SYNOPSYS®
Silicon to Software™

Accelerating GTM Software Development and Test

In the Software and Hardware Supply Chain, by using Virtual Hardware ECUs.

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Agenda

- Industry Challenges
- Virtual Prototyping
- Supply Chain Enablement with GTM
- GTM reference Model Integration and Features

Five Biggest Automotive Industry Challenges

1

Supply Chain Disruption

- Worldwide chip shortage compressing the supply chain
- OEMs, Tier 1s, New Entrants are designing own SoCs

2

Overhaul of E/E Architectures

- Demand for new HAD/ADAS features, electrified powertrain, infotainment
- New zonal architectures

3

Complex Software Development & Deployment

- Millions lines of code
- Software updates over the air
- SW Ecosystems

4

Increasing Security Challenges

- New vulnerabilities from OTA software updates, self-driving cars, 5G connectivity
- Additional focus on security + safety

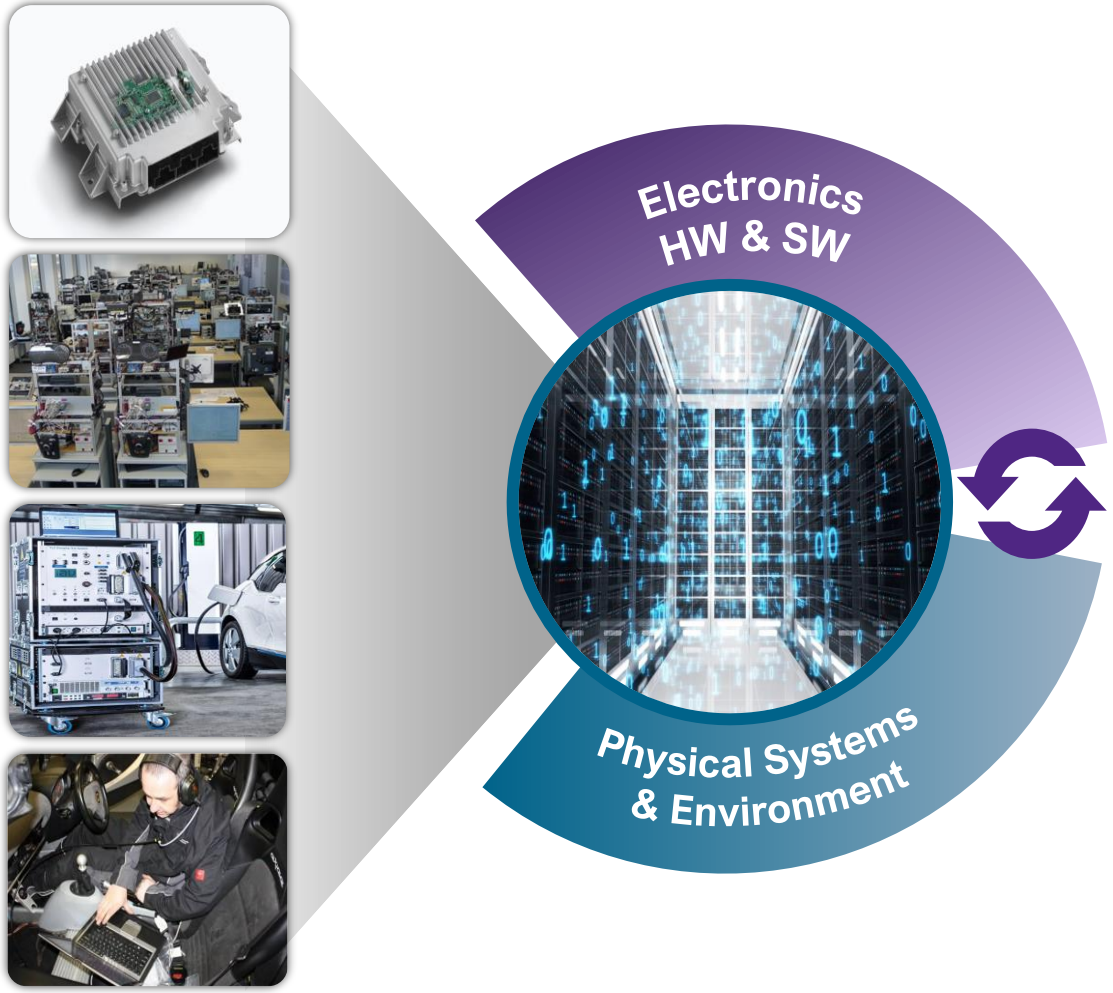
5

Accelerating Time-to-Market to Compete

- New automotive entrants challenging traditional processes

Conquer the Challenges of HW/SW System Validation

Virtual Prototyping Enables a Software-First Mindset



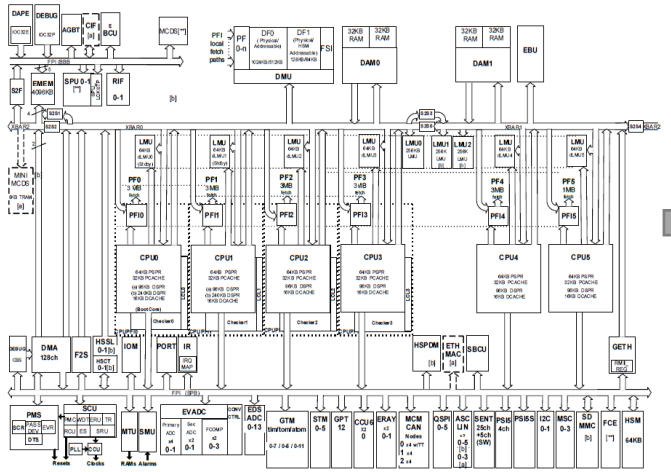
- ✓ Supply chain collaboration with executable specification
- ✓ Early SW bring-up
- ✓ More productive system testing with
  - Software-in-the-Loop
  - Virtual Hardware-in-the-Loop
  - Virtual vehicle
- ✓ Supports agile development, continuous integration and delivery
- ✓ Functional safety and security system validation

What is a Virtualizer Development Kit (VDK)?

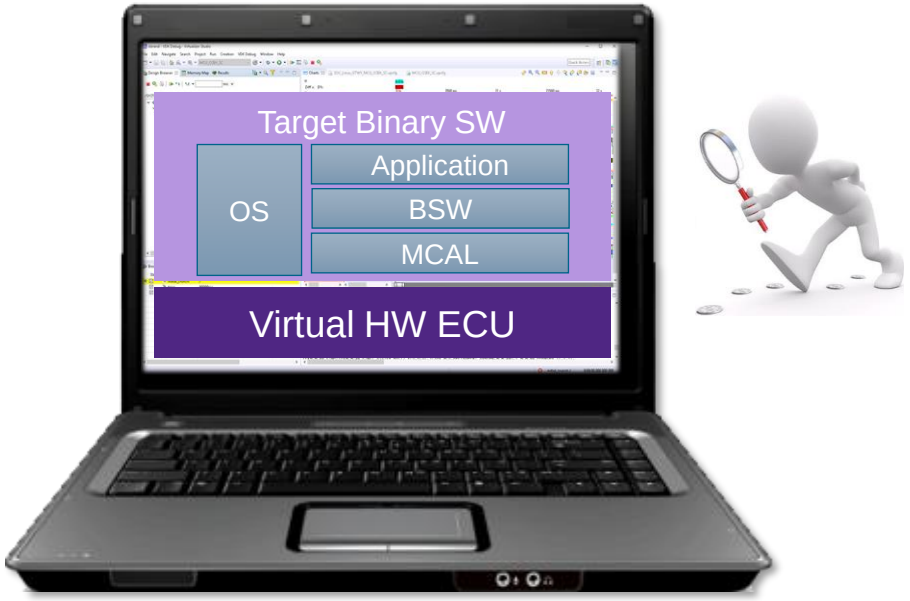
ECU

MCU

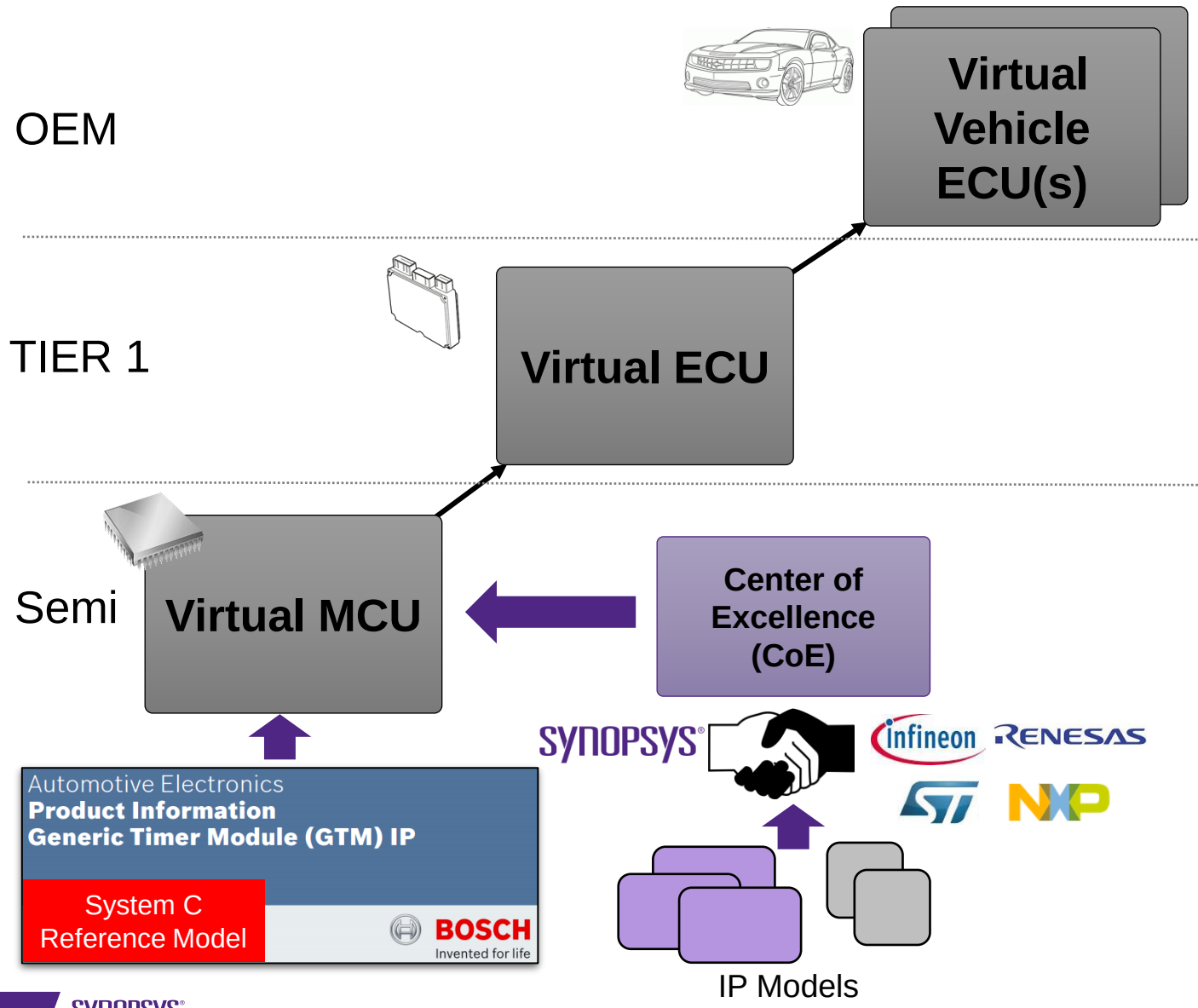
- Fast software model of the digital hardware ECU or MCU
  - Abstracted for Software Execution
- For the purpose of executing unmodified binary production software
  - Without dependency on real hardware
- And providing a higher debugging/analysis efficiency
  - And solving hardware accessibility issues, pre and post silicon



Model Creation



Supply Chain Enablement with GTM use cases



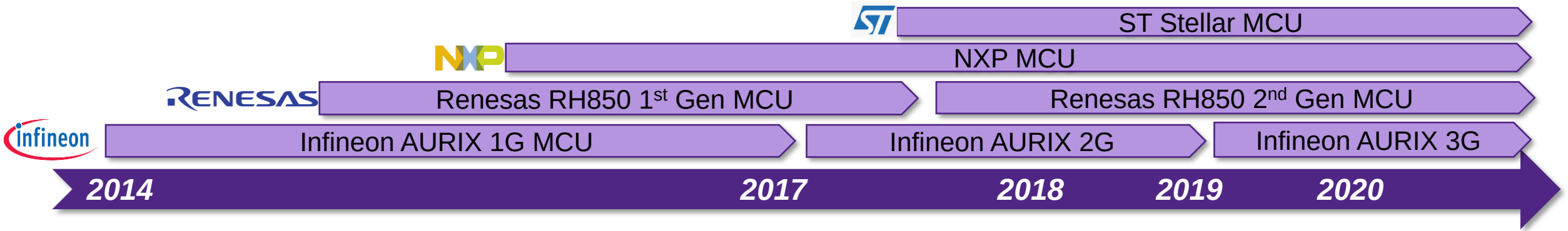
- System Level Test
- Application SW Integration
- Requirements Verification
- Full Stack Regression Testing

- CDD Development
- MCAL Integration/Dev/Test
- BSW Development/Test
- OeM Customer Enablement

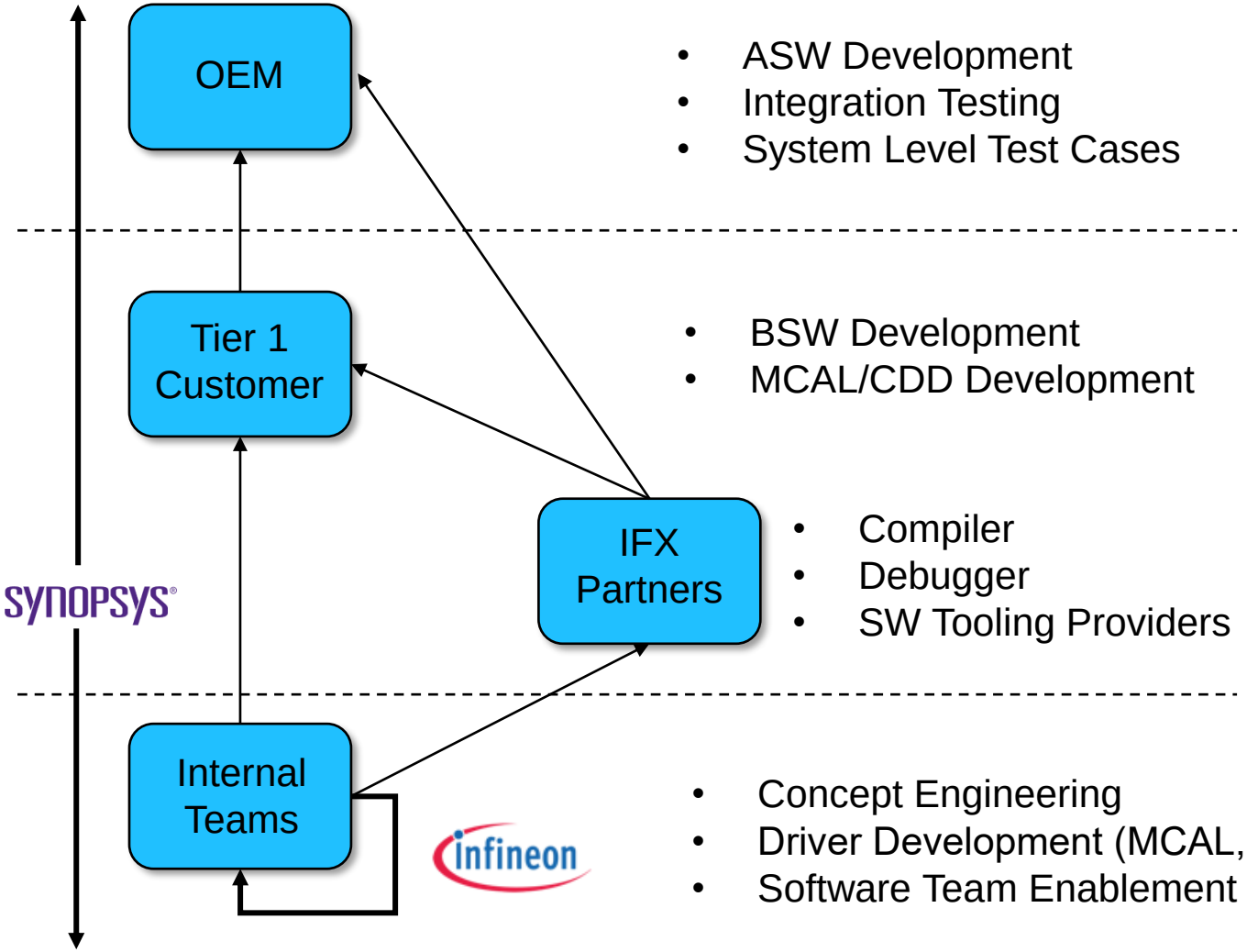
- Early Concept Studies
- MCAL/Driver development
- SW /HW Integration and Verification
- SW Partner/Tier2 Enablement
- Tier1 Customer Enablement

Enabling VDKs with the GTM & Reference Model.

- Multiple VDKs Support GTM Enablement with Multiple Semis
  - SNPS partners with top Semis in Automotive
- Synopsys Integrates Bosch GTM Reference Model Sources.
  - Including enhancements for debugging/analysis and performance
- Synopsys has a long-term relationship with Bosch
  - Delivers feedback from heavy Tier1/OEM usage
  - Delivers feedback and performance enhancements



Semi Customer and Partner Enablement Example



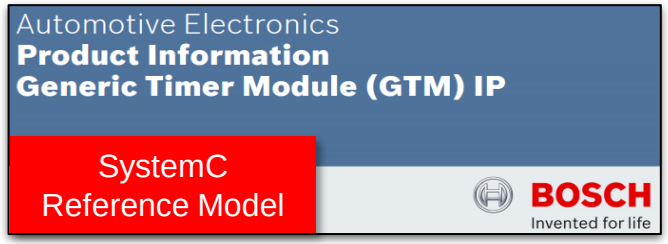
- ASW Development
- Integration Testing
- System Level Test Cases

- BSW Development
- MCAL/CDD Development

- Compiler
- Debugger
- SW Tooling Providers

- Concept Engineering
- Driver Development (MCAL,…)
- Software Team Enablement

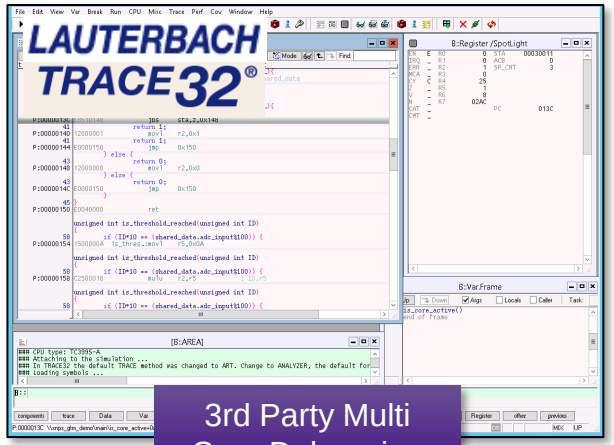
SAE INTERNATIONAL. https://event.webcasts.com/starthere.jsp?ei=1396695



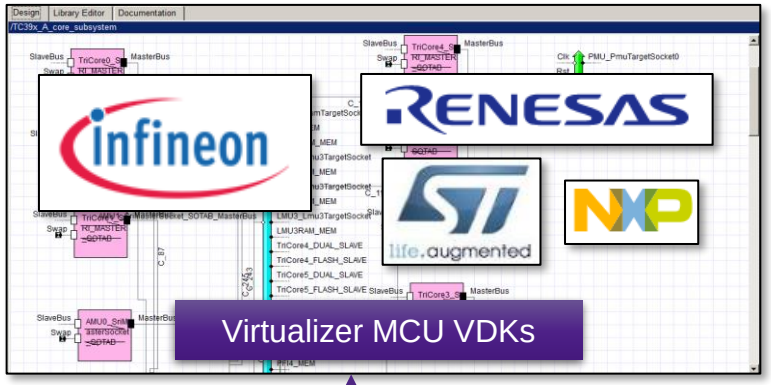
GTM Reference Model Integration Features

Enabling development, integration and test in the Supply Chain

Virtualizer GTM Reference Model Integration



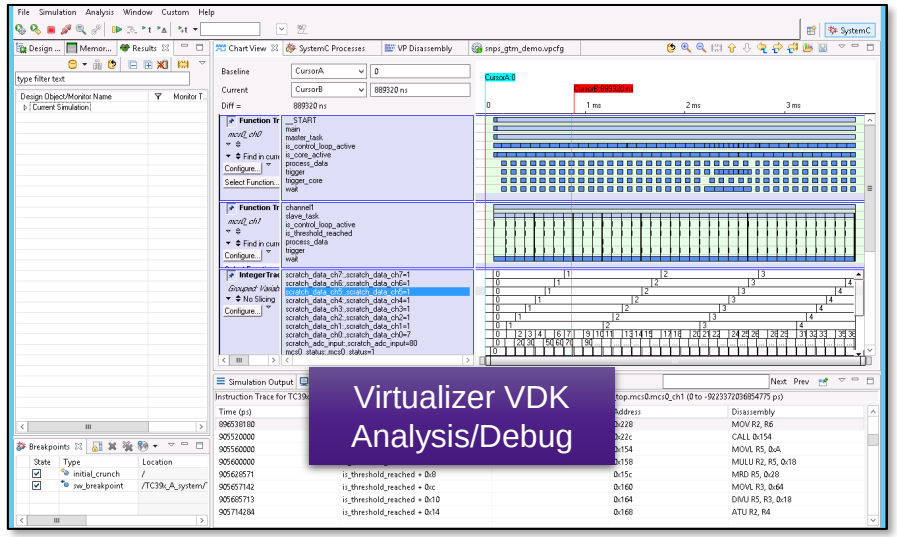
3rd Party Multi Core Debugging for MCS Cores



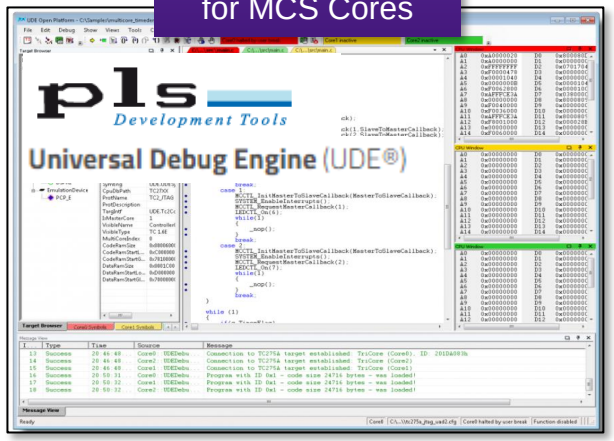
Automotive Electronics
Product Information
Generic Timer Module (GTM) IP

SystemC Reference Model

BOSCH
Invented for life



Virtualizer VDK Analysis/Debug



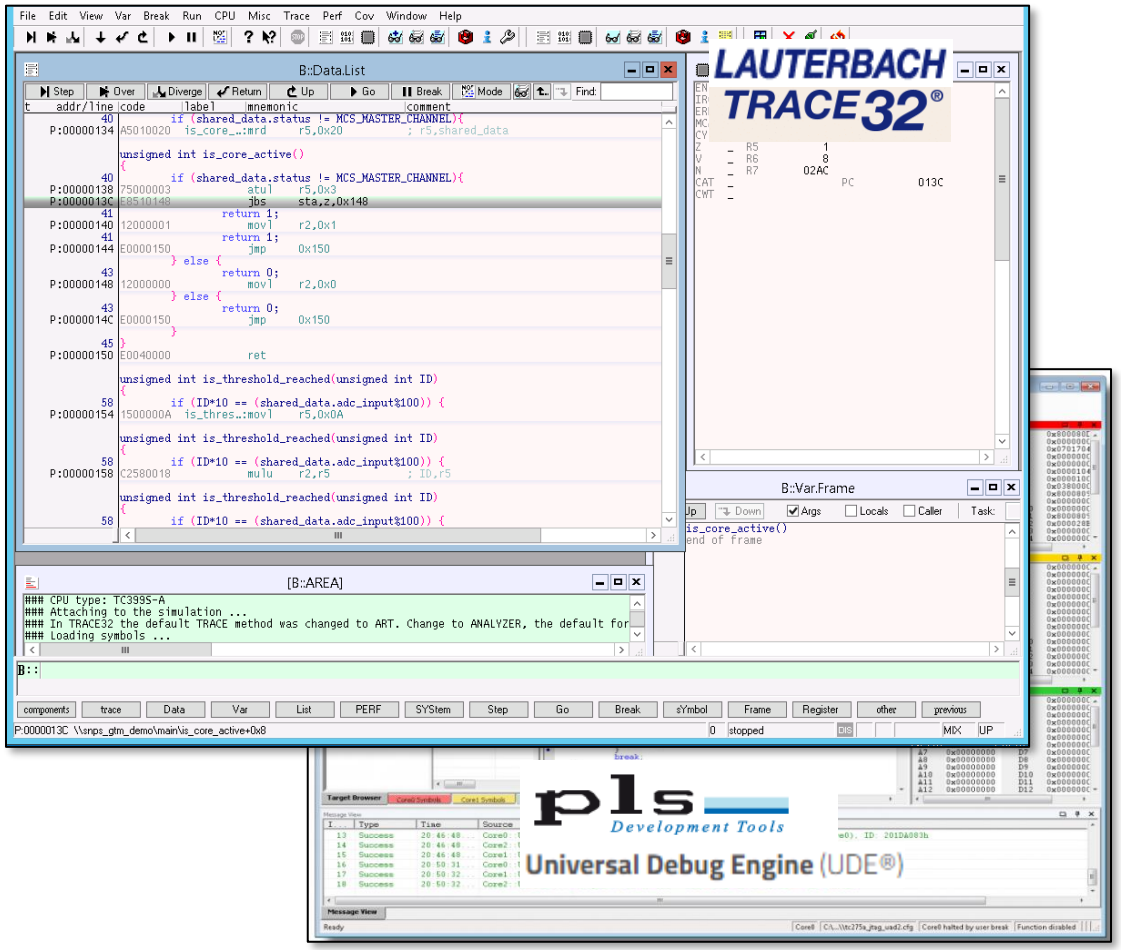

```
def function_entry_cb(observer, args):
    global symbol
    sim.print_message("Entry
    sim.resume_script()

coreProbe = sim.CoreProbe("/VP
symbol = coreProbe.find_symbol
# Attach Memory probe
regProbe = sim.MemoryProbe('/GTM/memory', 4, 0)
# Attach Signal probes and Function Probe
funcObserver = coreProbe.create_begin_instruction_observer(function_entry_cb, symbol.start_address)
```

Virtualizer Simulation Probes

```
Problems  Properties  Console
<terminated> Hitachi STM ERROR [VSP Simulation] C:\usr\synopsys\virtualizer-comet-K-2015.06\ampi3\bin\sys_loader.exe
INFO:    [0.000 ns] in /Top/TC29x/STM0.STM0 : Updating Clocks : kernel Clock 0 s, bus Clock 0 s, Divide Ratio 1
INFO:
INFO:
INFO:
Ampi-Tcl-Probe
INFO:
INFO:    [990.000 ns] in /Top/TC29x/STM0.STM0 : Power on Reset is DeAsserted.
INFO:    [990.000 ns] in /Top/TC29x/STM0.STM0 : Clock signal value: 20 ns
```

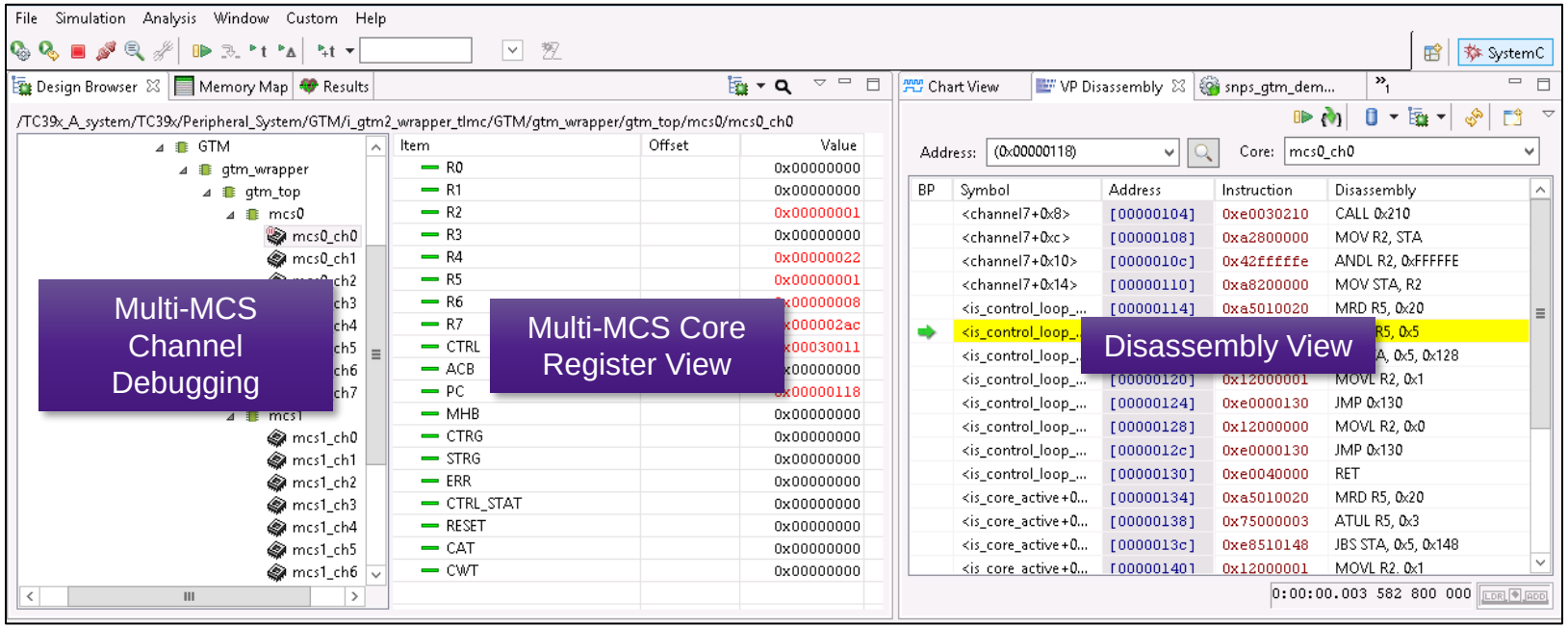
Model Debug Tracing in Virtualizer unified Console

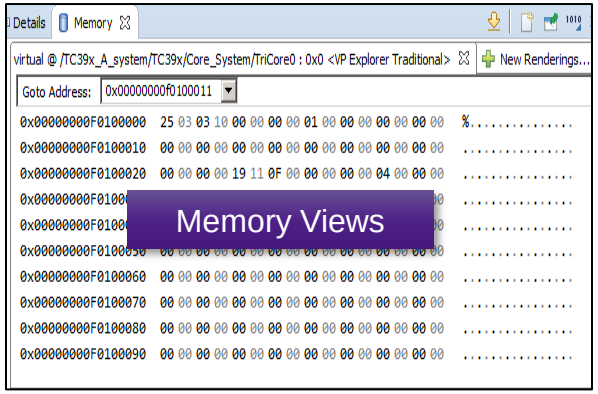
Third Party Debugger Tooling - Multicore Capable

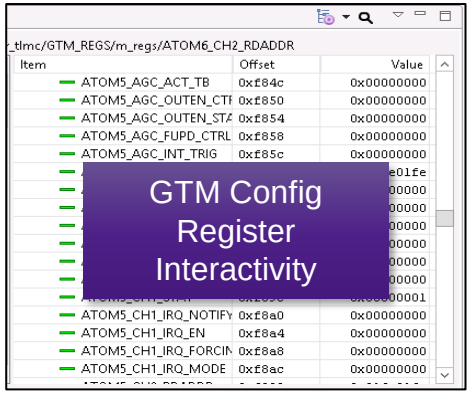


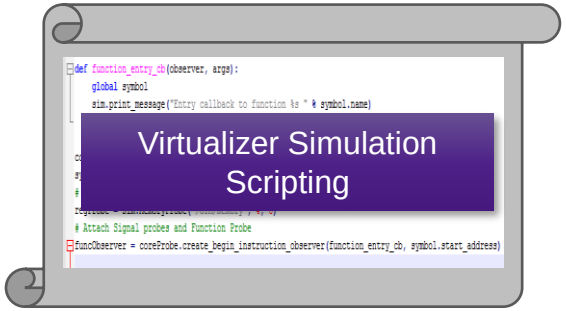
- Support for Full Register Set (PER file)
- MCS memory visibility and interactivity.
- Support for synchronized multicore debugging for MCS channels
  - Synchronised to MCU cores to maximize visibility and correlation.
  - Co-debugging with MCU cores supported
- MCS-asm debugging support
- High Level Language (C/C++) debugging support for MCS engines.

Virtualizer GTM Synchronized Debugging and Visibility



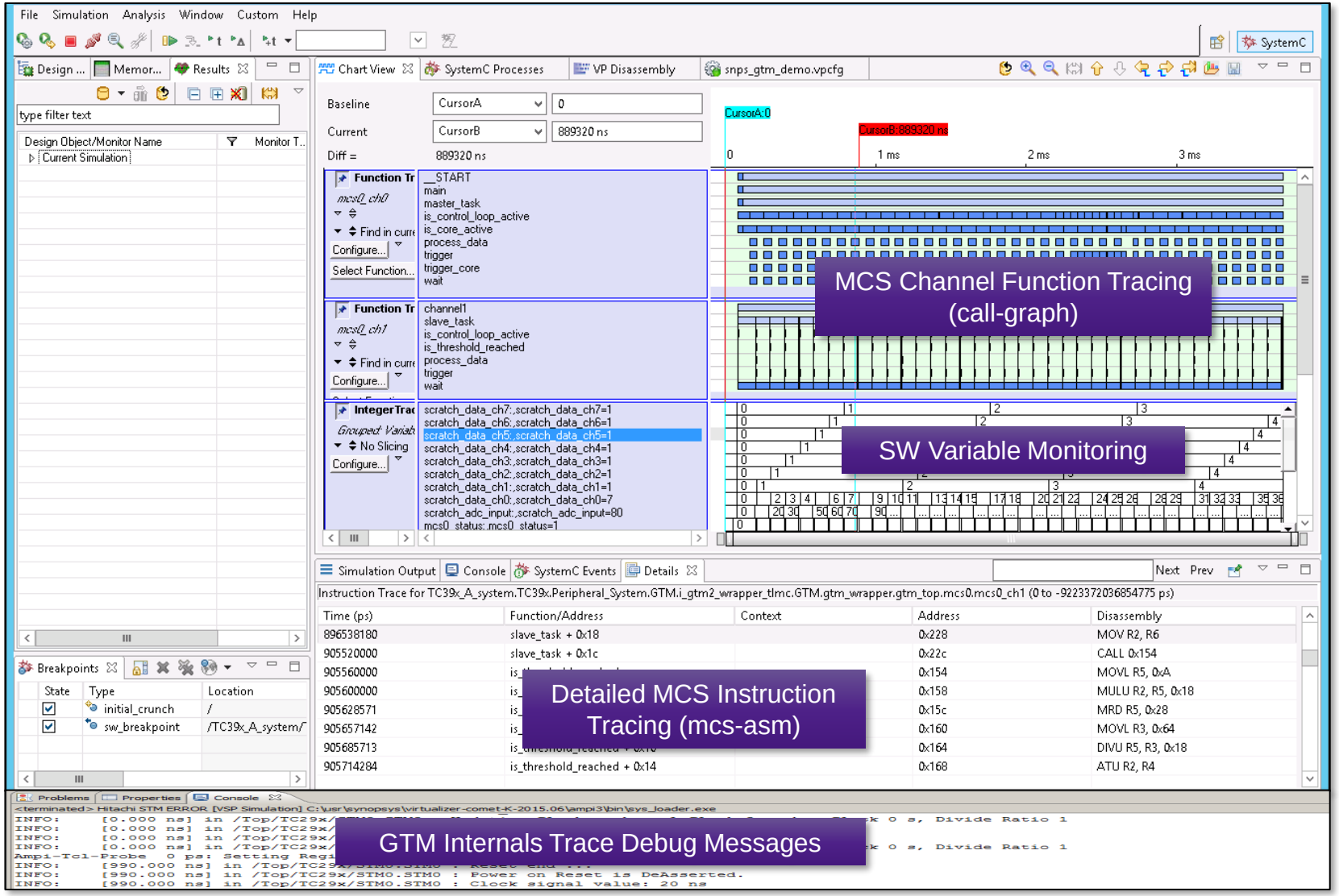






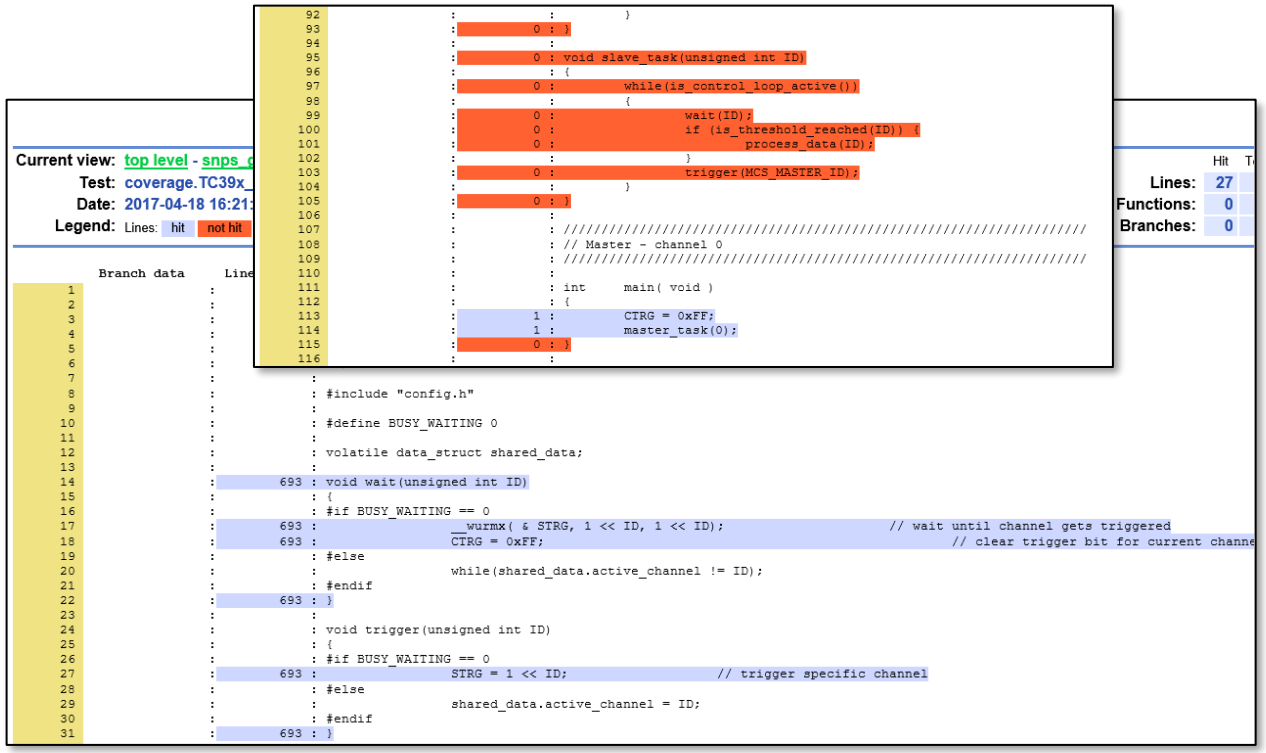
- All MCS executable Channels instrumented as Virtualizer “Cores”.
- Seamless Channel switching with MCU cores and GTM MCS “cores”
- Interactive MCS Register Views
- Interactive Config Register Views
- Virtualizer Debugger Scripting supported for integrated system debugging.

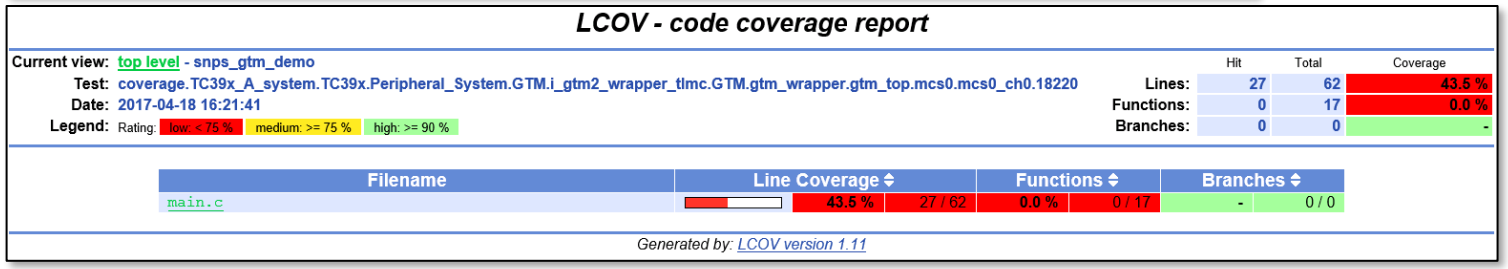
Virtualizer GTM Tracing and Analysis



- Virtualizer Integration for Software Analysis
  - MCS Function Call-Graph Tracing
  - MCS Instruction Tracing
  - GTM config register tracing
  - MCS Memory access tracing
- Integrated GTM Ref Model “Internals” tracing in unified console.
  - Controlled via scripting or interactively
- Viewing and Debugging in context of mainline MCU SW execution.

Virtualizer GTM MCS Code Coverage Solution.



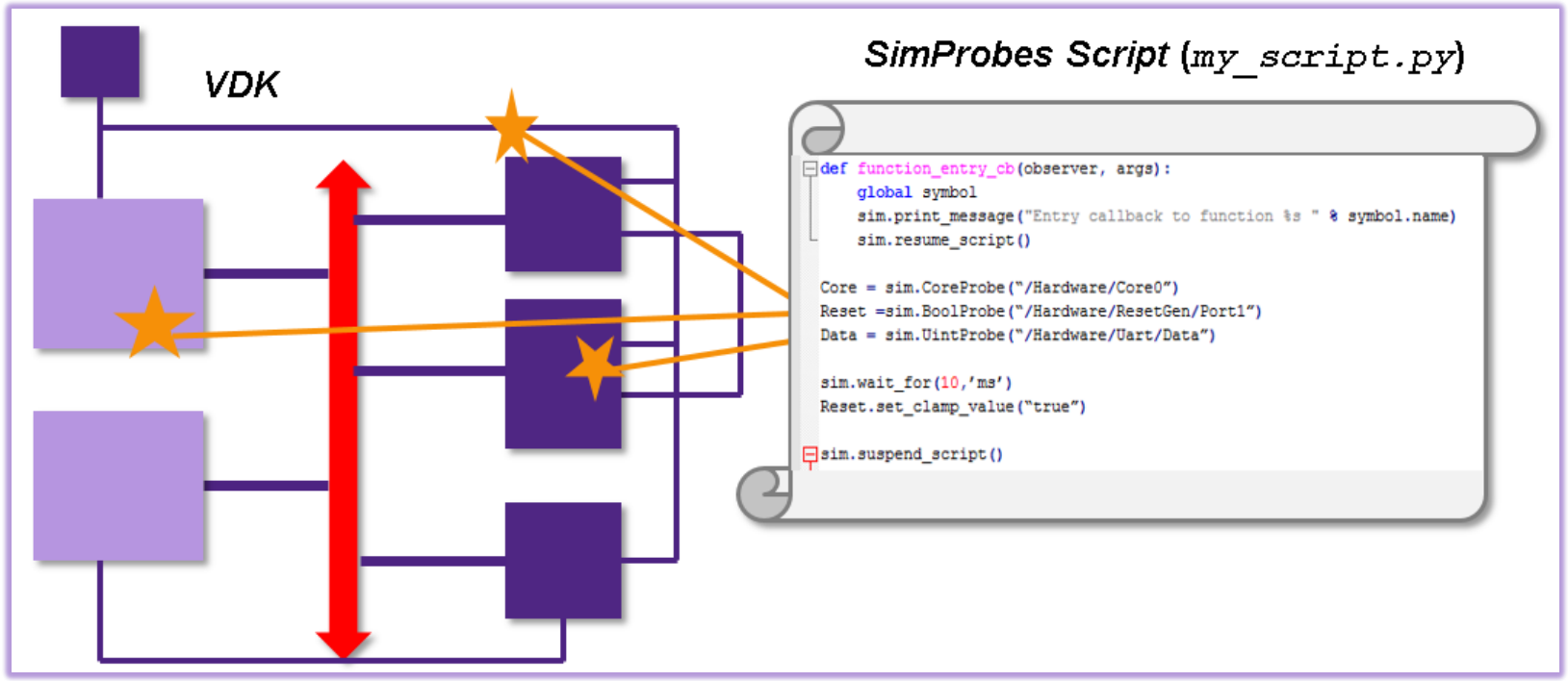


- Non-Intrusive Code Coverage for high level language MCS.
- No ‘gcov’ code modifications needed in MCS code
  - Uses Virtualizer’s non-intrusive instrumentation
- Industry standard LCOV Reports.
  - Intermediate formats available for custom report generation
- Flexible MCS channel coverage reports
  - Can be per MCS channel or
  - Single merged multi MCS channel report
- Line, Branch and Function coverage stats

Virtualizer Simulation Probes

(stimulus, fault injection, and analysis)

- GTM integration is compatible with Virtualizer Simulation Probes
- What is Virtualizer Simulation Probes.
  - An in-simulation python scripting framework for fault injection, signal stimulus and analysis.



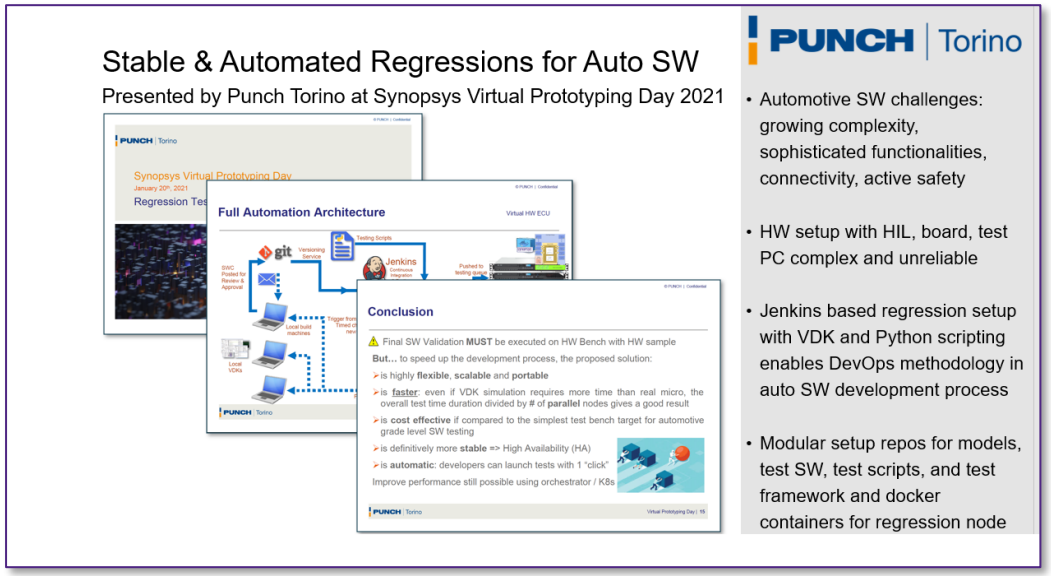
- Allows you to override and control signals anywhere in the MCU VDK model
- Override and control mechanisms are uniquely supported in the Synopsys SystemC kernel.
- Unlimited number of scripts allowed to run in parallel.
- It runs inside simulation process , so has high simulation speed.

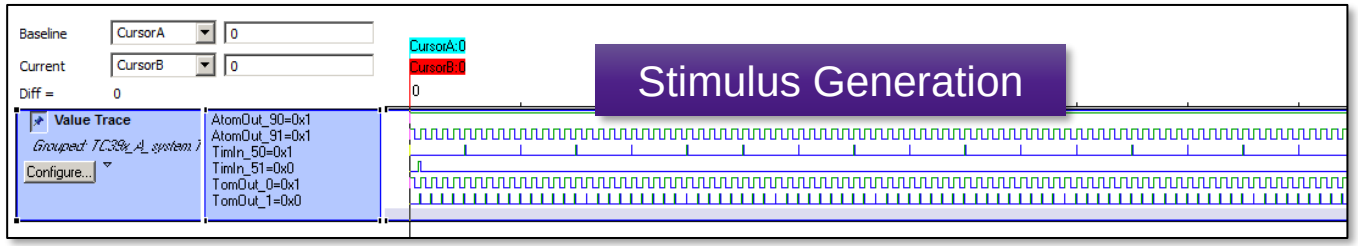
Practical GTM use Case on Powertrain Virtual HIL (vHIL)

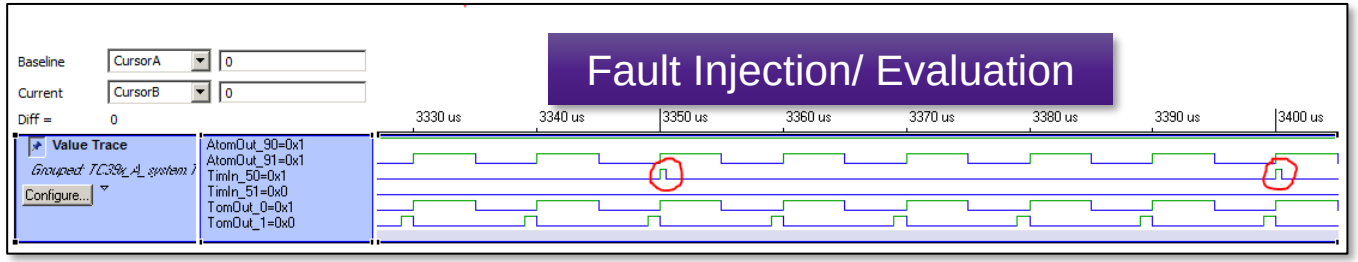
- Target –
  - Reliable testing methodology with regressions
  - Replacing HIL stimulus with scripted stimulus
    - Crank/Cam/Injection….

- Methodology -
  - Scriptable waveform generation for repeatable stimulus scenarios.
  - Inject faults into input stimulus or output signals to establish system impact.
  - Custom analysis for debugging purpose
  - Regression environment (CI/CD, Jenkins…)

  - VDK including an integrated GTM reference model critical part of the verification.

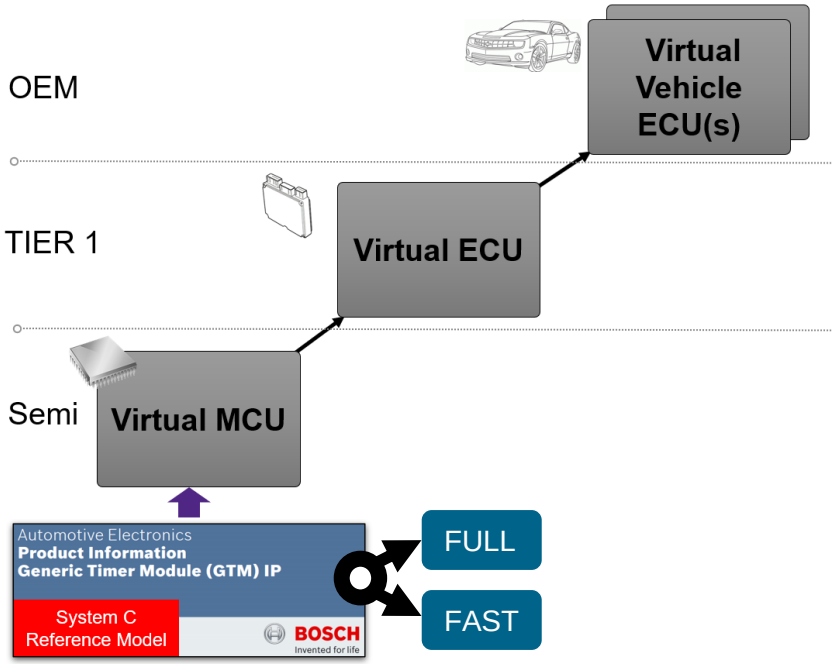






Working with GTM through the supply chain

- There is a need for more abstractions as we move up the design chain and systems become more complex
  - Mixing different representations VDK, Silver, …
- GTM is used along the supply chain from Semi to OEM
  - We need an “Optimized Fast GTM” based on the use case
  - OEMs can often get away with some abstraction of detail
  - Tier1 and Semi may not need all details, especially if GTM is not the focus of a particular test
- Use a switchable GTM model
  - A combination of the reference model with a more abstract implementation
  - User can decide which one to use, full detail or fast model



Summary

- Virtual Prototypes are essential to address today's automotive design challenges
- The GTM is a critical component of many MCUs and requires advanced debugging and analysis features to fully exploit its feature set
- Synopsys has a comprehensive solution around the GTM enabling SW development in the context of the full system at any point along the supply chain
- Synopsys is actively involved in integrating and optimizing the GTM reference model provided by BOSCH.

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Thank You