# VLAB

*System Level Design Solutions*

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# In this presentation

- ASTC Introduction
- VLAB Embedded System Solutions
- VLAB in Automotive

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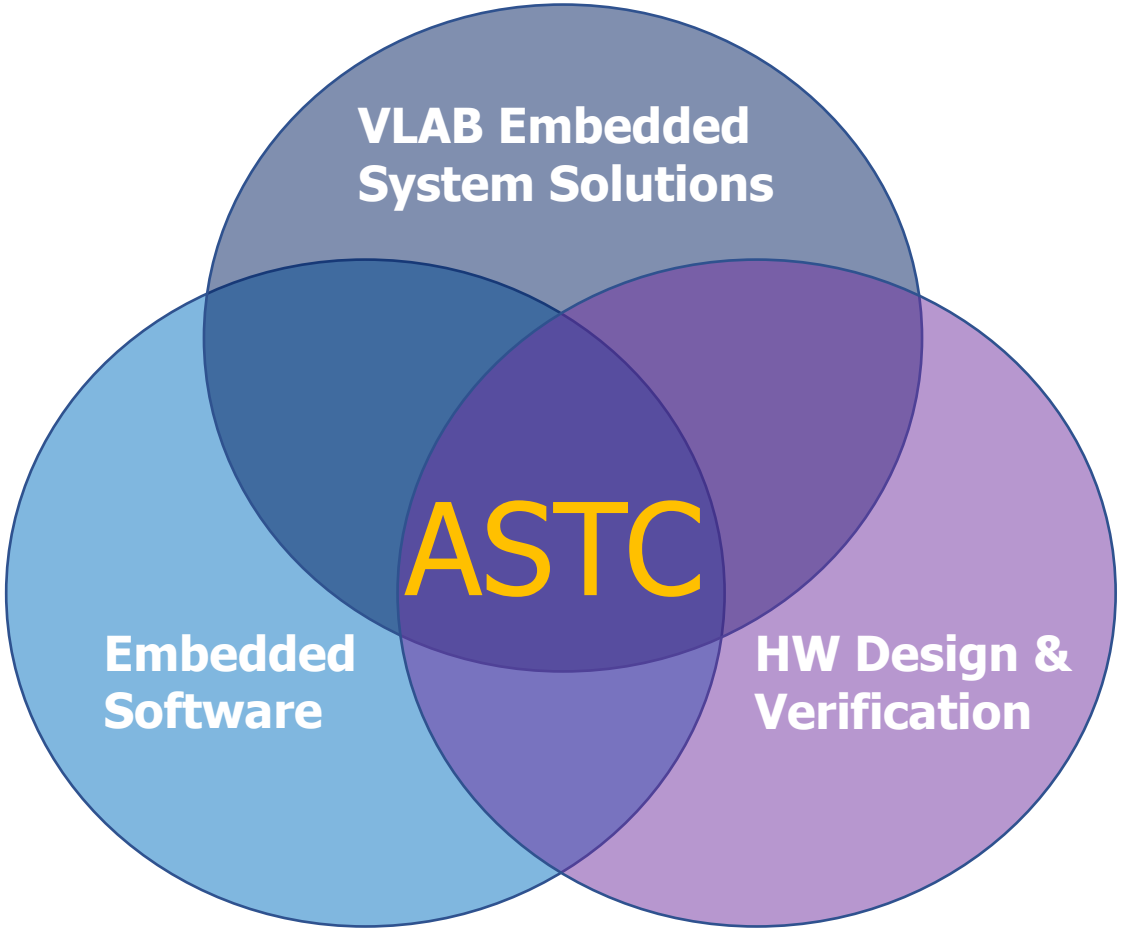
# Introduction to ASTC




ASTC has long and proud history of delivering Tools & Technology to our customers & partners.

With a unique combination of talent and expertise, from IP creation all the way through to developing embedded software, ASTC is ready to assist.

ASTC has established a strong global presence across the whole Automotive segment, from IP provider through to OEM.

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# ASTC Timeline

- Milestones
  - 1994 Motorola EDA team established in Adelaide (Jay Yantchev, GM)
  - ASTC incorporated 2005 in Australia
  - USA subsidiary (ASTC Inc) 2007
  - Japan office and subsidiary 2009
  - VLAB Works subsidiary created 2011
  - France team established 2014 (Toulouse)
  - IQonIC Works subsidiary created 2018

- Management
  - CEO – Jay Yantchev
  - CTO (VLAB Works) – Ata Parashkevov
  - CTO (Embedded Software) – Rod Whitby
  - CTO (IC & IP Design) – Scott Ditter

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# ASTC – Solutions for Embedded Systems, Software, and Semiconductors

## IC ENGINEERING

REQUIREMENTS THROUGH DESIGN TO SILICON

**IQonIC IP Library**

- Custom ASICs & FPGAs
- Mixed-signal IP & design services
- Continuously test & integrate
- From concept to production

## ANALOG / MIXED SIGNAL

HIGH RELIABILITY AND PRECISION, ANALOG AND MIXED SIGNAL IP AND ASIC DESIGN

## SYSTEM DESIGN

SYSTEM PROTOTYPING, SIMULATION AND ANALYSIS

**VLAB Virtual Platforms**

- Virtualized Product Development
- Test Automation
- Process Enablement

## EMBEDDED SOFTWARE

FIRMWARE, SYSTEMS SOFTWARE AND APPLICATIONS

**SOFTWARE DEVELOPMENT**

- Complex embedded projects
- Real-time applications
- System test, V&V, optimization
- Turnkey HW/SW solutions

***"Embedded made agile"***

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VLAB Works

ASTC's VLAB Works has a singular purpose and objective.

***Help customers be more competitive by deploying advanced system design flows using premium virtual prototyping and virtualization solutions.***

- Why is this important? Customers can take confidence from this being our primary business, not a complimentary or incidental venture.
- ASTC's competitors often take a narrow view and limit their offering to software development that happens pre-silicon.
- Our focus is to use our knowledge and experience in the automotive domain and apply virtualization and VPs across the complete embedded software development cycle.

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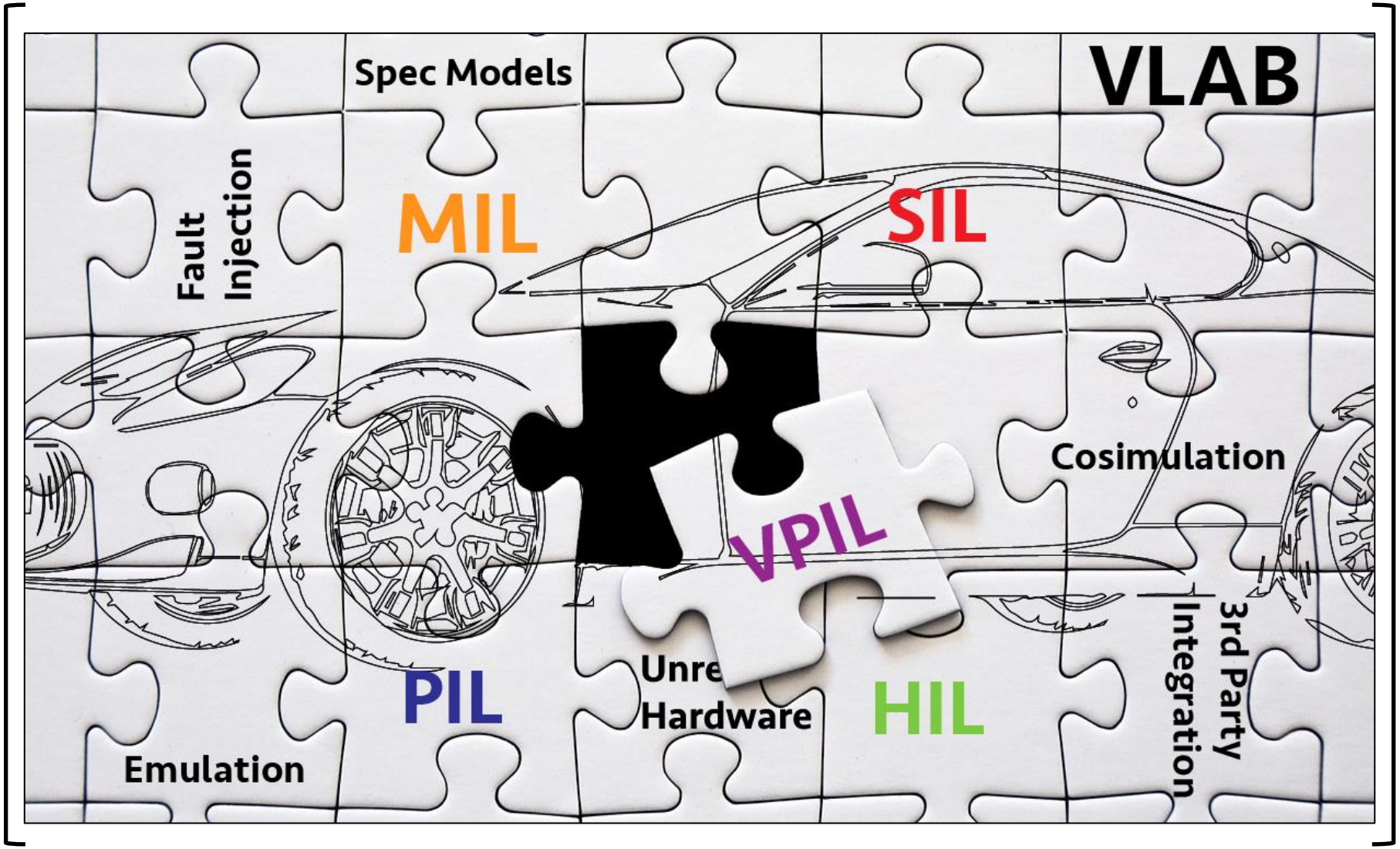


# VLAB Embedded System Solutions

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# VLAB Embedded System Solutions

VLAB, the leading virtual prototyping tool, and hardware virtualization and emulation environment, has been conceived and designed to specifically address **SYSTEM LEVEL DESIGN**, **VERIFICATION** and **VALIDATION** requirements from T1s and OEMs in collaboration with IP and SoC vendors.

ASTC understands what is important to customers:

- FOCUS
- PERFORMANCE
- INTEGRATION
- END-TO-END
- DOMAIN EXPERTISE
- RISK & COST
- SCALABILITY

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# BENEFITS OF USING VLAB

- **FOCUS** on software, applications, and system-level use cases
- Simulation **PERFORMANCE** that enables productive interactive and batch (regression) use
- **SCALABILITY** from SoC to ECU to subsystem to all of car multi-domain simulations
- **INTEGRATIONS** with leading 3rd party tools, using open architectures, standards-based tooling and interfaces

- Reduce **RISK & COST** with less physical test equipment at the same time as accelerating system development and improving quality optimize system performance
- Leverage growing internal automotive industry **DOMAIN EXPERTISE**
- **END-TO-END** **V**irtualization **B**ased **D**evelopment from requirements to maintenance

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# Introducing Virtualization Based Development

**Virtualization Based Development** (VBD), is a methodology, enabled by VLAB, that leverages virtualization in some or all phases of system development life cycle

- Definition / Specification
- Architecture / Design
- Implementation (Code & Test)
- Validation
- Optimization
- Post release field and customer support

Artifacts created and used in one phase of development are reused and leveraged in later development phases, for optimized ROI.

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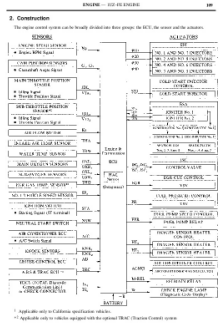
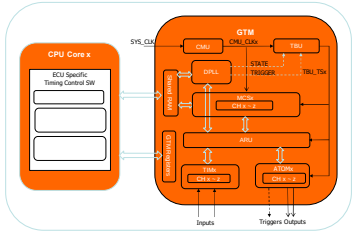
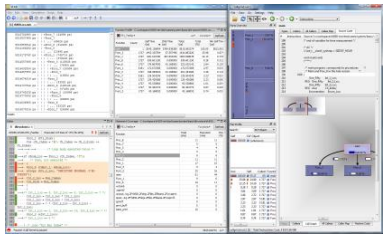
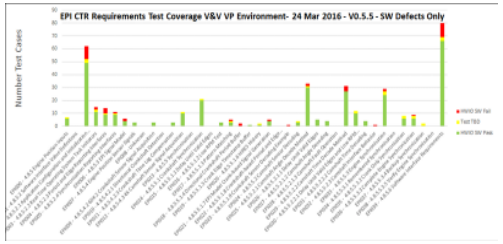
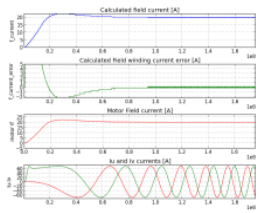
# End-to-End - The VBD Flow







**Definition / Specification** → **Architecture / Design** → **Implementation (Code/Test)** → **Validation** → **Optimization**

| Definition / Specification | Architecture / Design | Implementation (Code/Test) | Validation | Optimization |
|---|---|---|---|---|
| **Executable Specs** | **Arch / Design Platform** | **Software, RTL** | **SW, HW, System** | **ECU Control System** |
| CVR Tests<br>CTR Tests | Design Verification Tests<br>Performance Metrics | SW Tests (Unit, Feature, …)<br>RTL Tests | SW/HW/System Val Tests<br>Functional Safety Tests | System KPI Tests<br>ECU Calibration Tests |
| **Key Use Cases:**<br>✓ Req Spec Analysis<br>✓ Rapid Spec Prototyping<br>✓ Early Test Development | **Key Use Cases:**<br>✓ Arch/Design Analysis<br>✓ Rapid Design Prototyping<br>✓ Early Test Development<br>✓ HW Spec Validation | **Key Use Cases:**<br>✓ SW Development<br>✓ SW/HW Integration<br>✓ SW Test<br>✓ HW HDL Test (SWIL) | **Key Use Cases:**<br>✓ SW/HW Validation<br>✓ System (OL/CL) Validation<br>✓ FPGA/RTL Validation<br>✓ Functional Safety Analysis | **Key Use Cases:**<br>✓ BSP/BSW Optimization<br>✓ ECU SW Optimization<br>✓ ECU SW Calibration |

Virtualization Based Development can be used in isolated development phases or as a complete, end-to-end process that is complimentary to existing methodologies.

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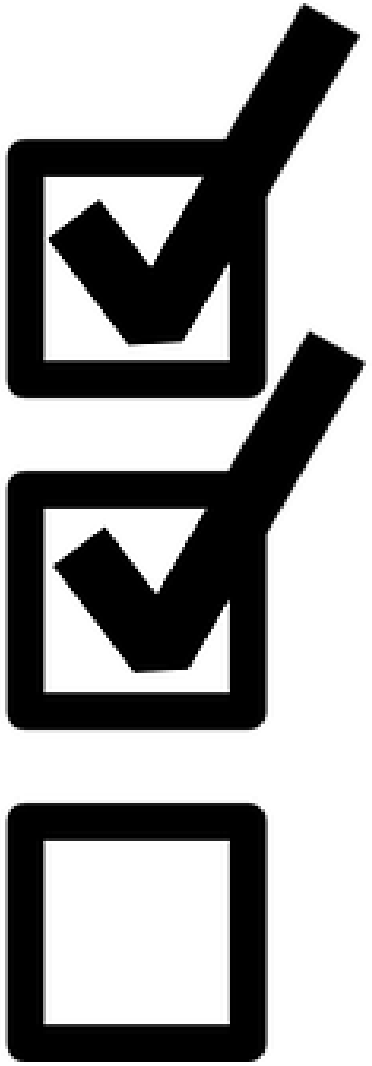

# VBD Advantages

- Accelerate development with shorter cycle times
  - Start development phases and tasks earlier
  - Overlap multiple phase activities and progress in parallel
  - Avoid the long tail of V&V
- Improve quality
  - Improve communication within teams and between cross-functional teams
  - Focus on verification and validation activities
  - Catch and resolve defects early
  - Deploy rigorous test automation and CI practices

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# VBD Advantages

- Create better products
  - Explore broader design space
  - Tune and optimize at system, software and hardware levels
  - Deliver to market earlier
- Improve the visibility, reliability, and predictability of the development process
- Reduce overall costs

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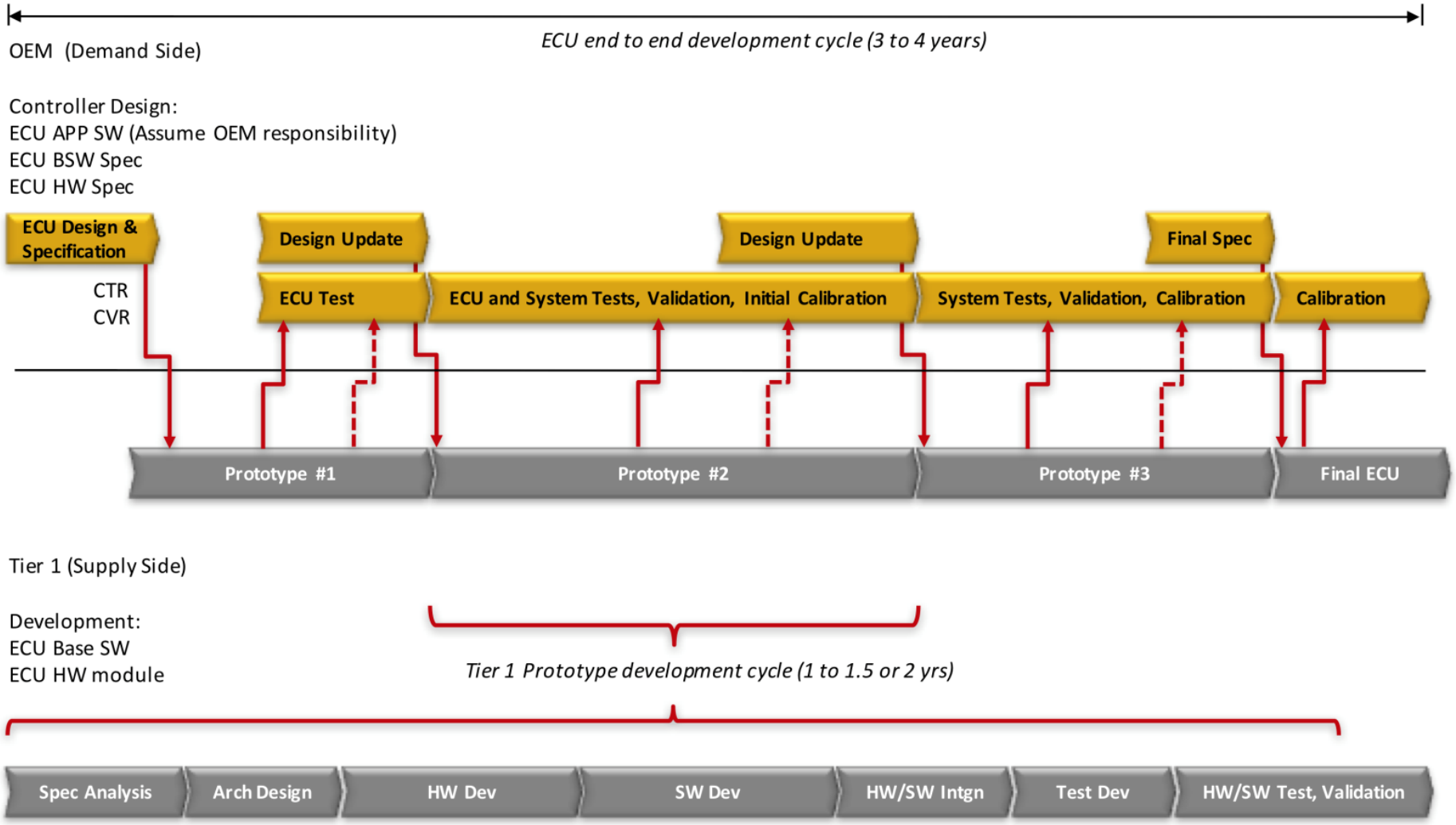


Typical ECU Development Cycle

*... timeline is 3 to 4 Years*

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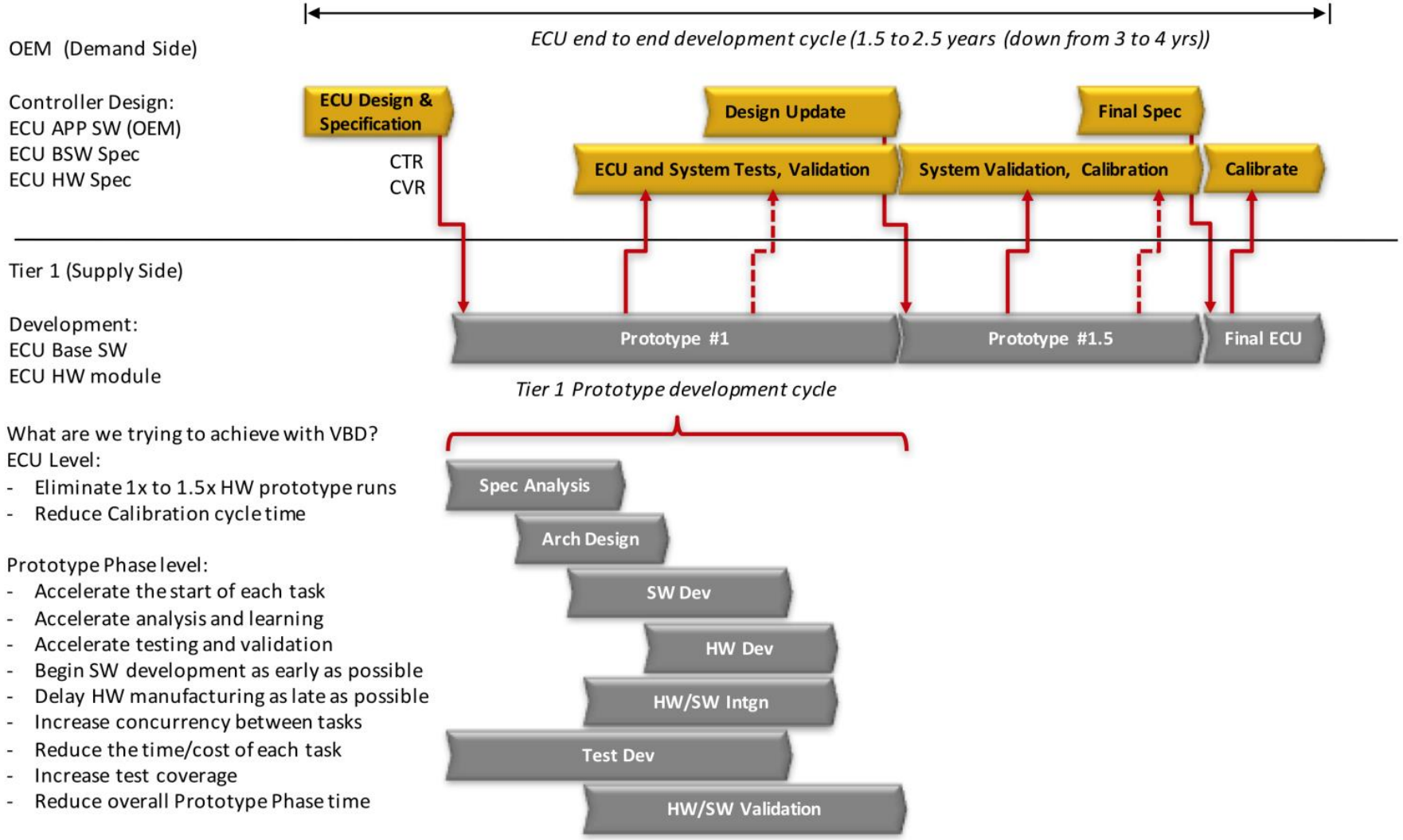
# ECU Development Cycle With VBD

*… timeline is reduced from 3 to 4 Years to only 1.5 to 2.5 Years*




What are we trying to achieve with VBD?
ECU Level:
- Eliminate 1x to 1.5x HW prototype runs
- Reduce Calibration cycle time

Prototype Phase level:
- Accelerate the start of each task
- Accelerate analysis and learning
- Accelerate testing and validation
- Begin SW development as early as possible
- Delay HW manufacturing as late as possible
- Increase concurrency between tasks
- Reduce the time/cost of each task
- Increase test coverage
- Reduce overall Prototype Phase time

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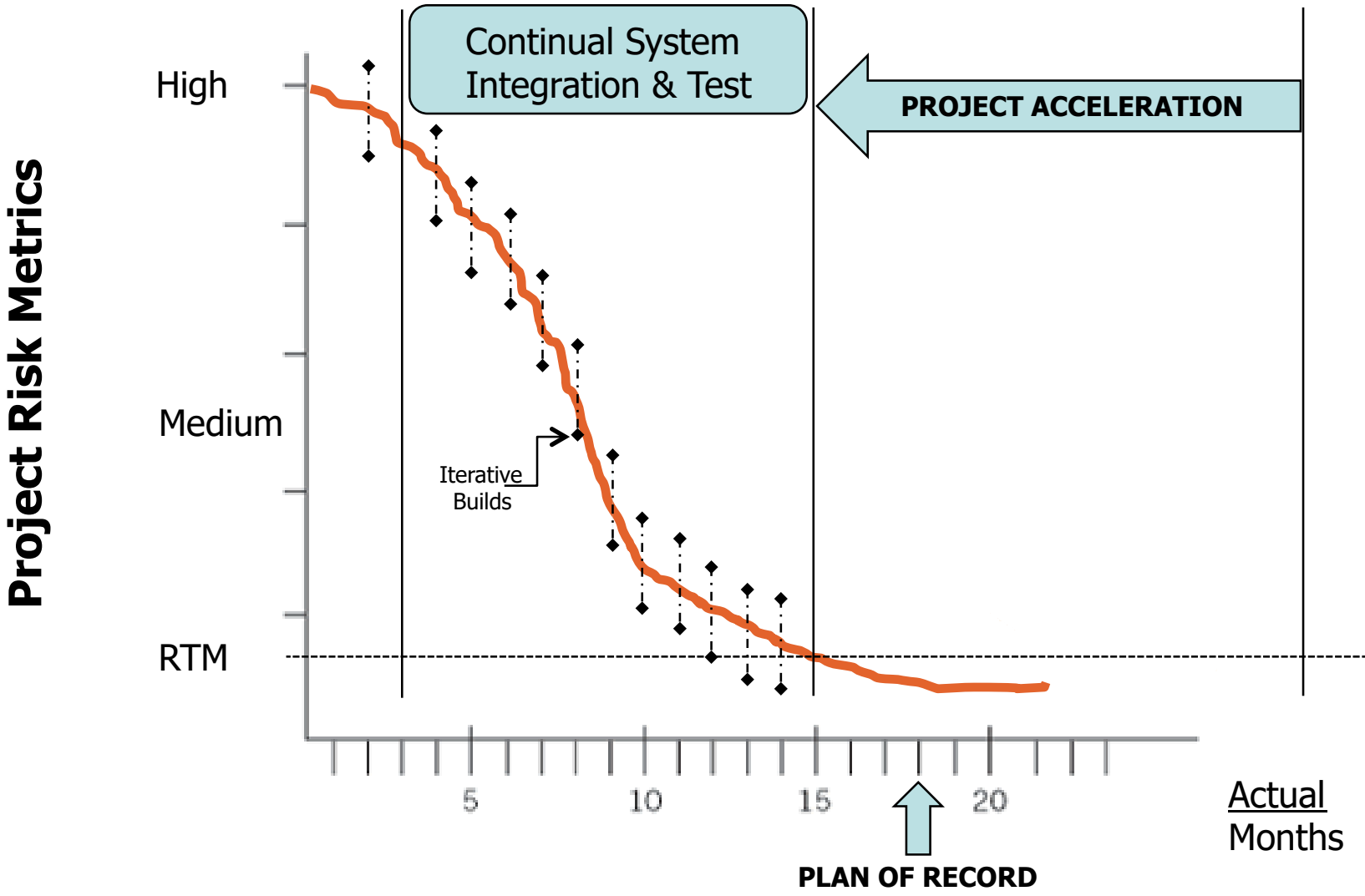
# Reducing COST & RISK WITH VBD

Accelerated Development

Defects detected and eliminated earlier – less iterations

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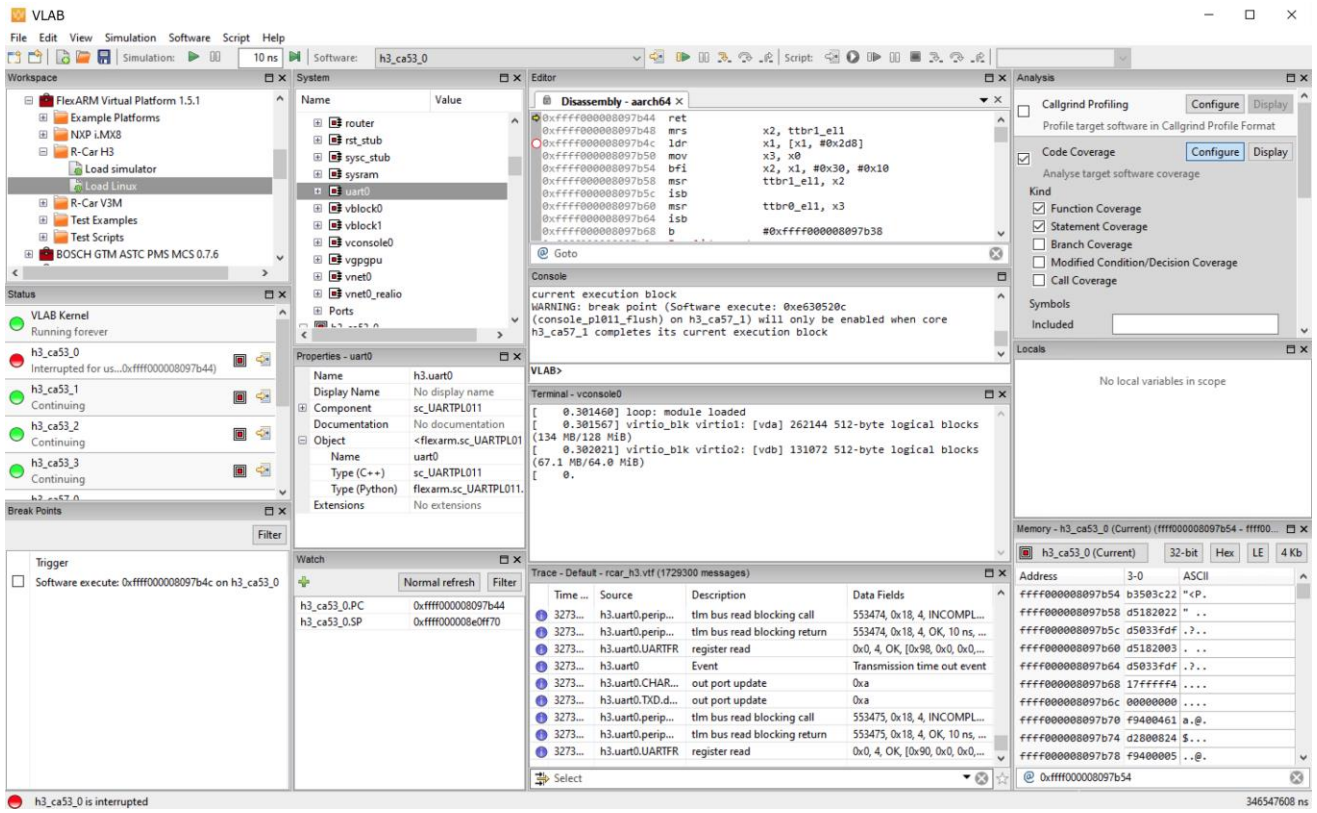
# VLAB UNPACKED

VLAB provides the tooling and operating environment for the implementation of VBD providing a unified environment for:

- Virtualization engineers: rapid development of virtualized components, models, platforms and test environments
- Software developers: code bring-up, debug, and analysis
- Verification and validation engineers: test creation and reporting
- Automation development engineers: test execution and continuous integration



# Use VLAB in all Phases of Development

**Define**

Create virtual specifications of new products and features.

Execute, evaluate, and validate the concept before investing design effort.

Develop tests for the spec not the design.

**Validate**

Continuously integrate SW, HW, and TW.

Regression test scenarios impossible to create on real HW.

Automate build, compile, test, measure, analyze, and report.

**Design**

Experiment with architectures, parameters, structure, or function.

Measure, analyze, validate, and optimize.

Iterate across HW and SW teams to rapidly converge on an optimal design.

**Optimise**

Measure without affecting the flow of execution.

Process and analyze either online or offline.

Visualize and report the data and analytics.

**Implement**

Develop target SW without HW.

Debug SW with full control, visibility, and perfect repeatability.

Develop TW using known good virtual HW.

**Support**

Replicate issues and add failures to automated regressions.

Analyze, diagnose, fix, validate, and release.

Maintain multiple customer testing environments.

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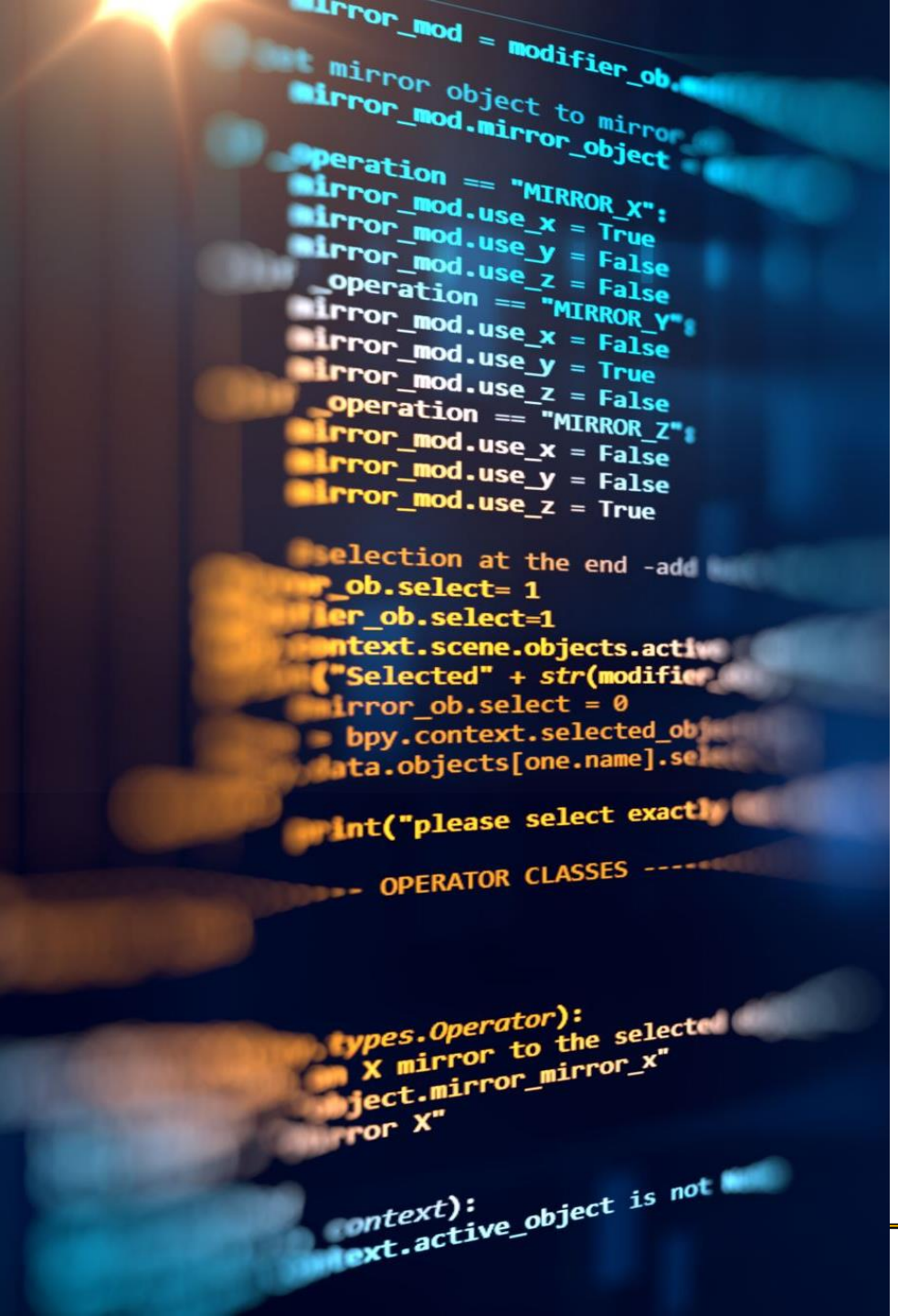


# VLAB FEATURES

- A standard Python software stack for rich application programming
- Standard SystemC model creation and simulation environment
- Comprehensive debug, instrumentation and analysis capability
- Industry leading simulation performance
- Interoperability with many third-party tools
- Rich hardware modeling library
- Application specific models
- Automated, deterministic regressions

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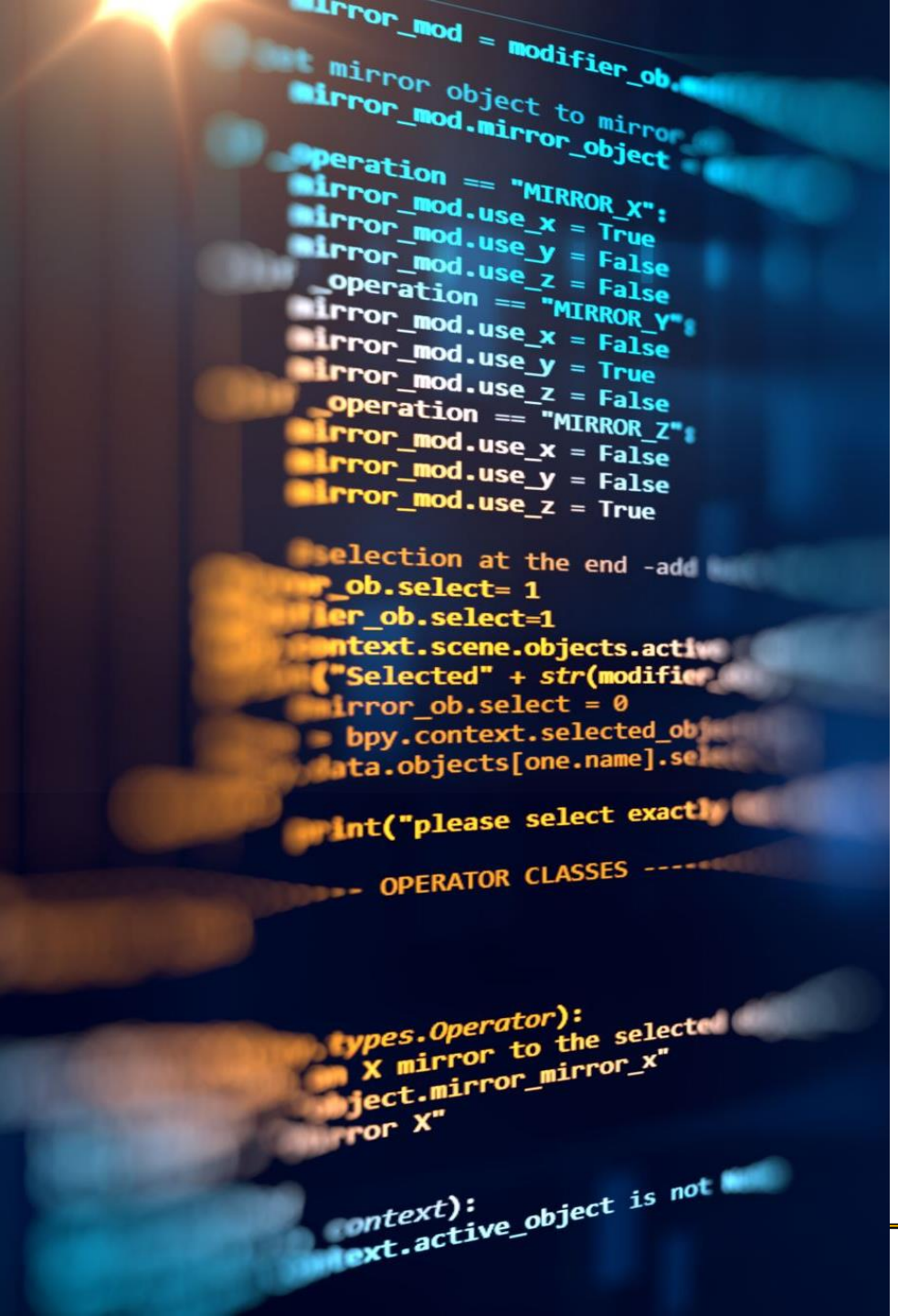

# VLAB ECOSYSTEM

Recognizing that VLAB is just part of a broader solution, VLAB Works have established an Ecosystem such that users can:

- Debug with their existing debug clients and tools
- Interoperate with other simulation and stimulus environments
- Work with pre-validated software such as RTOS
- Access Virtual Platforms for many of the leading embedded devices on or coming to market.

For more details on what is already available see:

https://vlabworks.com/vlab-ecosystem/

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# System Design Flow: VBD + VLAB

**DEVELOPMENT PHASES**

**Research & Development**

**Production**

**V & V**

**Maintenance**

**VLAB SYSTEM SOLUTIONS**

| Model In the Loop (MIL) | Software In the Loop (SIL) | Virtual Platform In the Loop (VPIL) | Hardware In the Loop (HIL) | VPIL |
|---|---|---|---|---|
| Models of Behaviour & Software | MIL + Host compiled Software | SIL + Target compiled Software | VPIL + Target compiled Software | |

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# VLAB & MIL - Model In the Loop

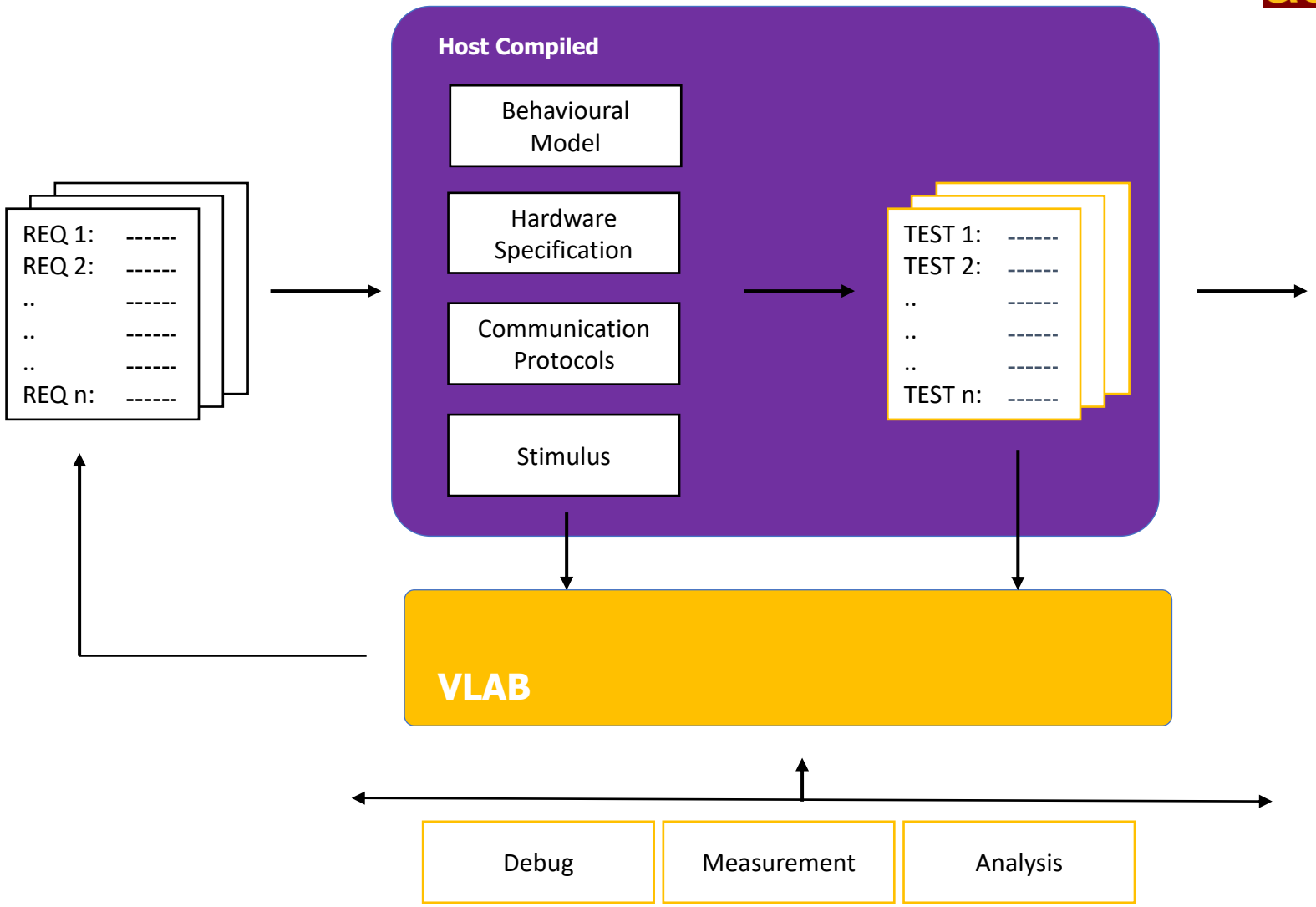
VLAB SYSTEM SOLUTIONS

**Model In the Loop (MIL)**

Software In the Loop (SIL)

Virtual Platform In the Loop (VPIL)

Hardware In the Loop (HIL)

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# VLAB & SIL - Software In the Loop

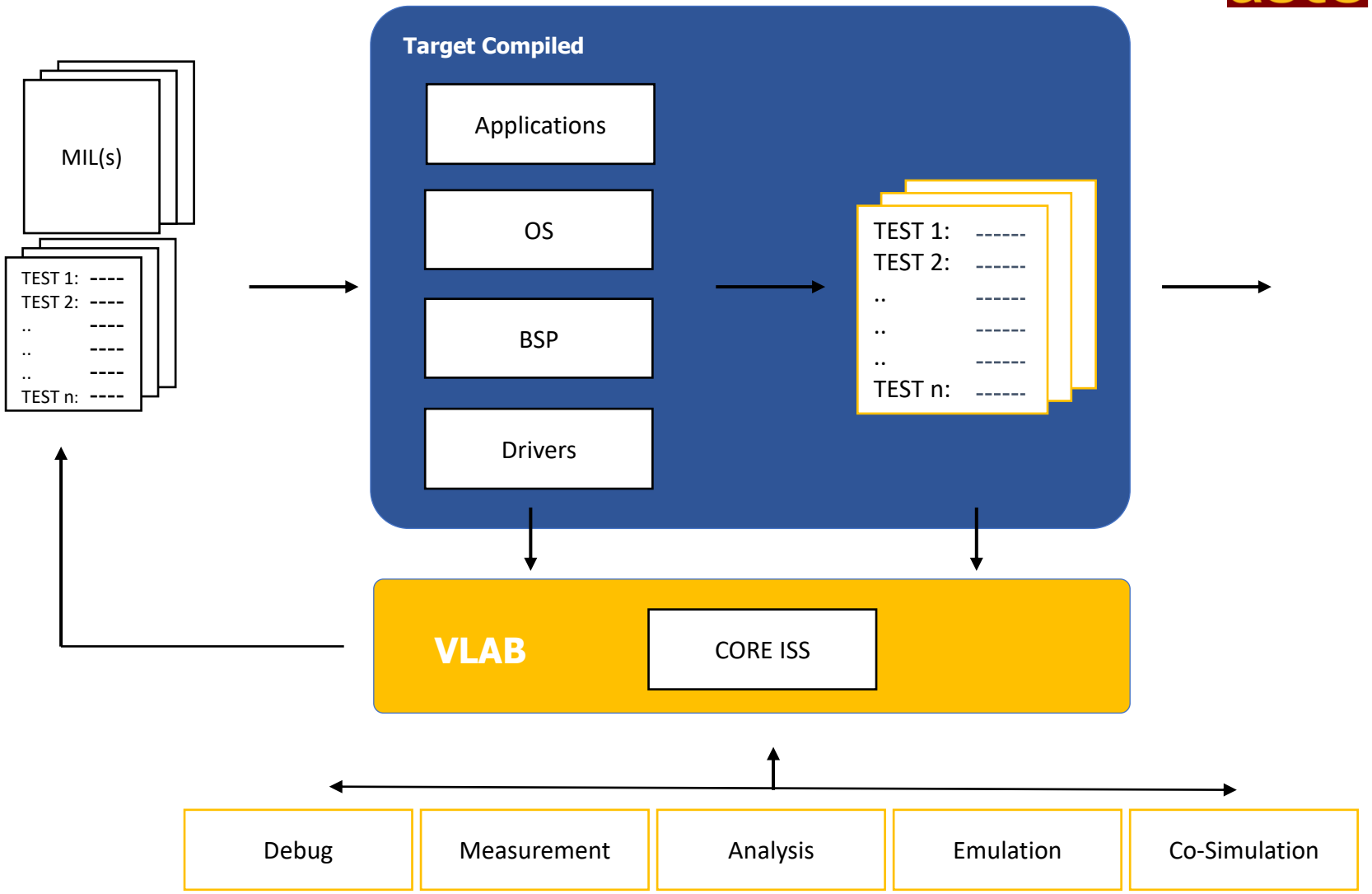
**VLAB SYSTEM SOLUTIONS**

Model In the Loop (MIL)

**Software In the Loop (SIL)**

Virtual Platform In the Loop (VPIL)

Hardware In the Loop (HIL)

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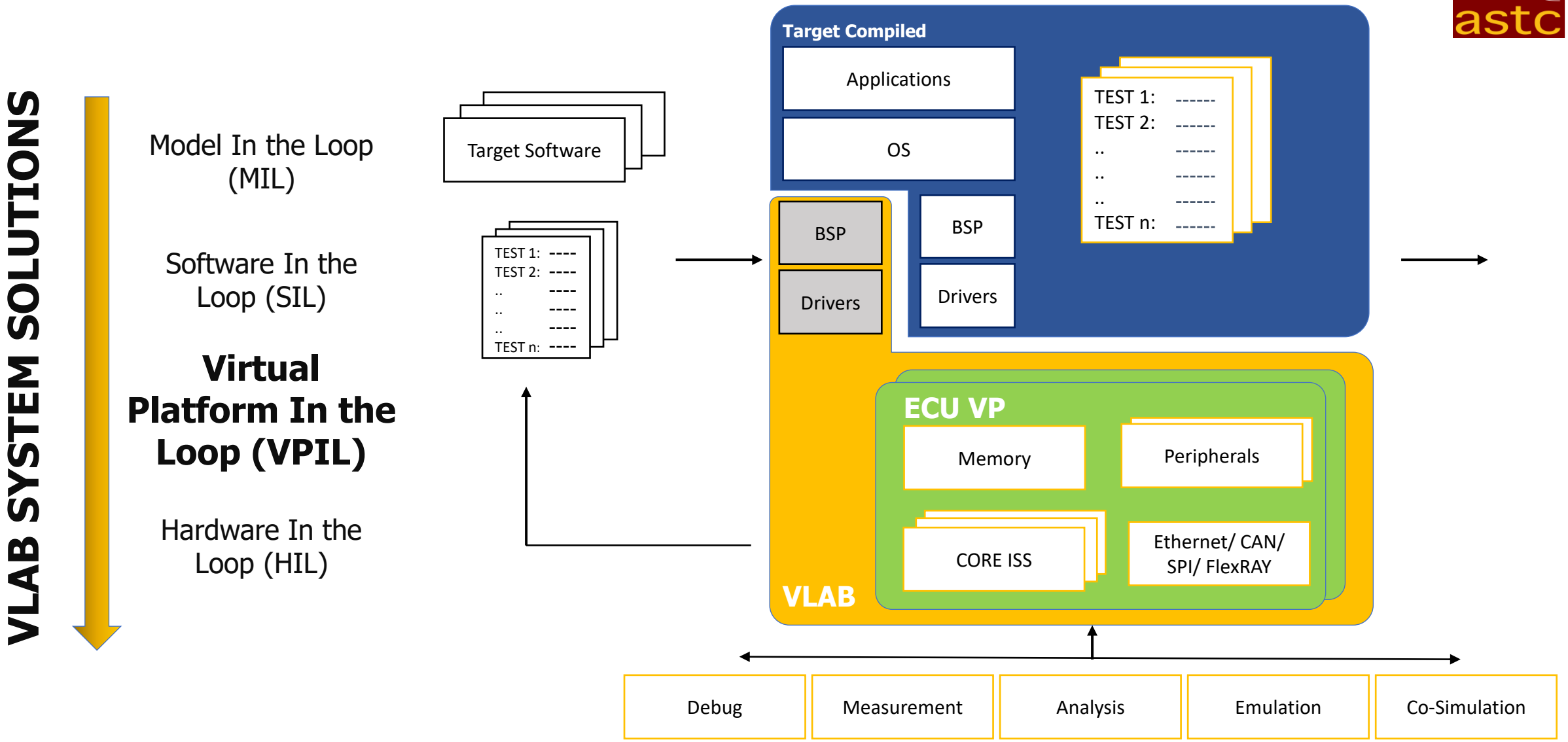
# VLAB & VPIL – Virtual Platform In the Loop

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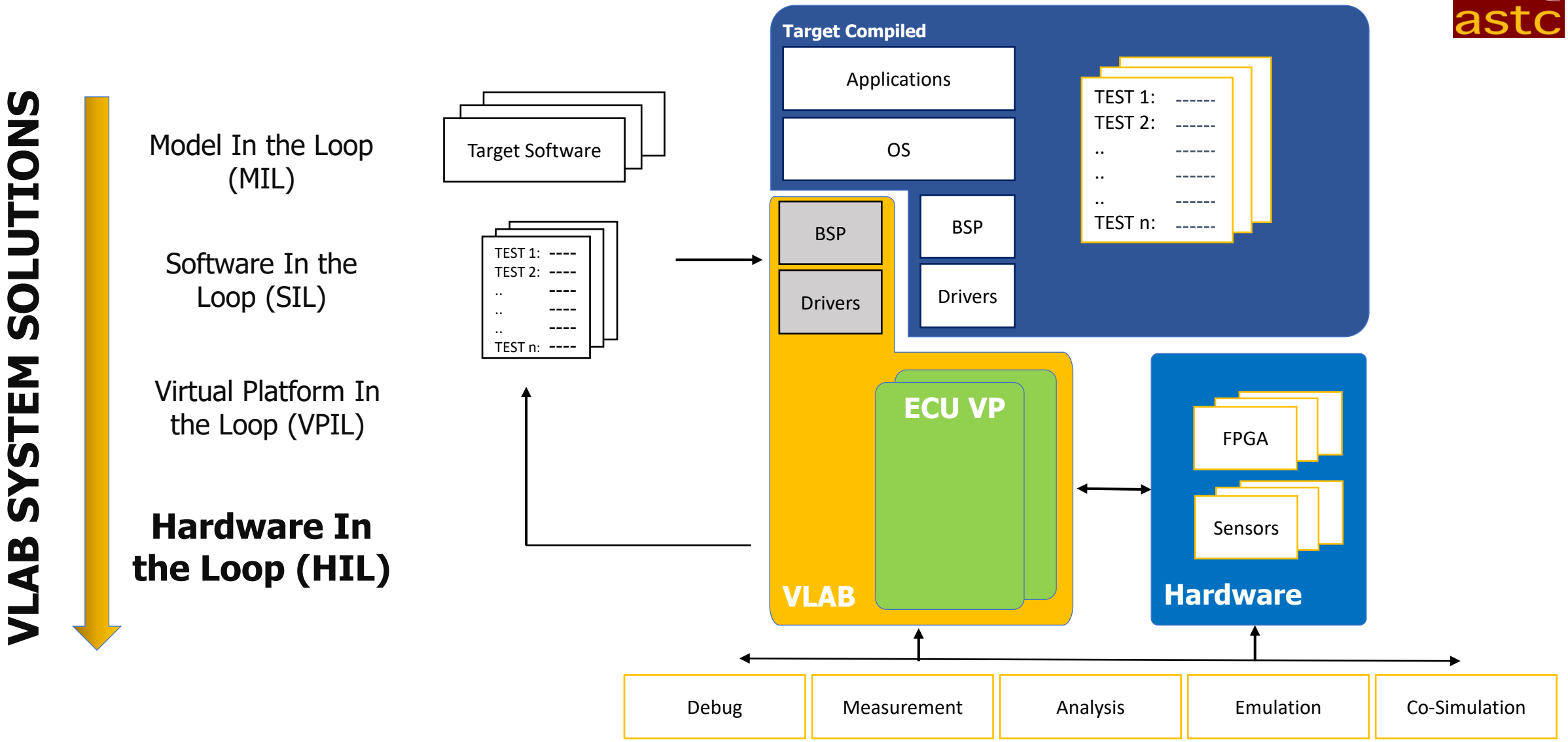
# VLAB & HIL – Hardware In the Loop

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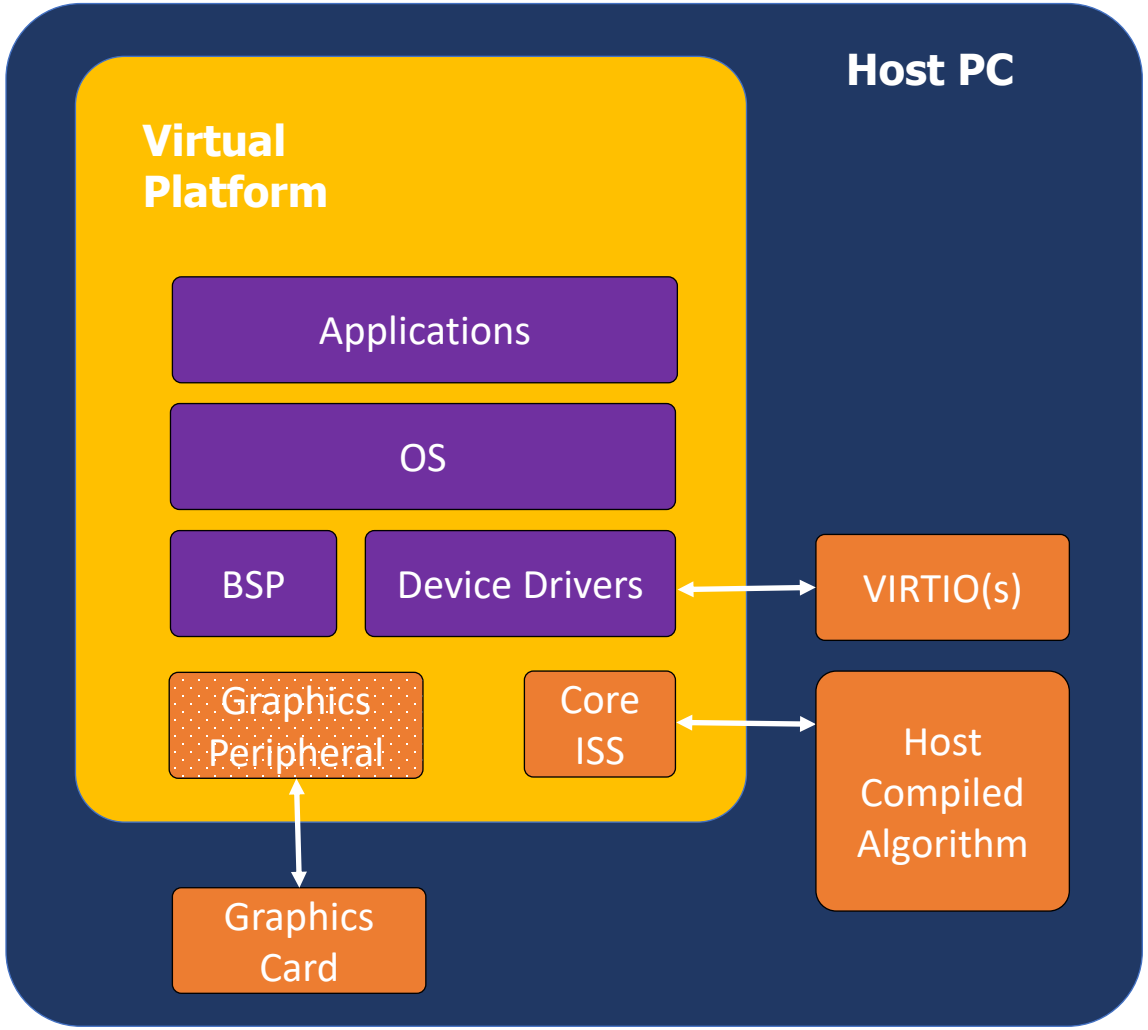
# VLAB FEATURE EXPLAINED: Host Emulation

**VLAB** takes advantage of the host capabilities to **EMULATE** different elements of the simulation:

- Only simulating what is necessary **increases simulation performance** … meaning **tests run faster** and **more often.**
- Reducing modelling **reduces costs** and are **available sooner**.

VLAB frequently emulates:

- Graphics calculations
- Display and communication devices
- Complex algorithm(s)

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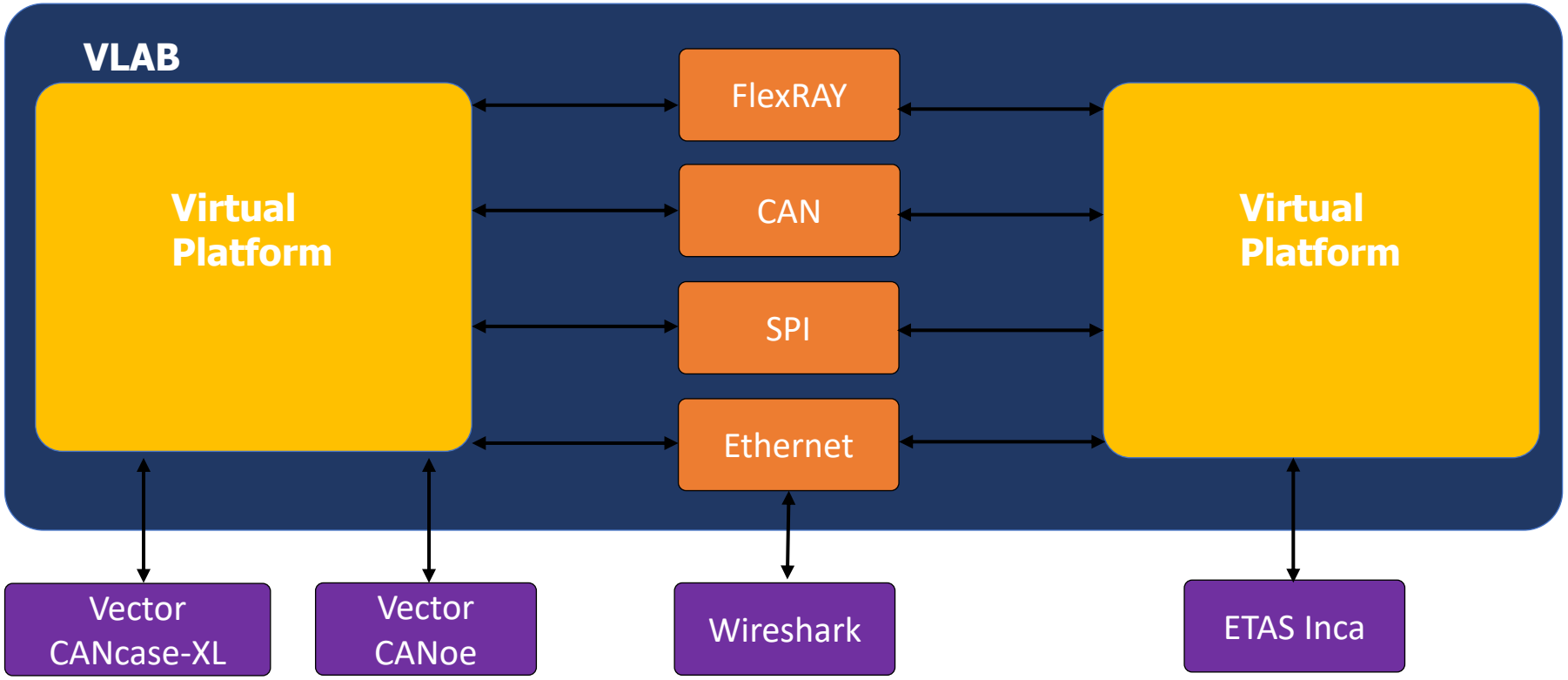
# VLAB Features Explained: Embedded Communication




VLAB offers inbuilt support for working with communication protocols, including:

- Test injection
- Analysis
- Fault injection
- Measurement

VLAB can connect to industry leading tools such as Vector CANcase-XL & CANoe, Wireshark and ETAS Inca.

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# VLAB FEATURE EXPLAINED: Fault Injection

With test coverage a vital component of compliance testing, VLAB can create the necessary test conditions to ensure all code is covered, even cases that are not possible to test in hardware.

## COMMUNICATIONS

CAN Node #1 → CAN Node #2

- Inject packet delay
- Modify payloads
- Drop packets
- Randomize timing

## MEMORY

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 01 | 34 | 2a | 53 | 74 | 10 | 00 | 00 |
| 67 | 43 | 89 | ec | ec | d0 | 10 | ff |
| ff | 00 | 00 | 00 | fe | 00 | 00 | 00 |

- Memory corruption
- Deny memory access
- Randomize contents

## HARDWARE

Sensor → ECU

- Simulate hardware failures
- Inject noise
- Assert error signals
- Silently change state
- Modify timing

## SOFTWARE

- Invoke target software calls directly
- Overwrite target software symbols

```
void
software_under_test(int flag)
{

…
    if (flag == ERR_VAL) {
        raise_error_signal();
    }
}
```

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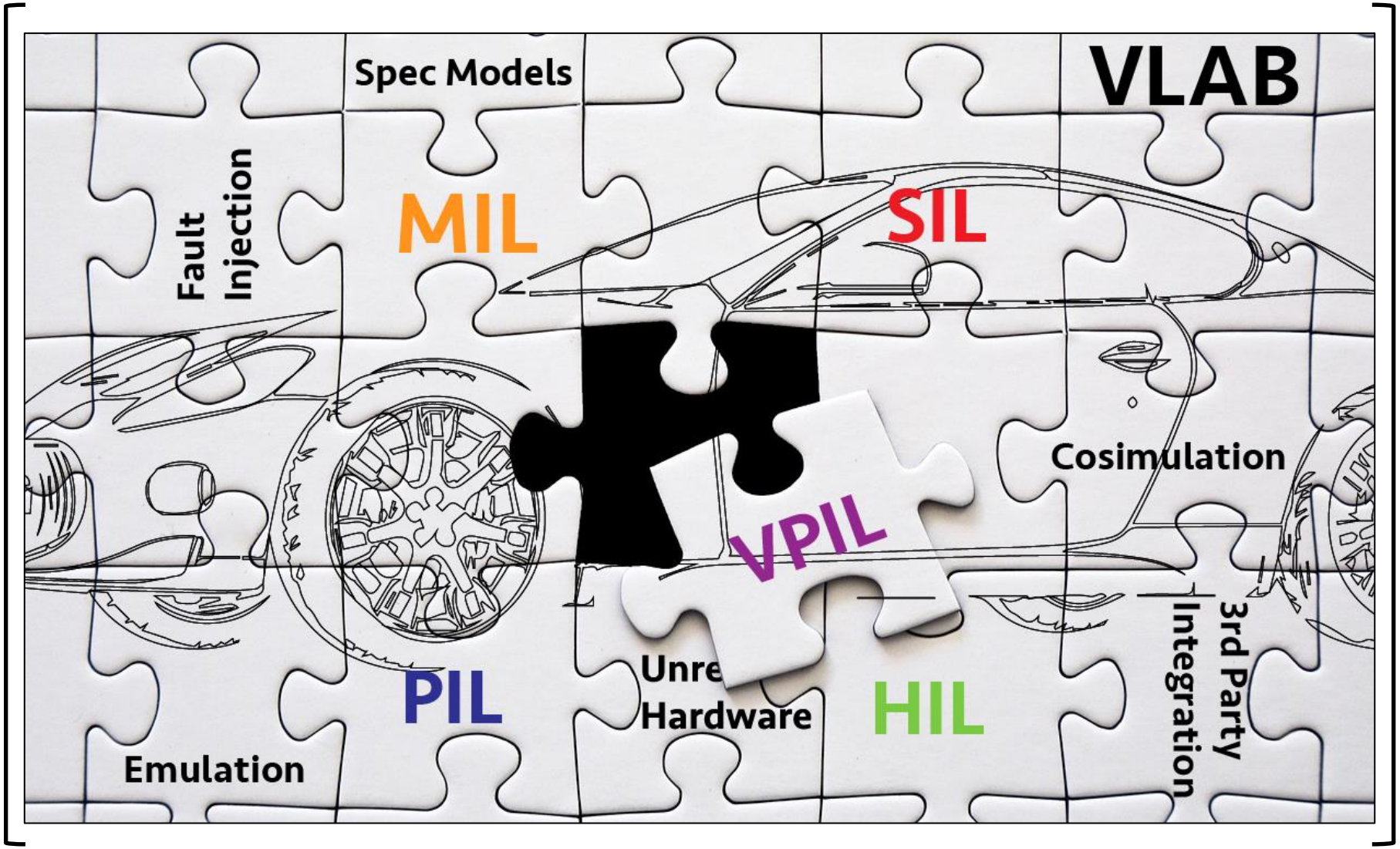


# VLAB in Automotive

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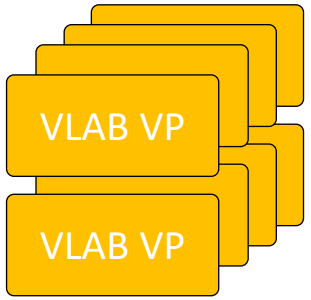
# VLAB Testing Solutions

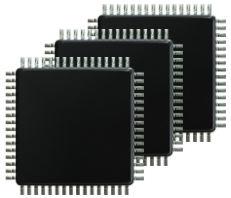
VLAB accelerates the pace at which tests are:

- Created
- Debugged
- Executed
- Reused




Tests can be executed in parallel, with only limit being compute resources and number of licenses.

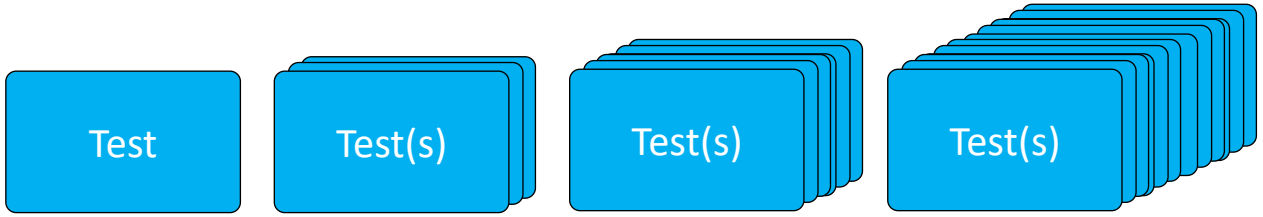
Test execution limited to available hardware, and by automation supported by the test environment



Unlimited Scalability

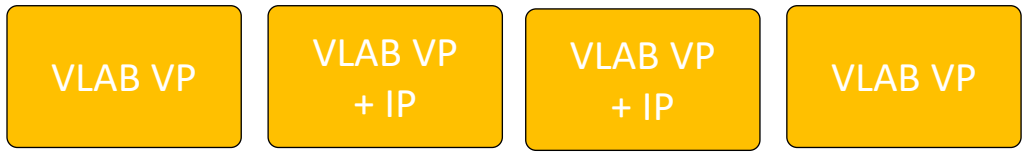
Limited Scalability

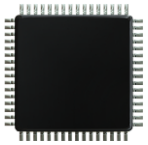
Project Timeline




Tests created / debugged / executed on Virtual Platform

Tests ready for Hardware



Flex VP Available

Additional IP Modelled

3rd Party IP Modelled

Full VP Available

Hardware Available

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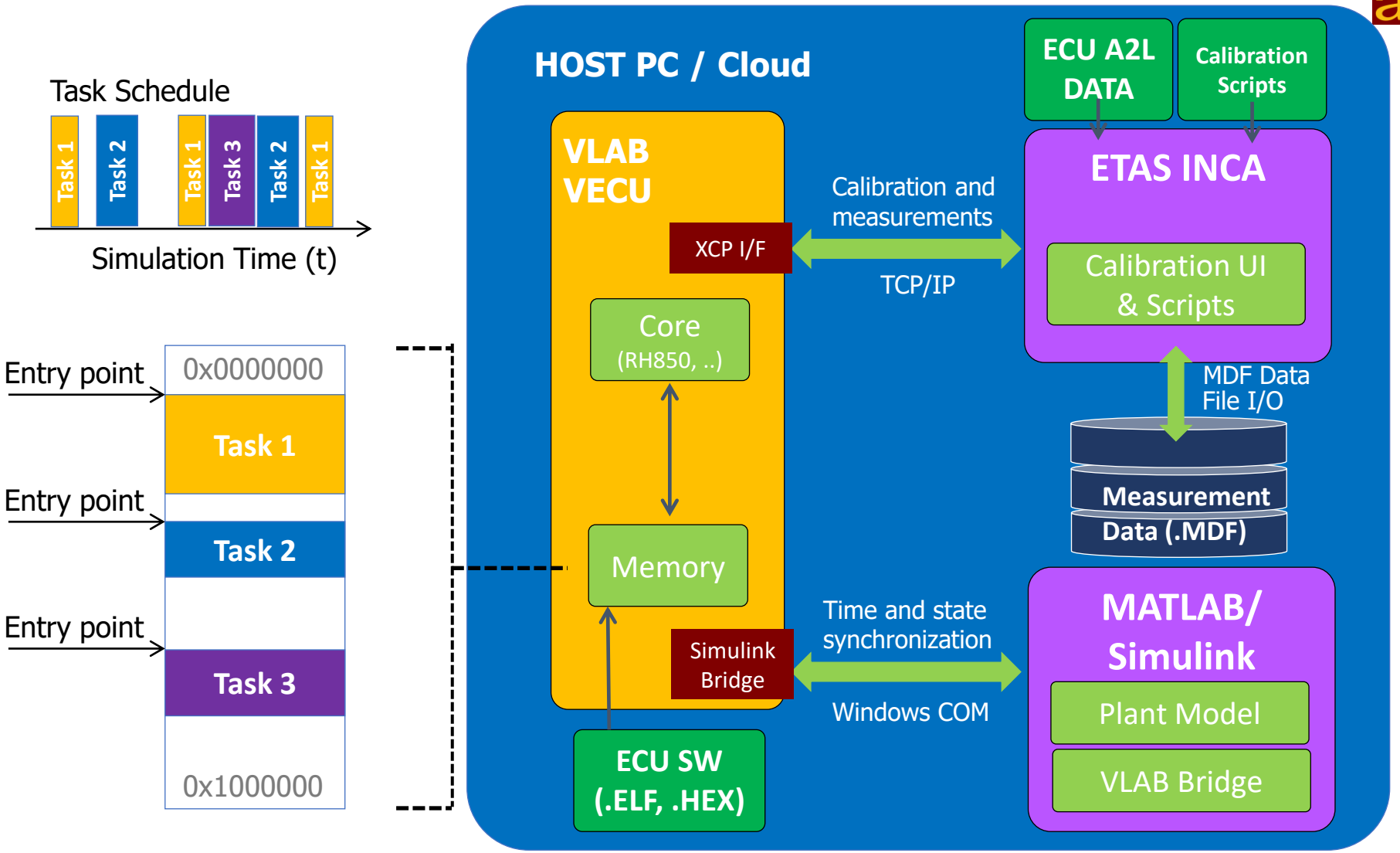
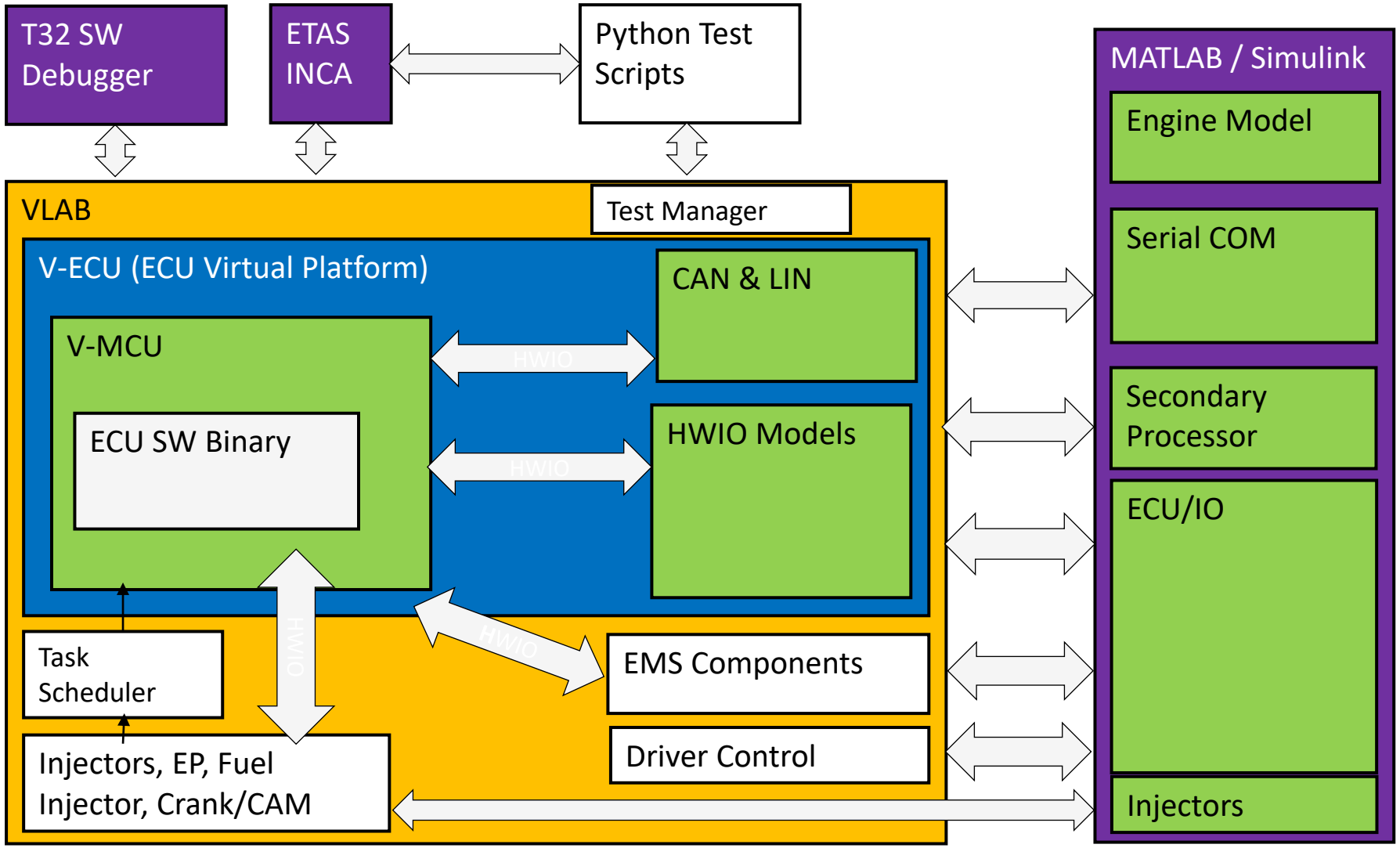
# VLAB Connected: ETAS INCA & MATLAB SIMULINK

Example of VLAB connecting Virtual ECU to a Virtual HILS.

This environment was used for Testing, Calibration & Measurement of ECU Application Software.



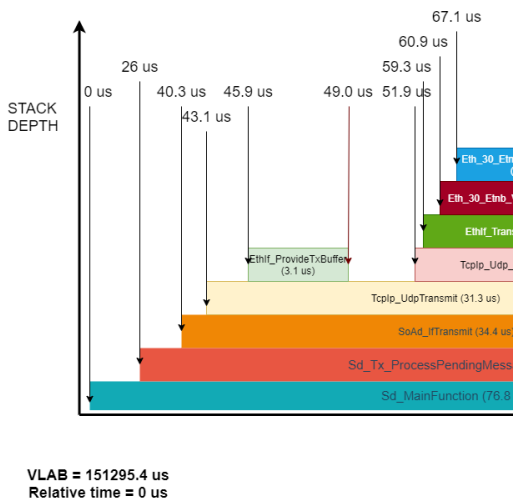
# VLAB CONNECTED: ECU Virtual HIL in DETAIL

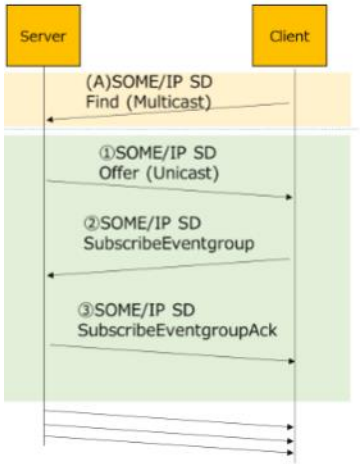


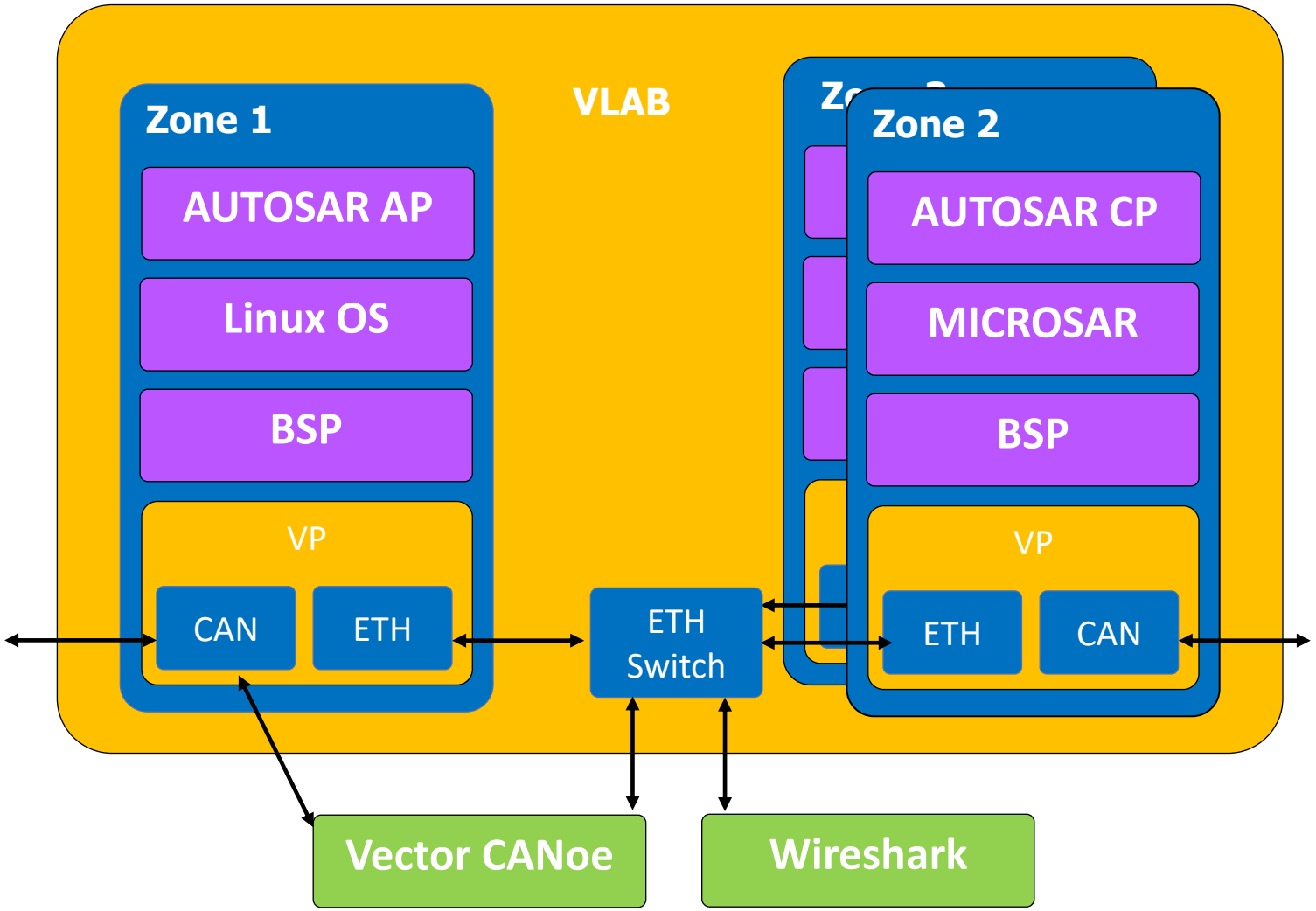
# VLAB Connected: AUTOSAR / Vector CANOE / Wireshark

Example of VLAB simulating multi-zone Automotive environment, connecting AUTOSAR AP & CP zones over Ethernet & CAN.

This environment connected to Vector CANoe and Wireshark to establish SOME/IP communication latencies in different scenarios.

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# Summary

- ASTC puts virtual prototyping and virtualization as central to its business
  - For many competitors, these are complimentary and incidental to their primary business
- ASTC has the depth and breadth of focus to apply VPs successfully across the complete embedded software development cycle, with good understanding of the automotive segment
  - Competitors typically focus on a narrow part: pre-silicon software development

| | ASTC | Typical Competitor |
|---|---|---|
| **Primary area of experise** | Virtualization and Modelling | RTL to GDS |
| **Primary customer segment** | Automotive | Semiconductors |
| **Key customers** | Semis, Tier1, OEMs | Semis and fabs |
| **Focus on** | Solutions first, tools second | Tools first, services second |

# End of Presentation

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