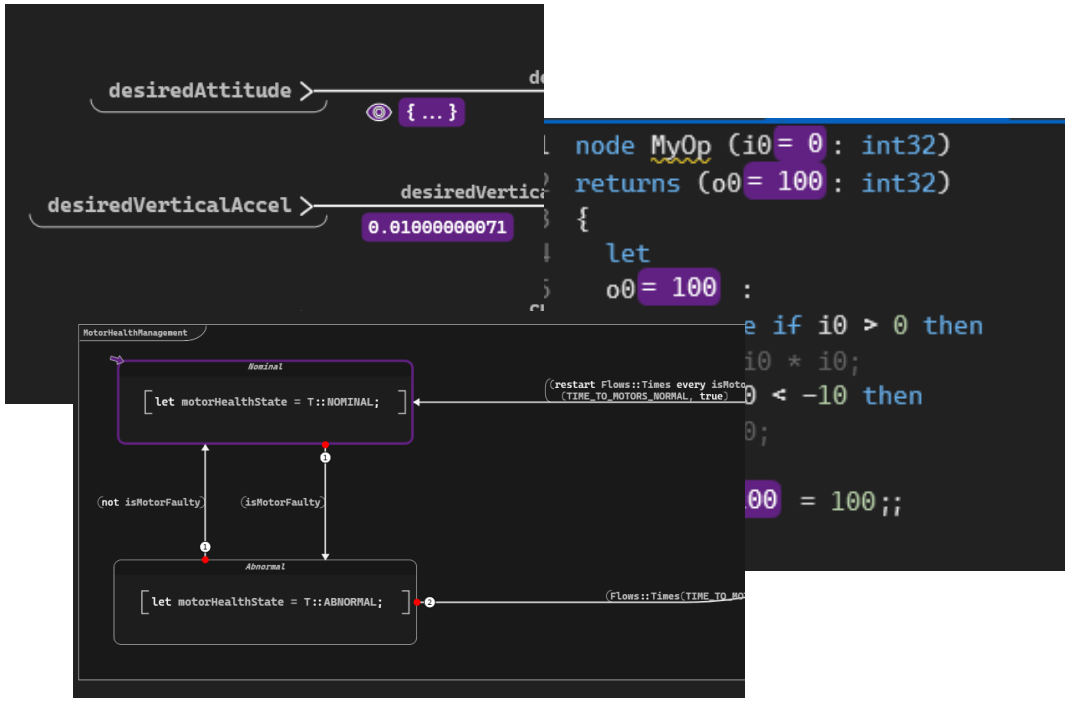
# Simulate models for quick feedback




## Run models

*Execute models and observe traces*
*Graphical panels*




## Debug models

*Observe any part of the model*
*Execute step-by-step*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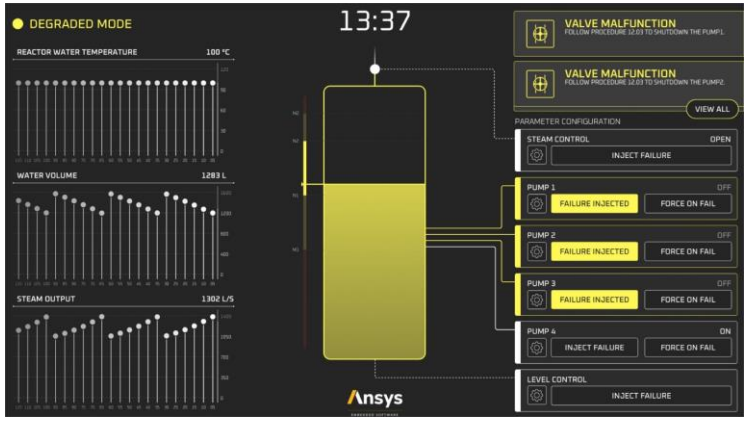
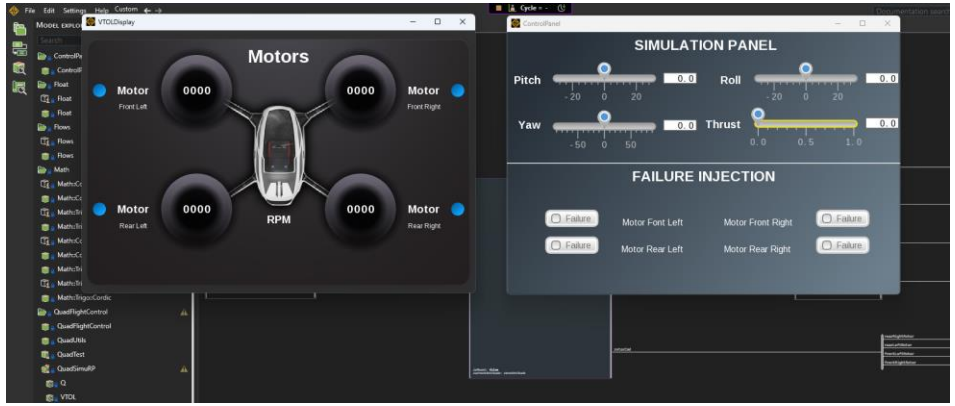
# Graphical simulation panels

- Easily create GUI panels from predefined & custom widgets for interactive simulation
  - Can be exported (FMI/FMU) for usage in simulation tools (e.g. Twin Builder, AVx, STK)

- Use cases
  - Interactive **simulation driver** GUI
    - Set inputs and visualize outputs
  - **Requirements/behavior validation** with stakeholders
    - Allows stakeholders to have an interactive simulation, without having to learn how to use a simulation tool
  - Customer product/system/application **demos**





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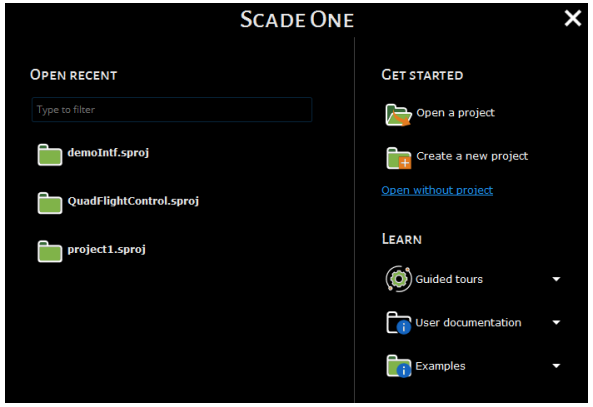
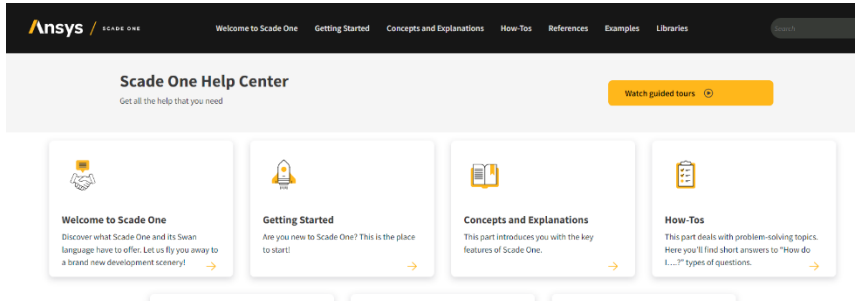
# Easy to use and learn



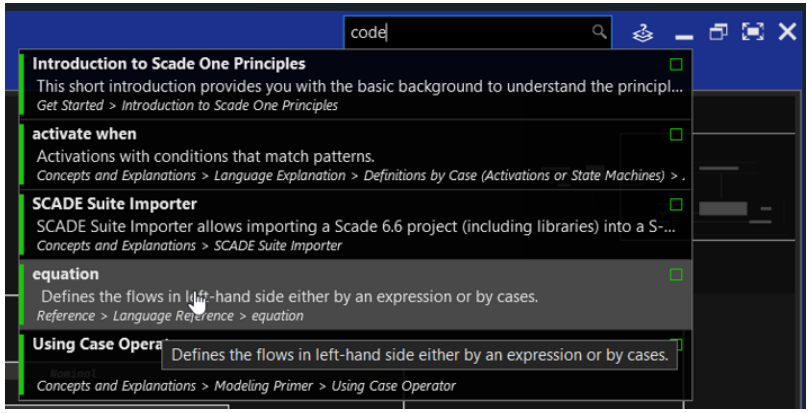

## Welcome page

*Quick access to getting started videos, examples and user documentation*

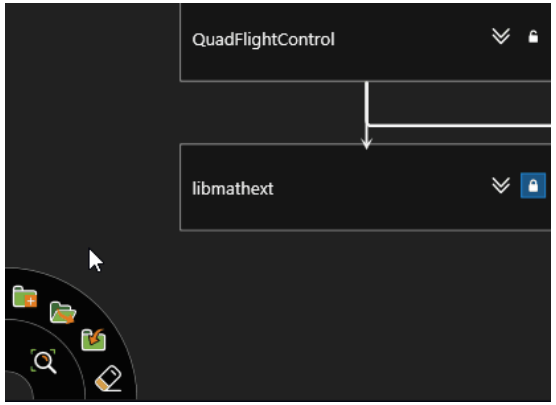



## User documentation

*Includes first steps with tool and language*




## Search bar




## Help overlay

*Quick access to UI documentation (F1)*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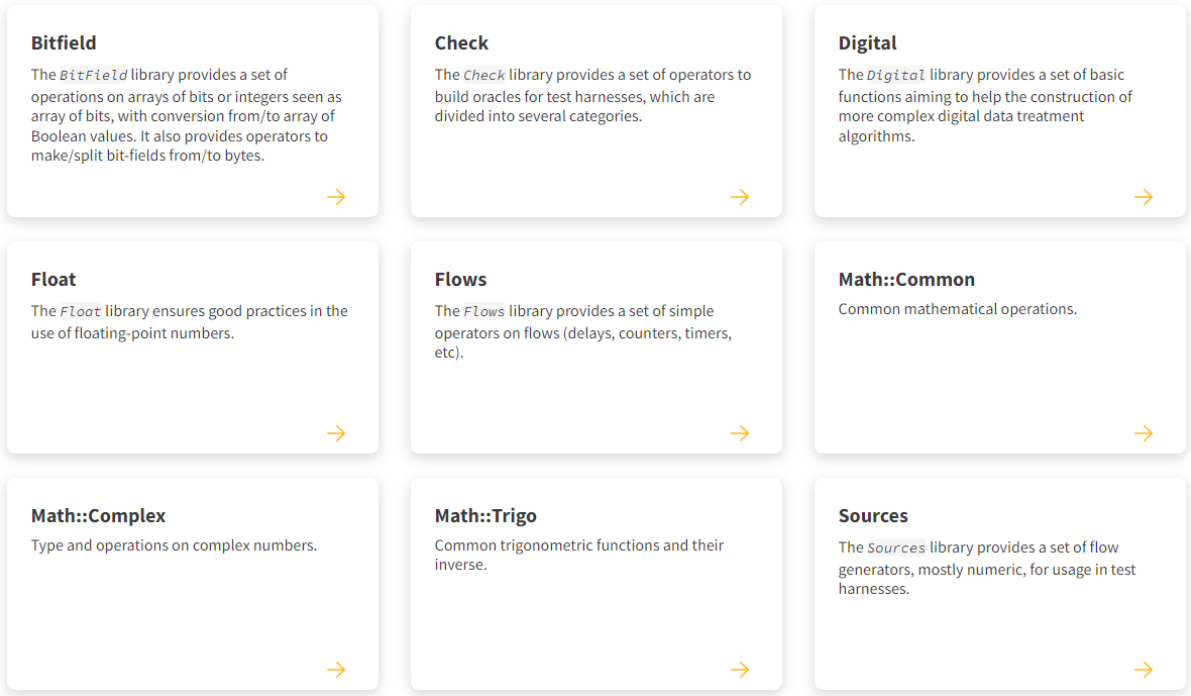
# Swan libraries as a starting point

- Scade One includes Swan libraries as a starting point for developing models
  - Common operators
  - Maths functions
  - Array/matrix operators
  - Sources and checks for tests
- Will keep being updated and extended in future versions





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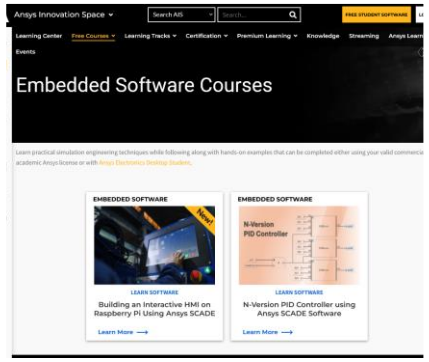
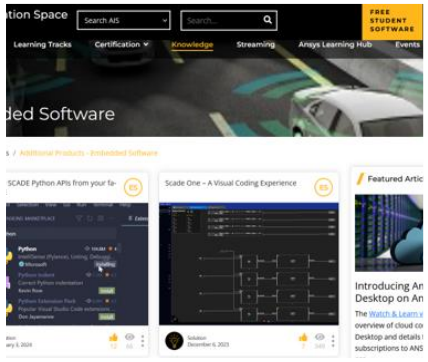
# Embedded Software Ecosystem - Fostering a Community



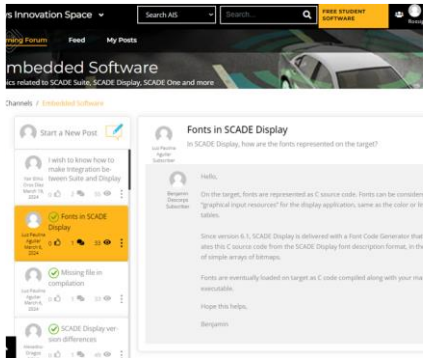

**Ansys Innovation Courses**

High-level courses with exercises



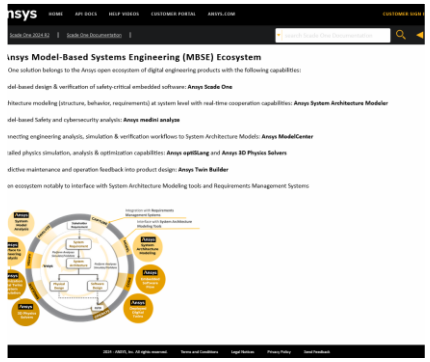

**Ansys Knowledge**

Technical blog articles




**Ansys Forum**

User Q&A community

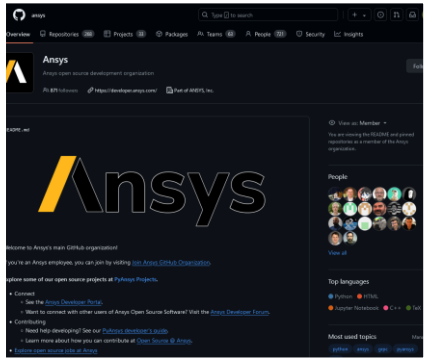



**Ansys Help**

Public user documentation

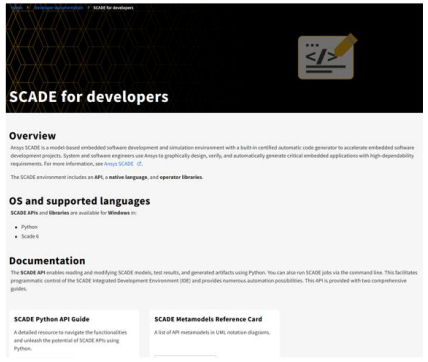
**Ansys Learning Hub**

Advanced trainings (paid)



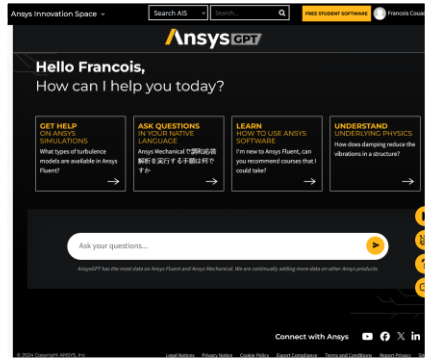

**Ansys GitHub**

Tools/utilities, examples, libraries




**Ansys Developer**

Developer-oriented docs (APIs, language, libraries)




**AnsysGPT**

"Chat with your docs" AI assistant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# Activities

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# Generate high-quality embedded code

## Safe

- Bounded memory and worst-execution time
- Complies with standards like MISRA
- Traceable to the input model

## Secure

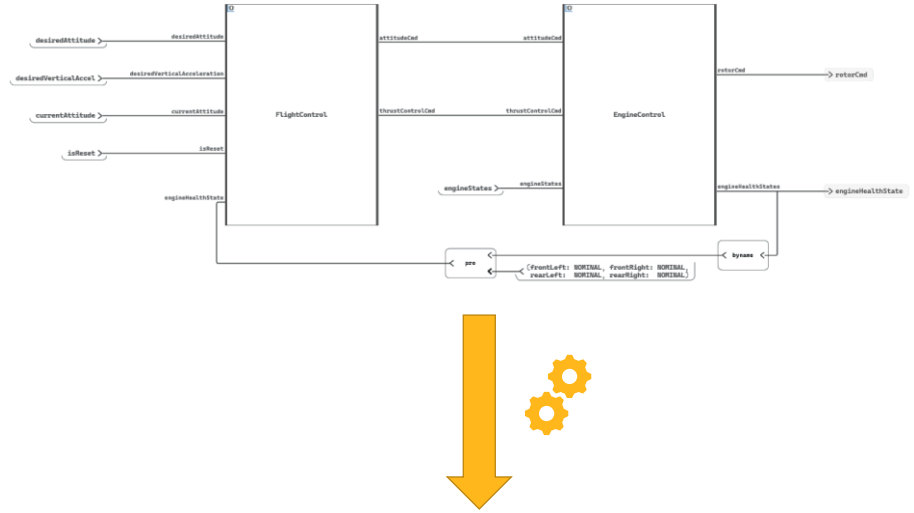
- Complies with CERT-C standard

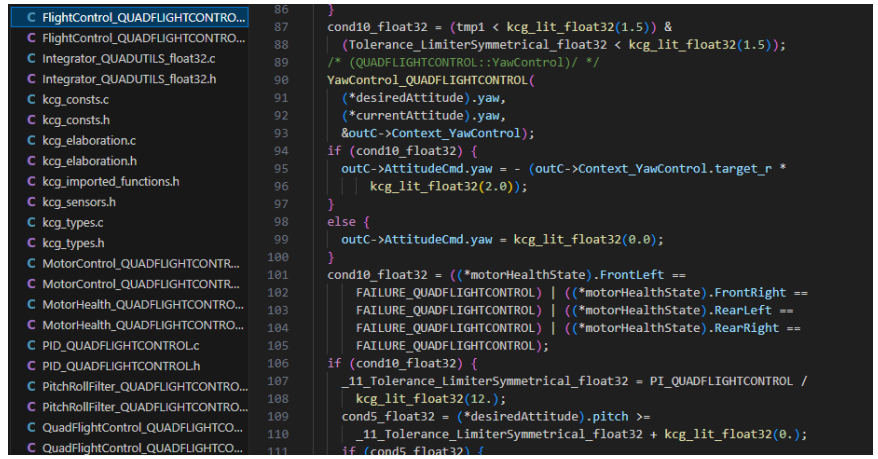
## Portable

- No external dependency
- Can be integrated in any environment

## Efficient

- As efficient as hand-written code





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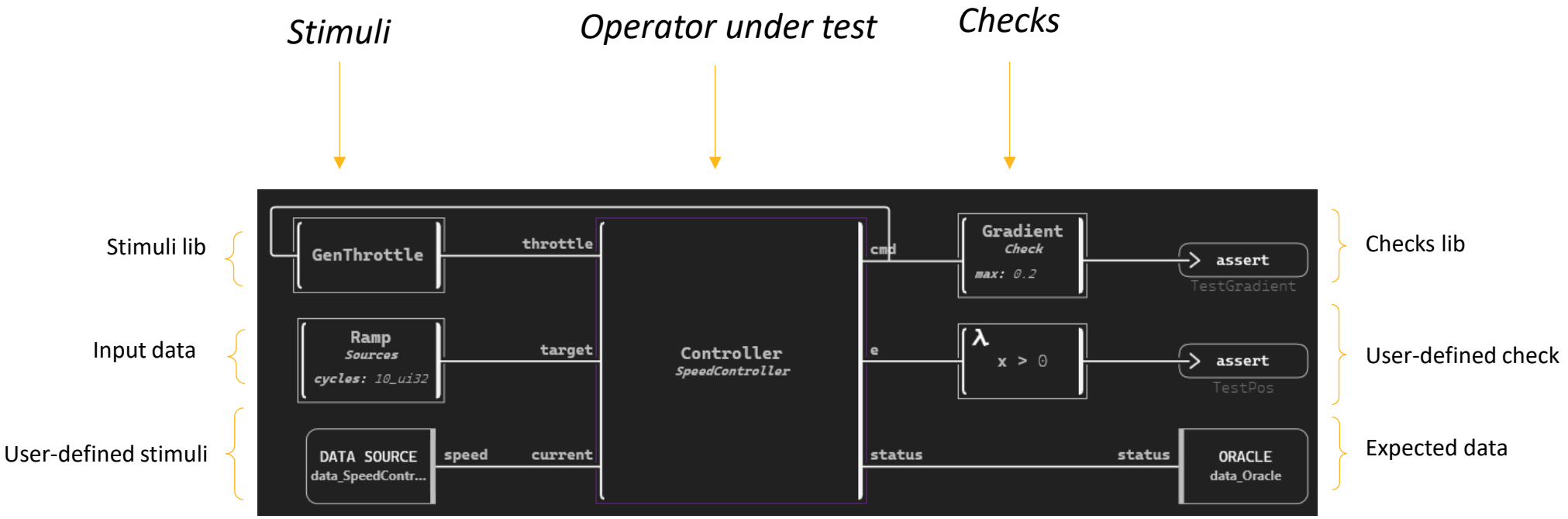
# Brand new approach for scenarios

A **test harness** describes stimuli and checks using a Scade One model

Used for run, debug and test





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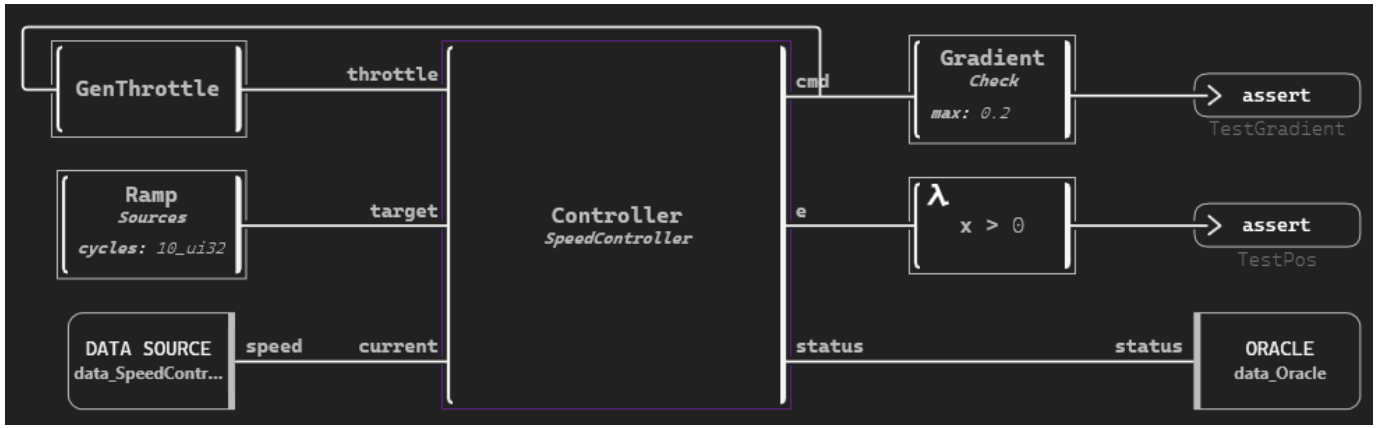
# Test workflow

*Stimuli*

*Checks*




***Create test harness for stimuli and checks***

Test report

Python library

```
Process output

Ansys Scade One - Swan Simulator - Version 2.2.0 - Build 076
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(1/2) QuadTest::TestVerticalAccel ... passed
(2/2) QuadTest::TestRightRoll ... passed
2 tests executed: 0 failed, 2 passed, 0 error
Success -> out\QuadTest.json
```

***Execute all test harnesses***


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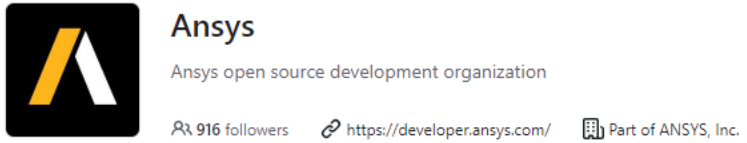
# PyScadeOne Python library

- A **unified library** for all scripting needs related to Scade One
  - Access all data created and generated by Scade One
  - Extend and customize Scade One
  - Integrate with Python ecosystem
    - NumPy, SciPy for numeric computing
    - Control Systems for control law design
    - Jupyter, Matplotlib for visualizing data and reporting
- **Developer-friendly**
  - Published freely online as Open-source
  - Can be easily deployed in any Python environment
  - Including user documentation and examples




*Ansys Github organization*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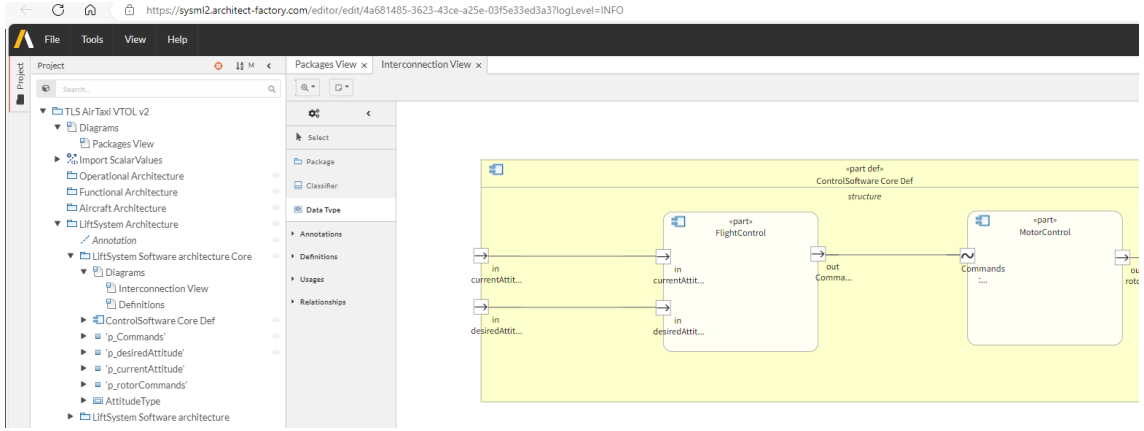
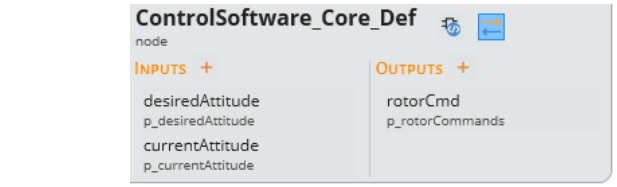
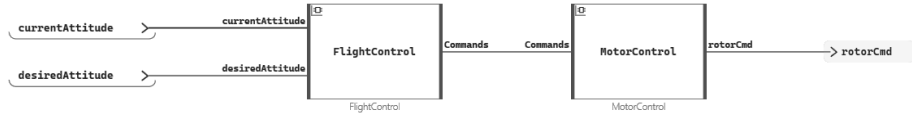
# From system to software




*System Architecture with*
***Ansys System Architecture Modeler***

***Reuse** parts of model*




*Software Prototyping & Implementation with*
***Ansys Scade One***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# Roadmap

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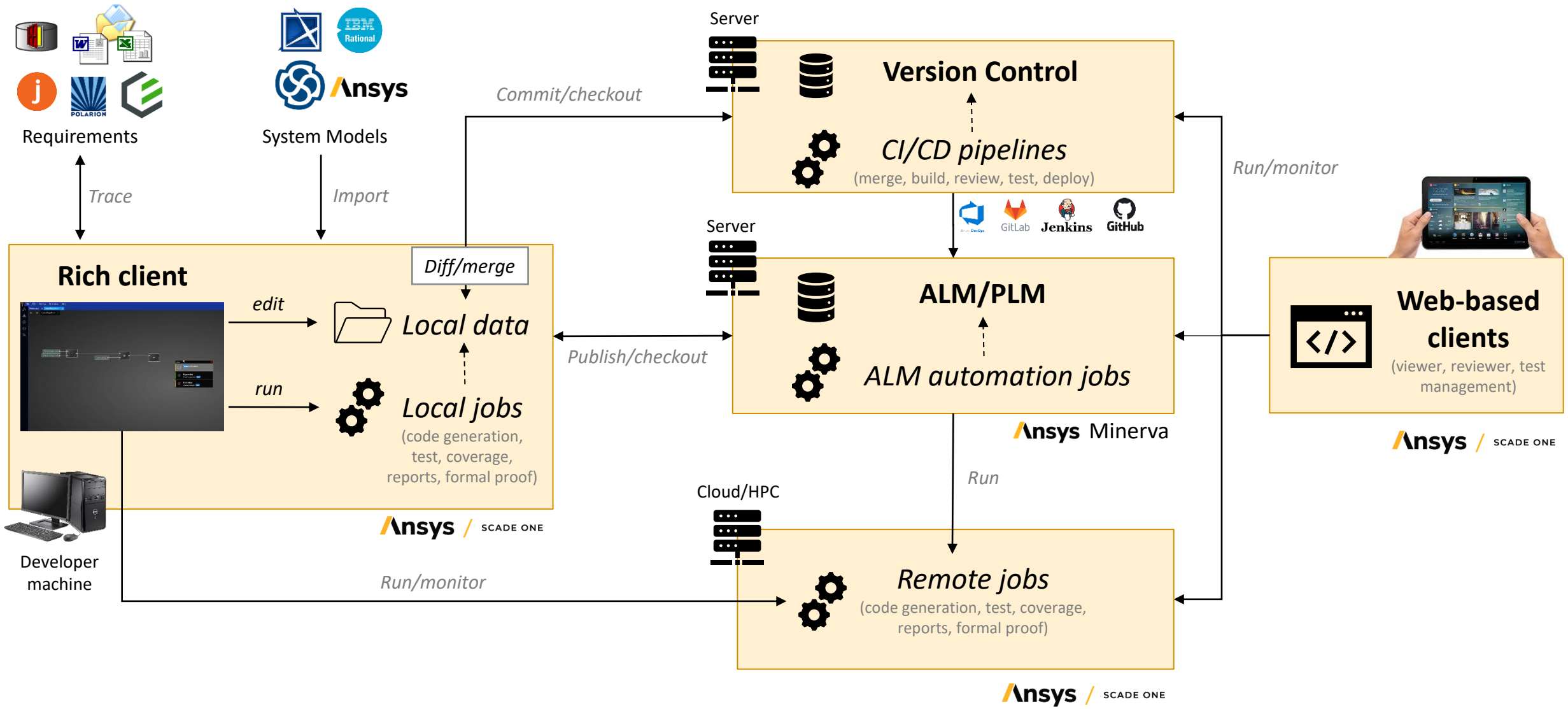
# Roadmap: DevOps and Collaborative Workflows





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# Scade One Roadmap / Qualification

- Supports all safety standards
  - **DO-178B/C** up to DAL A - Aerospace/Defense
  - **ISO 26262** certification up to ASIL D – Automotive
  - **EN 50128 up to SIL 3/4** - Rail Transportation
  - **IEC 61508 up to SIL 3 –** Industrial & Energy
    - IEC 62304 full compliance – Medical Systems
    - EN 13849 full compliance – Industrial Machines Safety
    - IEC 60880 full compliance – Nuclear Instrumentation & Control

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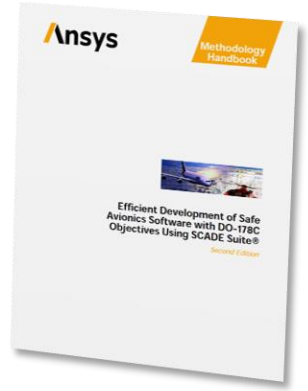
# Safety is our expertise

## Decades of experience

- Proven track record: 200+ systems certified
- Ansys experts have been part of safety-standard committees for 20 years

## Team of experts to help you secure your certification journey

- Not just tools
- Also certification kits, templates, guidelines and best practices





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# Scade One Roadmap / Qualification schedule

- We are preparing qualification activities
  - Plans, standards and procedures
  - Requirements, architecture and tests
- Already working with certification authority (TUV)
- But we won’t start qualifying a specific version yet
  - ‘Go’ if complete workflow available + customer usage
  - 12/18 months between ‘Go’ and certification kit availability


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# Scade One Roadmap / HMI Software Design

## Scade One HMI principles

### One experience

- Modern UI/UX seamlessly integrating HMI and control software
- Single IDE for rapid prototyping, iteration and safe embedded code

### One ecosystem

- Collaborative work including diff/merge, libraries
- Cloud-enabled workflows with CI/CD integration
- Python APIs

### One toolchain

- Shared tools for design, code generation, testing and model coverage
- Smart modeling with on-the-fly checks and inference

### One paradigm

- Formal, unambiguous language
- Shared abstractions : operators, dataflow, state machines, sync. execution


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