Accelerating GTM Software Development Integration and Test using Virtual Hardware ECUs

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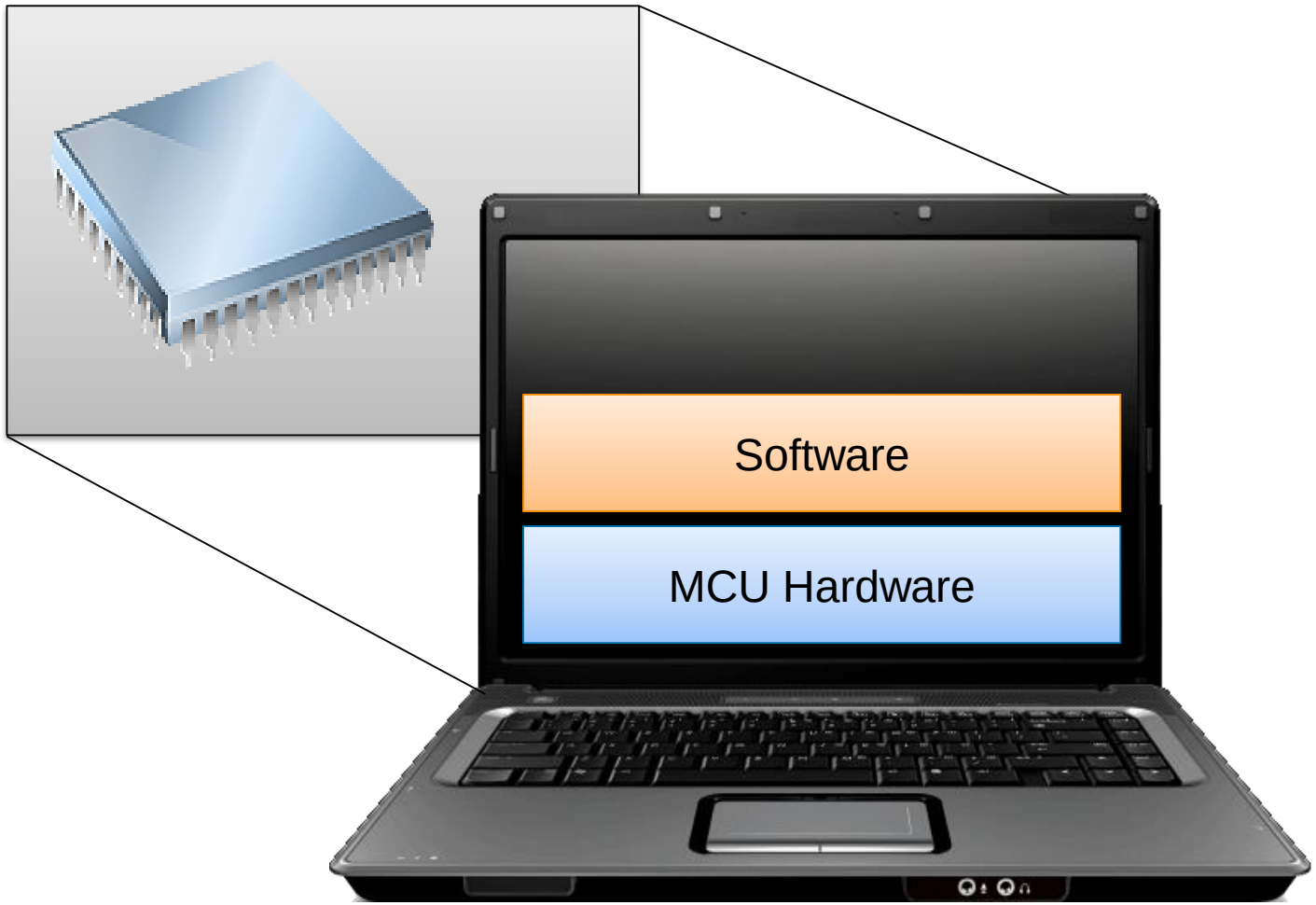
Agenda

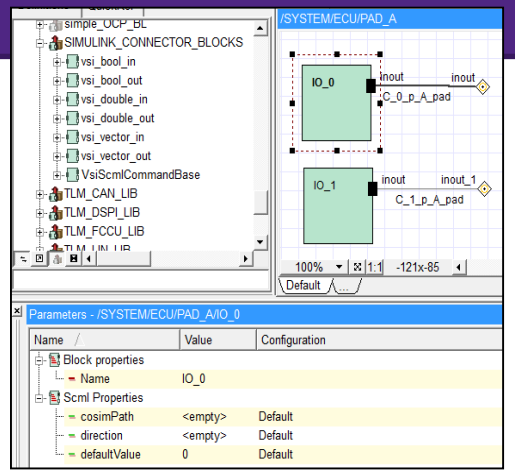
- Virtual Hardware ECU introduction
- Increasing GTM software development efficiency
- Comprehensive solution for GTM based software development and test

Virtual Hardware ECU introduction

What is a Virtual Prototype?



Fast model of a microcontroller (MCU) or system-on-chip (SoC) that can execute an unmodified binary executable



Example NXP MPC5777M

Start HW/SW Development Early

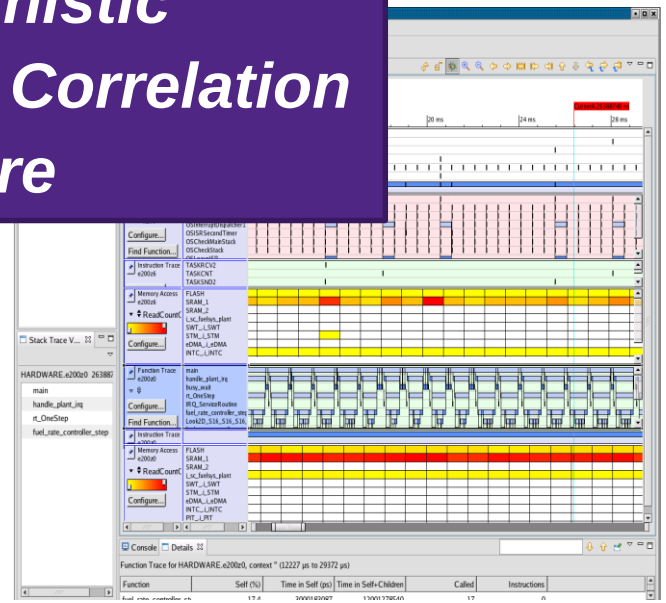
Better than Hardware – available earlier, easier to use for debug!

SW development 9-12 months earlier

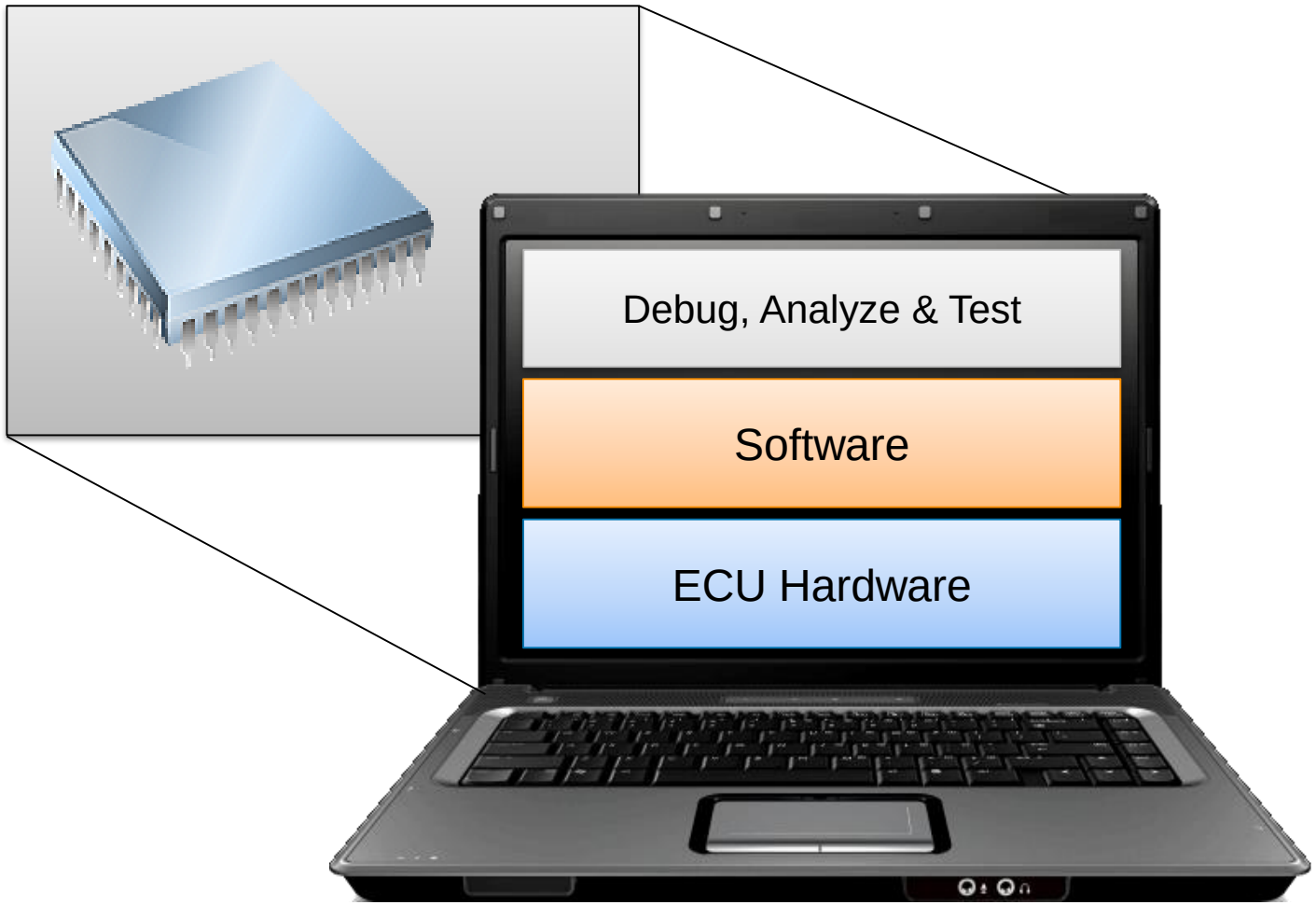
Experience from Automotive Semi and Tier1/OEM SW Teams

- Pre-silicon Dual OS (AUTOSAR & Linux) + Hypervisor bring up.
- Complex driver and communication
  - GTM, CAN, Ethernet communication, vision accelerators/sub-systems, …
- Algorithm flow from Matlab/Simulink to embedded software

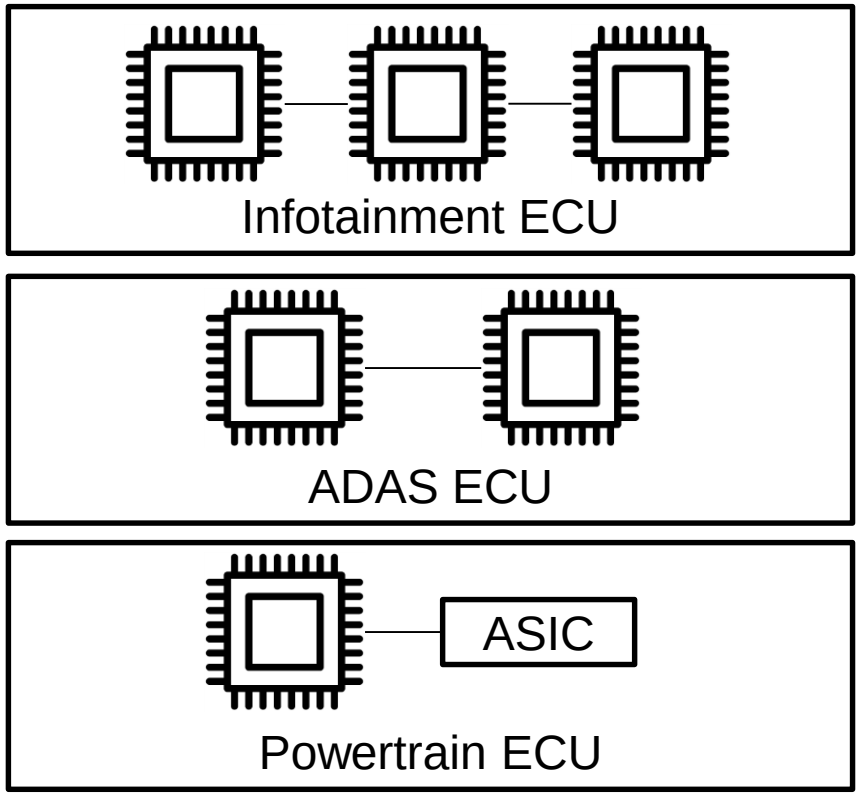
- ***Faster Debug***
- ***Non Intrusive***
- ***Deterministic***
- ***HW/SW Correlation***
- ***OS aware***



What is a Virtual Hardware ECU?



Fast model of the ECU Hardware with the benefits of virtual prototypes



Hardware-in-the-Loop

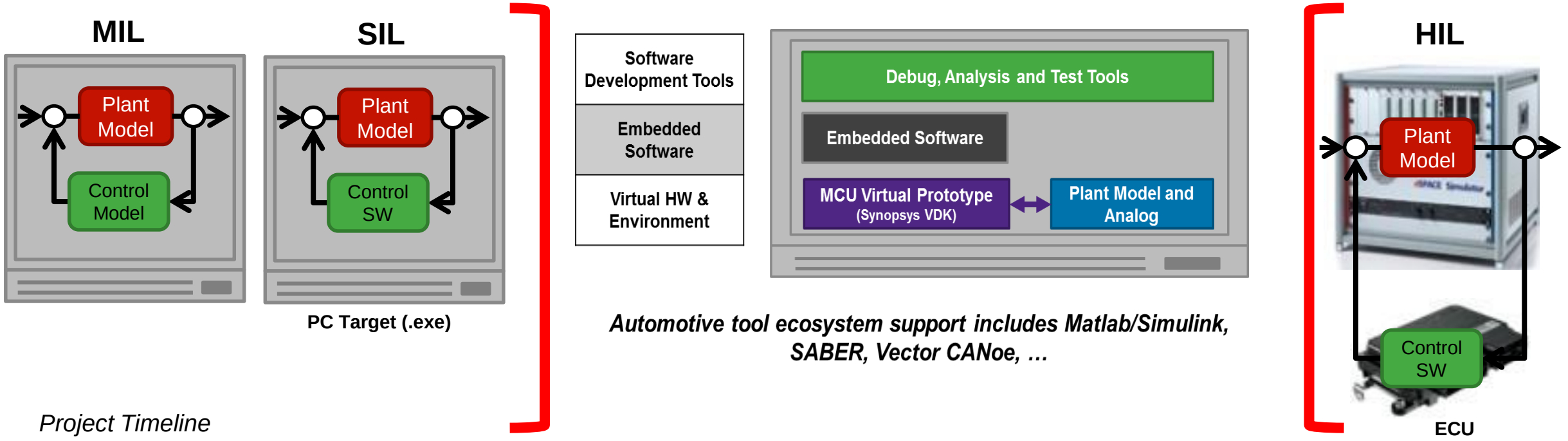
Development Gap

HIL Limitations:

- Access due to limited number of HIL systems (cost and access)
- Limited visibility and controllability
- Hard to deploy in regression
- Complex to set up, share, maintain and archive

Virtual Hardware-in-the-Loop

Start Before Test Benches are Available

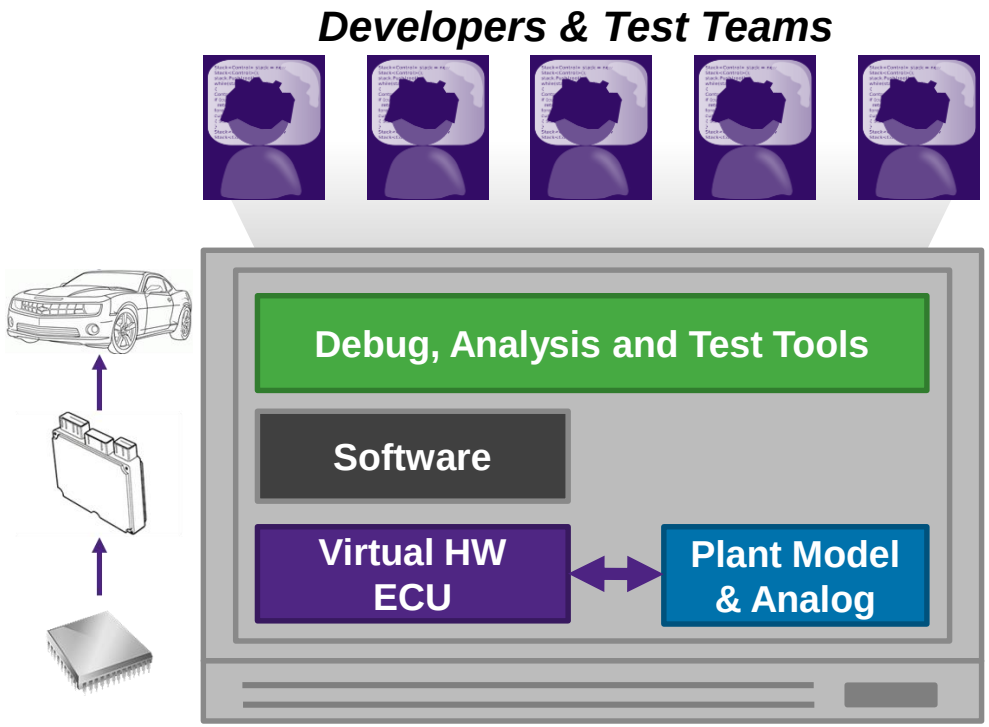


SW Development Early & Increased Testing Throughput

From Virtual SoCs to Virtual Hardware ECU(s) with Virtualizer and Automotive VDKs

Start early & accelerate development

- When SoC evaluation boards or ECU HW boards are not available
- 12-18 months earlier
- Easier and more efficient debug



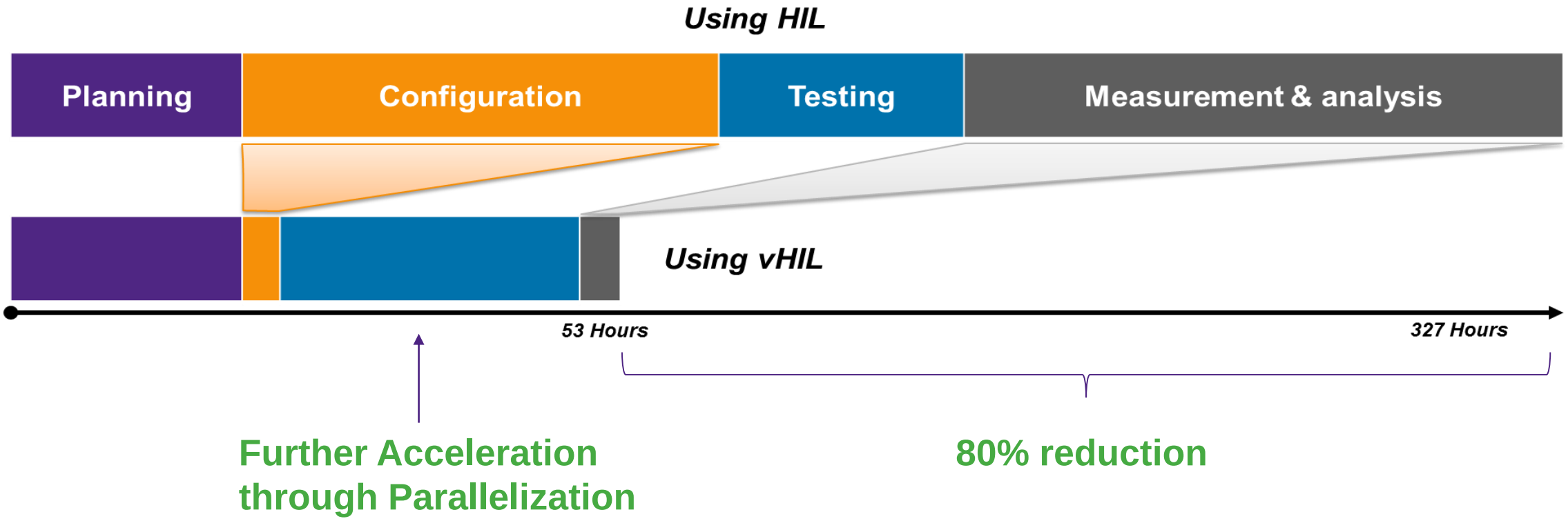
Start earlier, test faster and better

- Frontload test development
- System SW testing
- Fault & coverage testing
- Regression

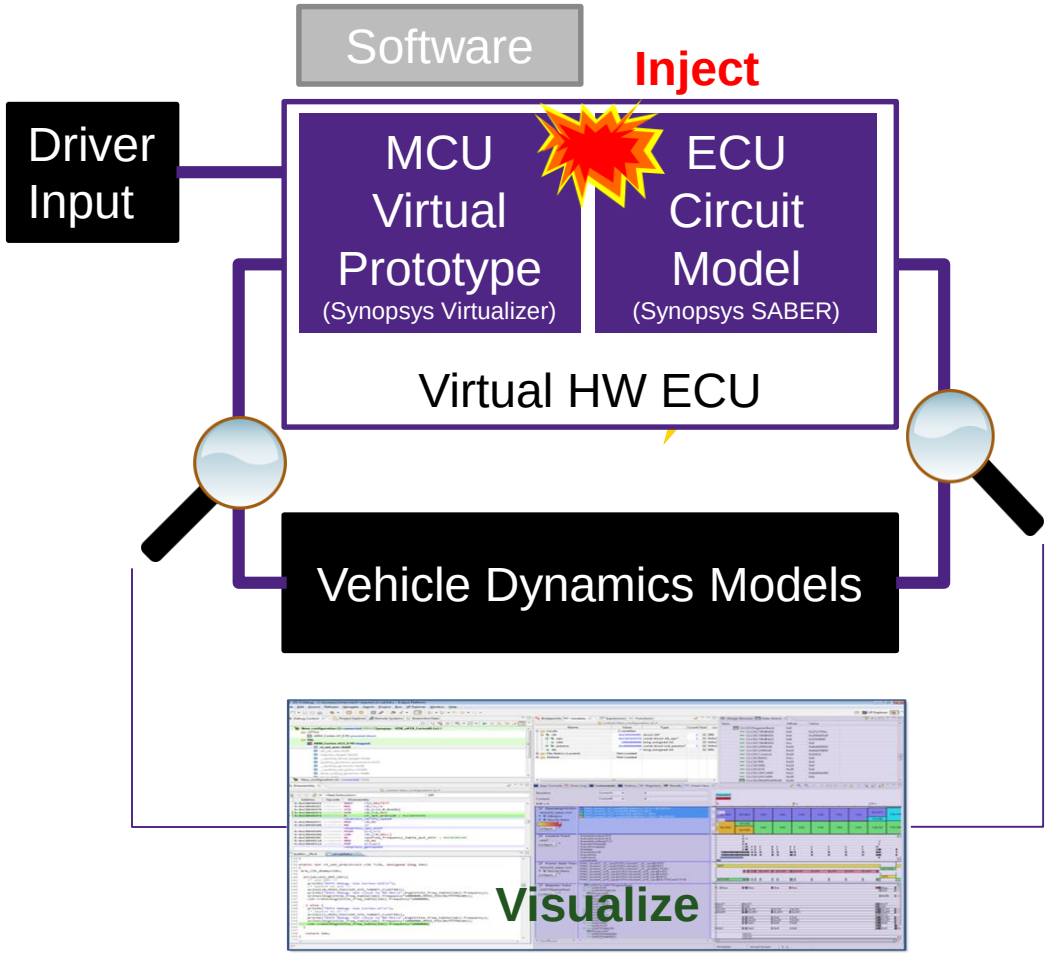
Early Software Development — HW Availability — **Increase Testing Throughput**

Significantly Increase Test Throughput

Test More and Faster – Higher Software Quality Earlier, at Every Development Milestone



Application Example to vFMEA



Actual Results

- Increased test coverage 200 to 900 tests
- Testing effort reduced from 3 man/months to 2 man weeks
- Reusable, safer and distributed access
- Faster analysis of result and change iteration

Increasing GTM software development efficiency

Challenges

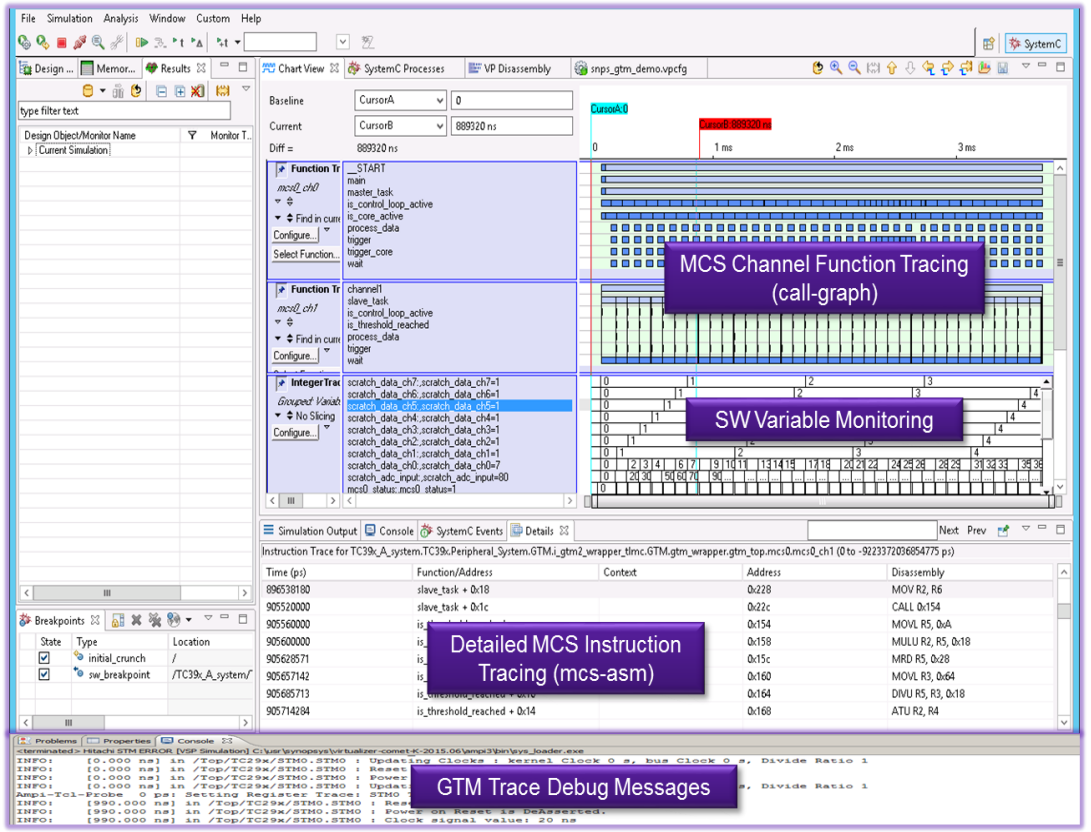
- Understanding and debugging GTM software efficiently
- Getting the right visibility into GTM itself for debug, analysis and coverage
- Getting visibility in the context of other processor core and debuggers
- Stimulating the GTM – stimulus, fault injection and associated analysis

MCU Virtual Prototypes and Virtual Hardware ECUs accelerate and simplify GTM based development!

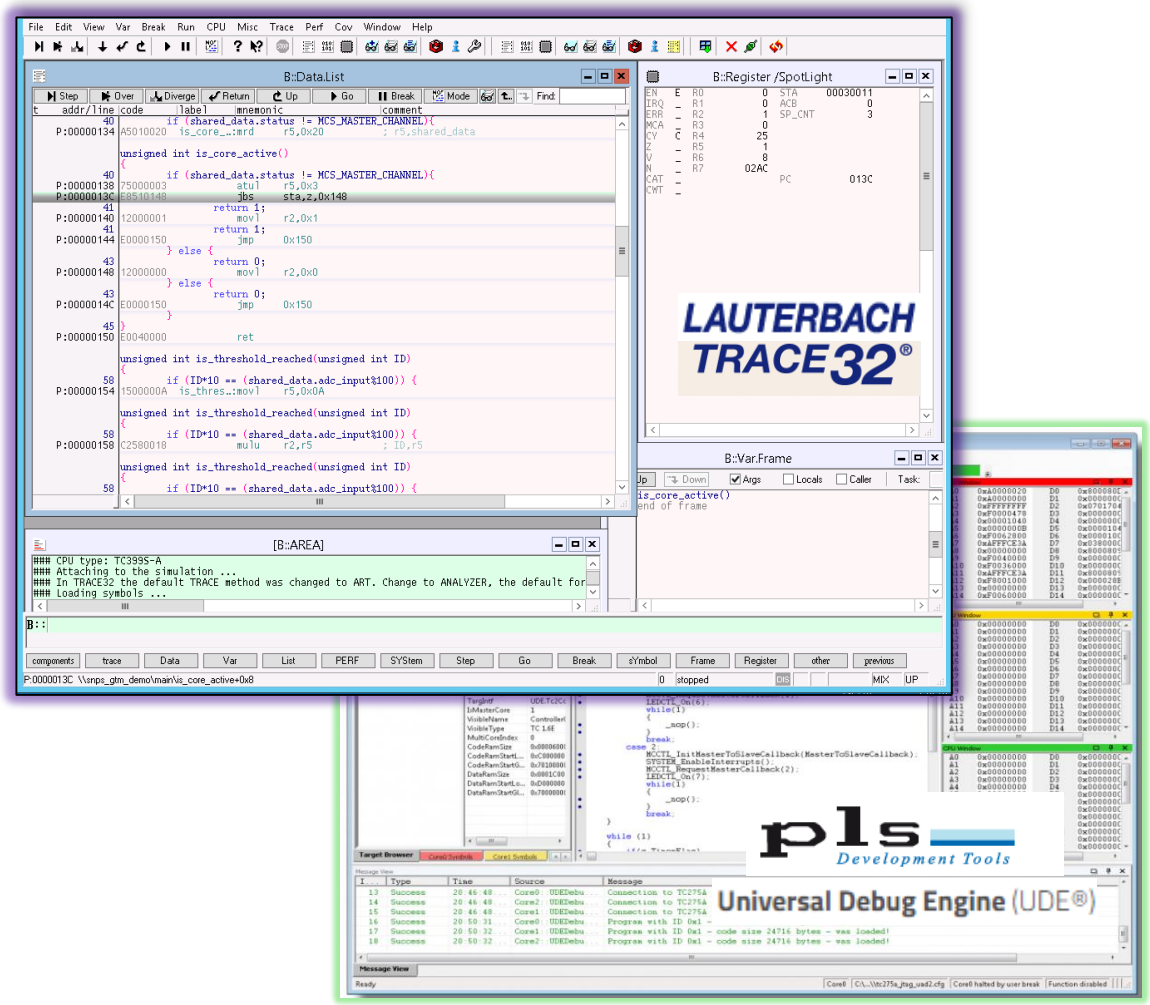
Integrated and Comprehensive GTM Debug, Tracing and Analysis

- Visibility
  - MCS Function Tracing
  - MCS Instruction Tracing
  - MCS core register and GTM config register tracing
  - MCS Memory access tracing

- Integrated and comprehensive
  - Integrated GTM “internals” tracing in unified console.
  - Viewing and Debugging in context of mainline MCU SW execution.
  - Interactive and offline



Synchronized Debugging



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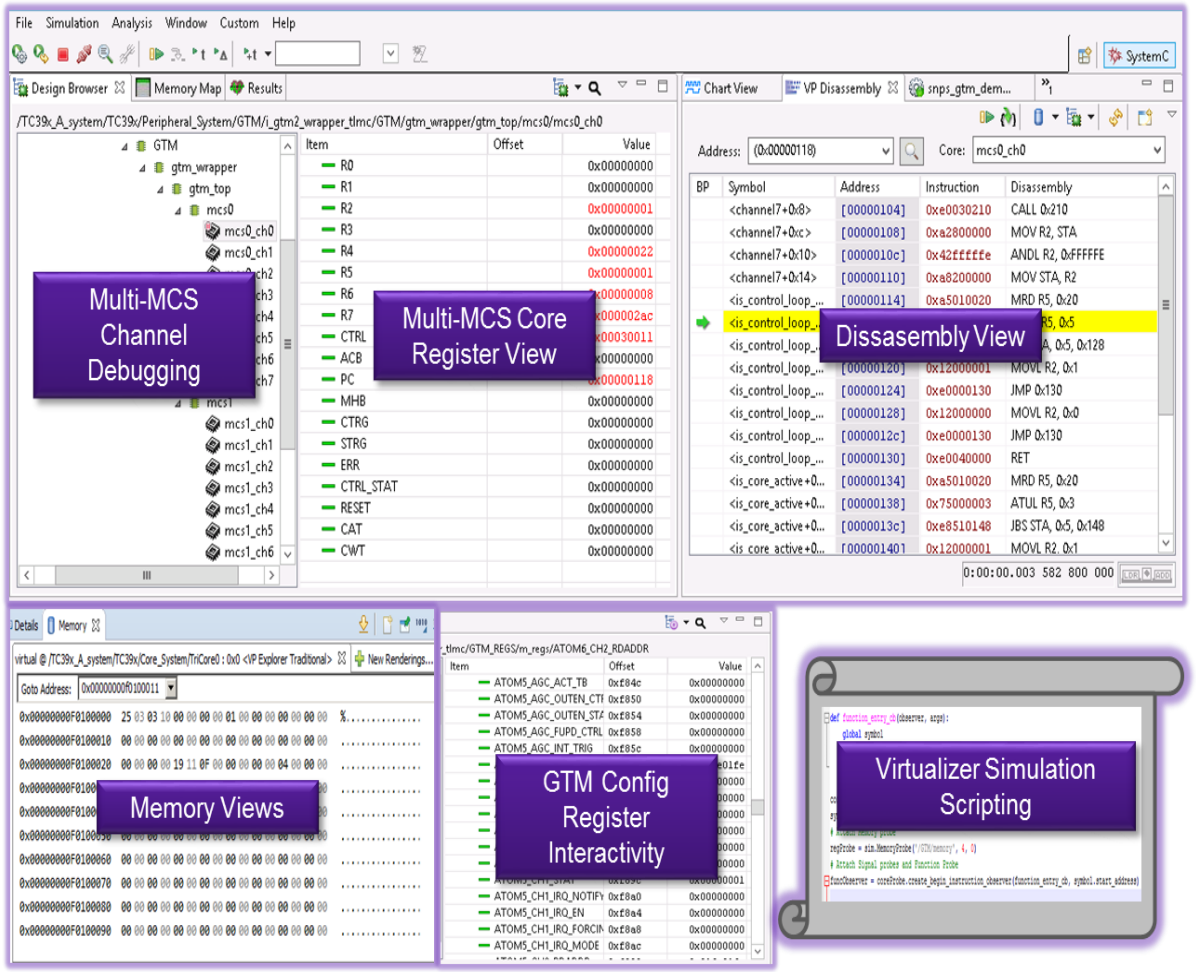
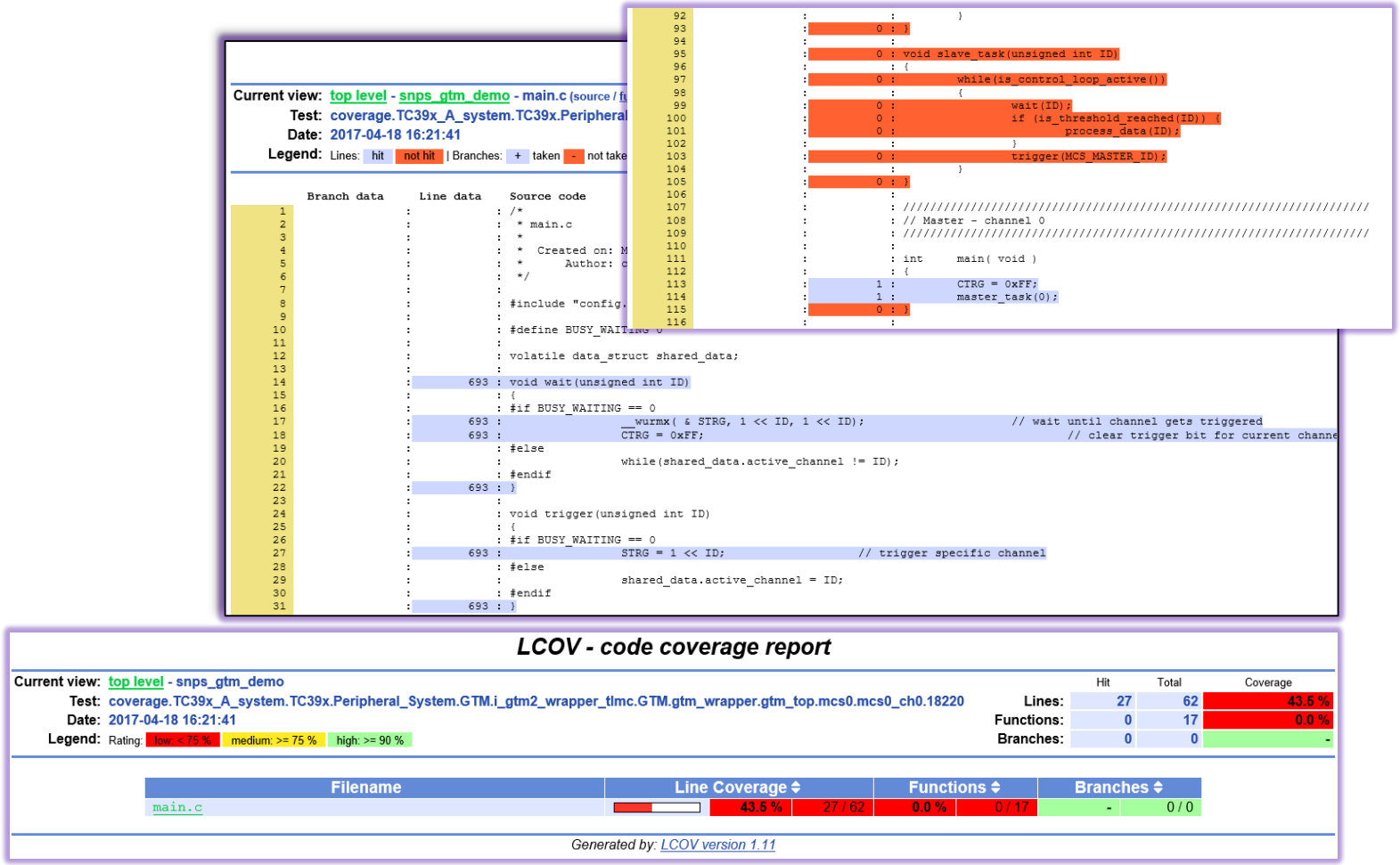


3rd Party Software Debuggers + GTM advanced visbility

GTM MCS Code Coverage

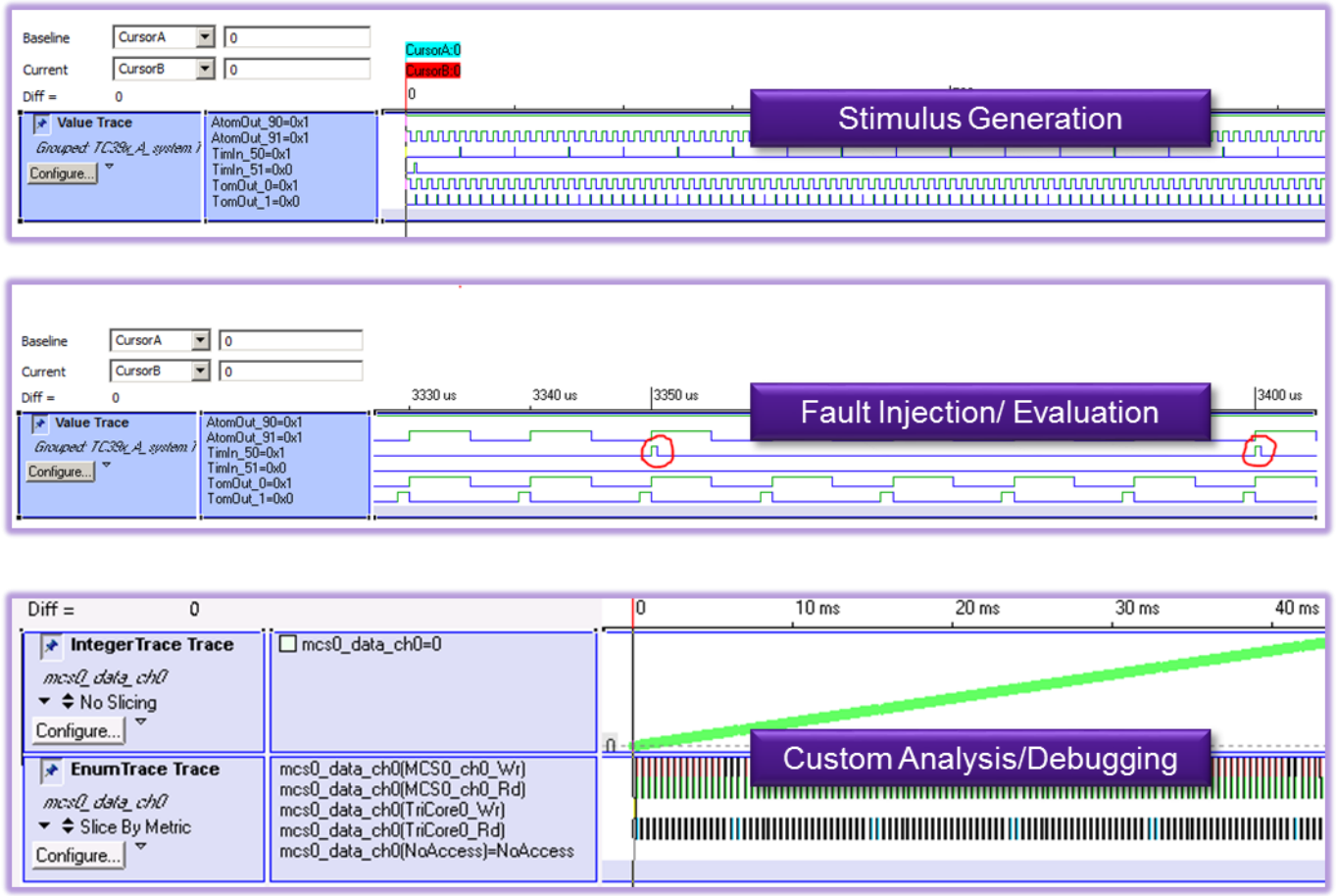
- Non-Intrusive Code Coverage for high level language MCS software
- No code modifications needed in MCS code
- Industry standard LCOV Reports
- Per or multi MCS channel coverage reports



Testing and Understanding GTM System Impact

scripting framework for fault injection, signal stimulus and analysis.

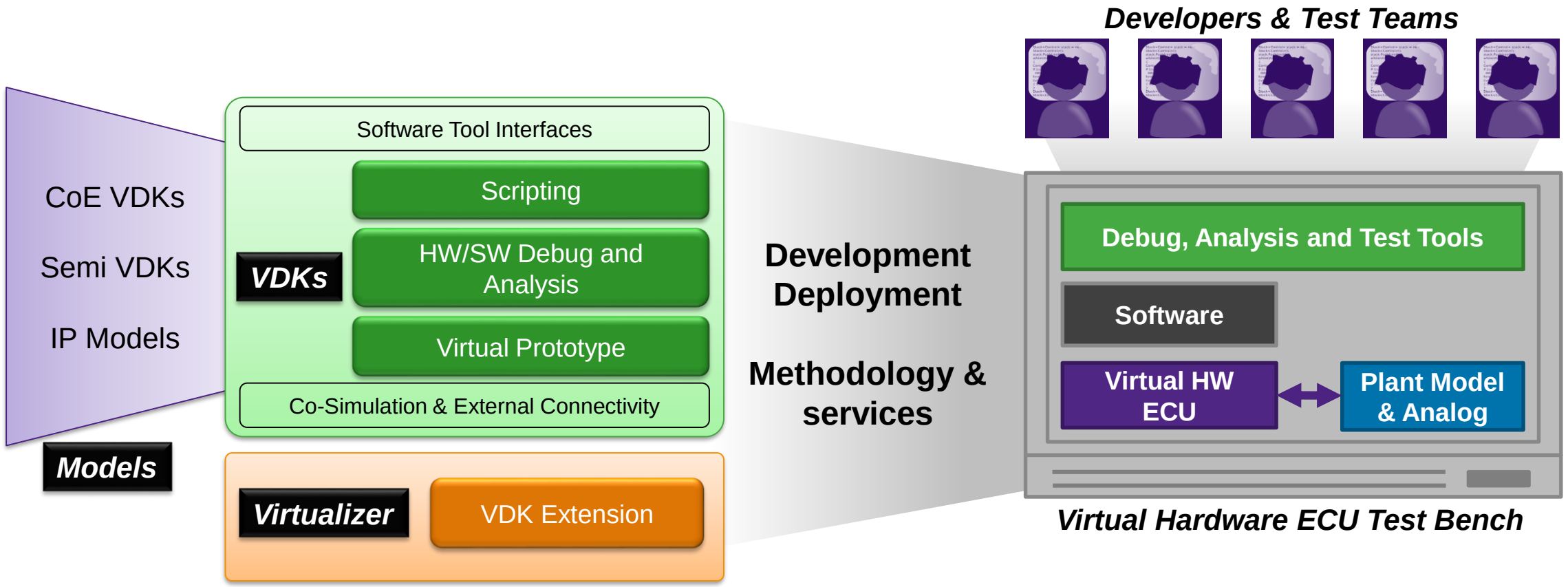
- Scriptable waveform generation for repeatable stimulus scenarios.
- Inject faults into input stimulus or output signals to establish system impact.
- Custom analysis or debugging to investigate
  - Verify data processing
  - Investigate race conditions
  - Playback of “field” issues through the GTM Reference model in MCU VDK.



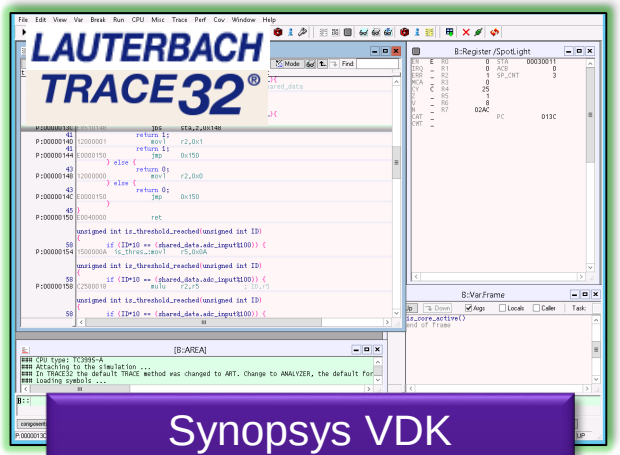
Comprehensive solution for GTM based software development and test

The most comprehensive Virtual Hardware ECU Solution

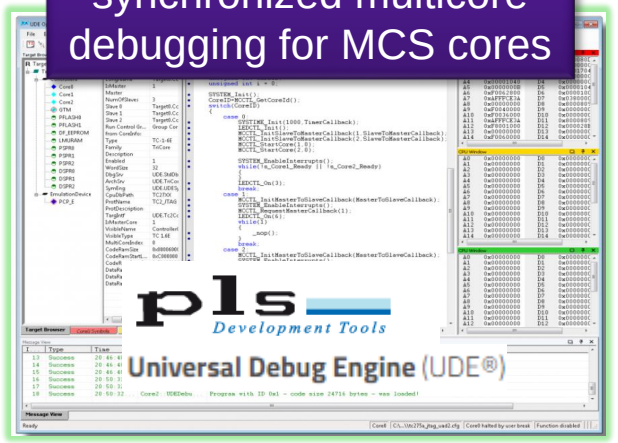
Synopsys Solution from Modeling to Test Bench Deployment

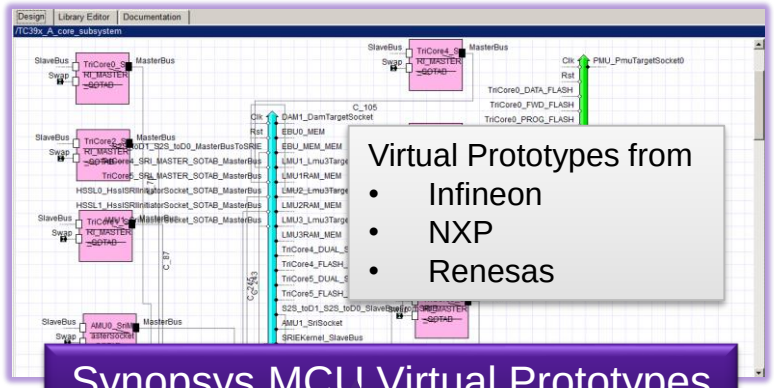


Integrated Environment to Efficiently Develop and Test GTM Software



Synopsys VDK synchronized multicore debugging for MCS cores





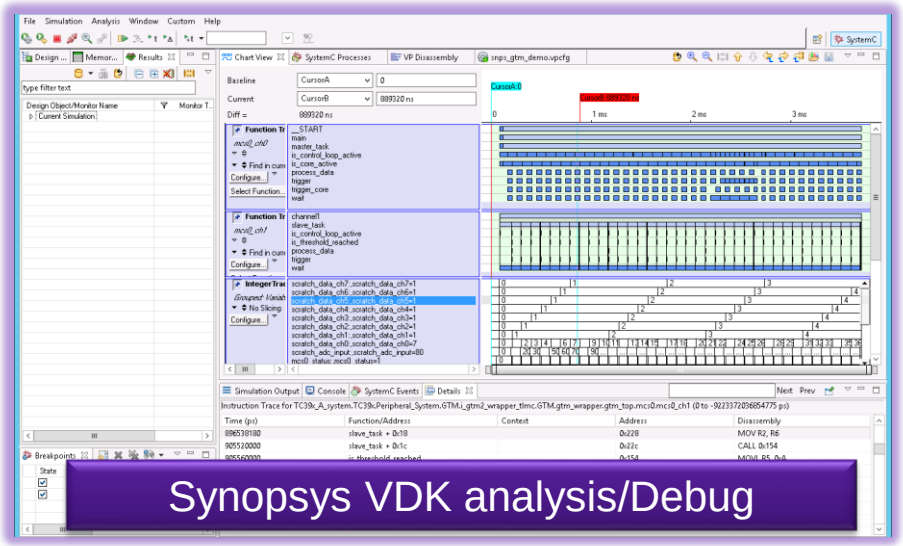
Synopsys MCU Virtual Prototypes

Automotive Electronics
Product Information
Generic Timer Module (GTM) IP

Reference Model

BOSCH
Invented for life

Execute unmodified GTM binary code on the reference Model



Synopsys VDK analysis/Debug

```
def function_entry_cb(observer, args):
    global symbol
    sim.print_message("Entry callback to function %s " % symbol.name)
    sim.resume_script()

coreProbe = sim.CoreProbe("/VP/GTM")
symbol = coreProbe.find_symbol_by_name(function_name, 'function')
# Attach Memory probe
regProbe = sim.MemoryProbe('/GTM/memory', 4, 0)
```

Synopsys VDK simulation probes

```
INFO:    [0.000 ns] in /Top/TC29x/STM0.STM0 : Updating Clocks : kernel Clock 0 s, bus Clock 0 s, Divide Ratio 1
INFO:    [0.000 ns] in /Top/TC29x/STM0.STM0 : Reset start ...
INFO:    [0.000 ns] in /Top/TC29x/STM0.STM0 : Power on Reset is Asserted.
INFO:    [0.000 ns] in /Top/TC29x/STM0.STM0 : Updating Clocks : kernel Clock 0 s, bus Clock 0 s, Divide Ratio 1
Ampi-Tcl-Probe  0 ps: Setting Register Trace: STM0 TIM0SV 0xf0000044
```

Synopsys VDK unified model debug tracing

Summary

- New approaches are needed to start development earlier and increase testing throughput for GTM based designs
- Virtual prototypes and Virtual Hardware ECUs deliver key benefits – earlier availability and faster testing throughput
- Synopsys has the most comprehensive solution in the market specifically tailored for GTM development
  - Tools enhancing GTM debug visibility and control
  - Full MCU models from companies such as NXP, Infineon and Renesas
  - Proven deployment for more than 10 years
  - Financially stable, long term vision and recognized industry leader

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