Boosting Debug Productivity -
Practical Applications of Verdi Debug Innovations
Embedded Software Debug Tutorial

Alex Wakefield

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Agenda

Synchronized HW SW Debug

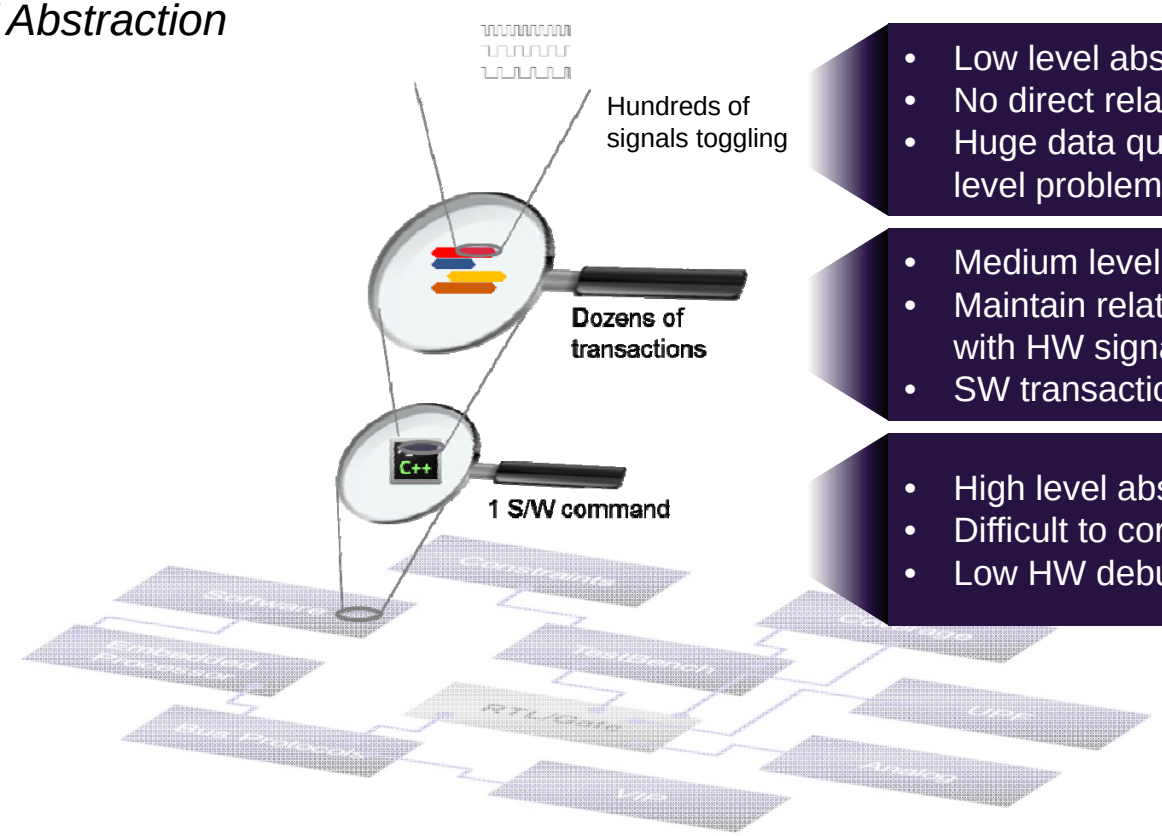
Practical Debug Application: Linux Boot

Performance Profiling of Embedded Software

Coverage Metrics for Embedded Software

SoC Debug Challenges

Levels of Abstraction



- Low level abstraction
- No direct relation to SW transaction
- Huge data quantity to debug system level problems

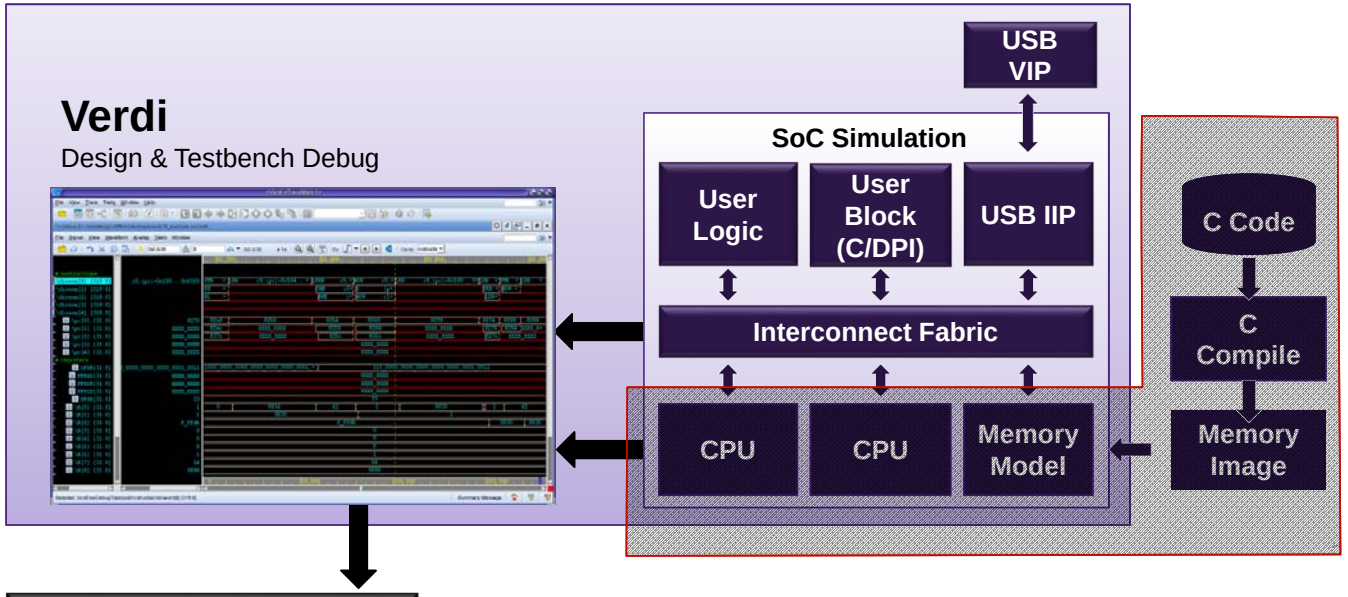
- Medium level abstraction
- Maintain relation to correlate with HW signals
- SW transaction concept available

- High level abstraction
- Difficult to correlate to HW
- Low HW debug visibility

Correlated debug across abstraction levels is required

SoC Debug Challenges

Lack of Visibility on the Software Side



CPU Software Debug

- Encrypted Model ?
- Registers + Nets ?
- No or Low-Visibility
- Looks like a Black Box

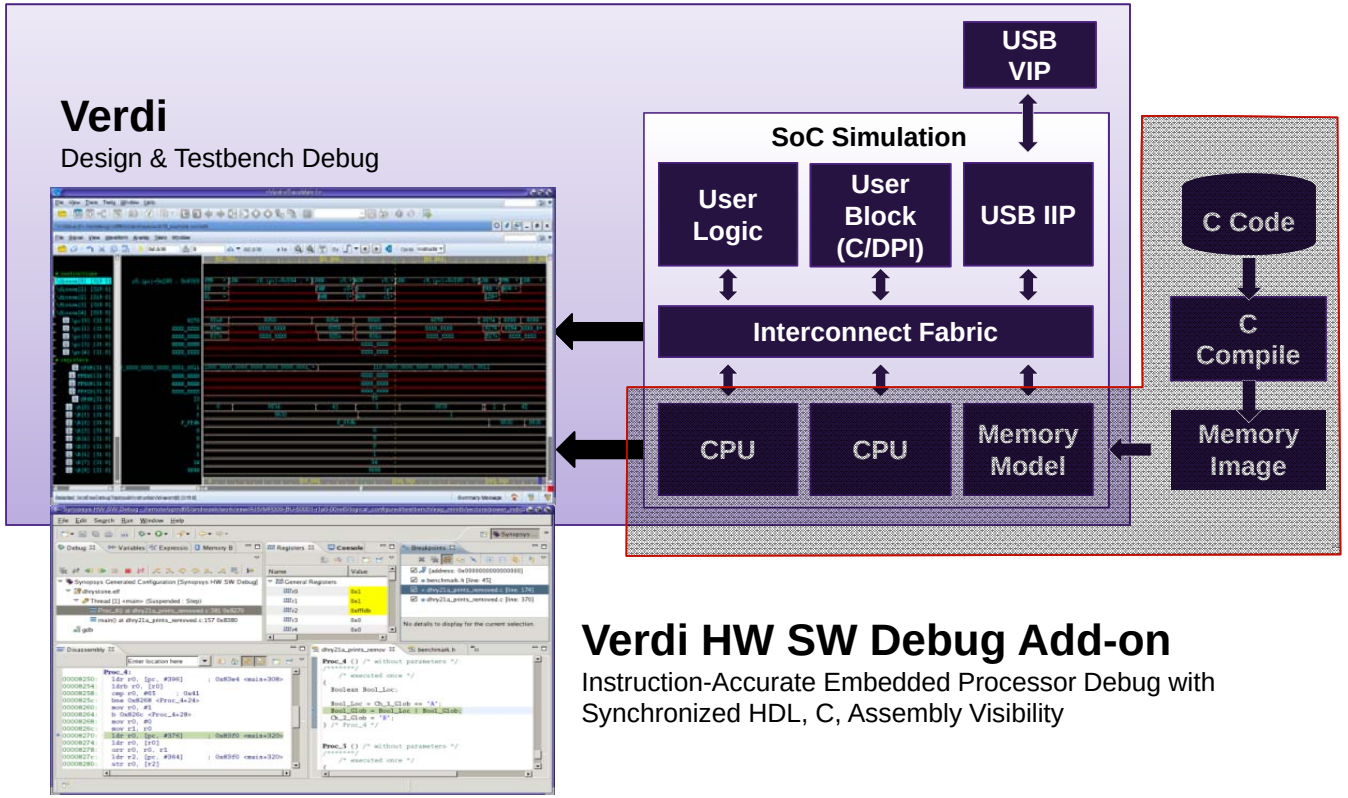
Time Consuming Manual Debug:

- Log-files, Waveforms
- ELF Dump, Disassembly
- Decoding Stack, Variables

At every point in time…

SoC Debug Challenges

Lack of Visibility on the Software Side



Verdi HW SW Debug Add-on

Instruction-Accurate Embedded Processor Debug with Synchronized HDL, C, Assembly Visibility

Embedded Software Debug in Eclipse

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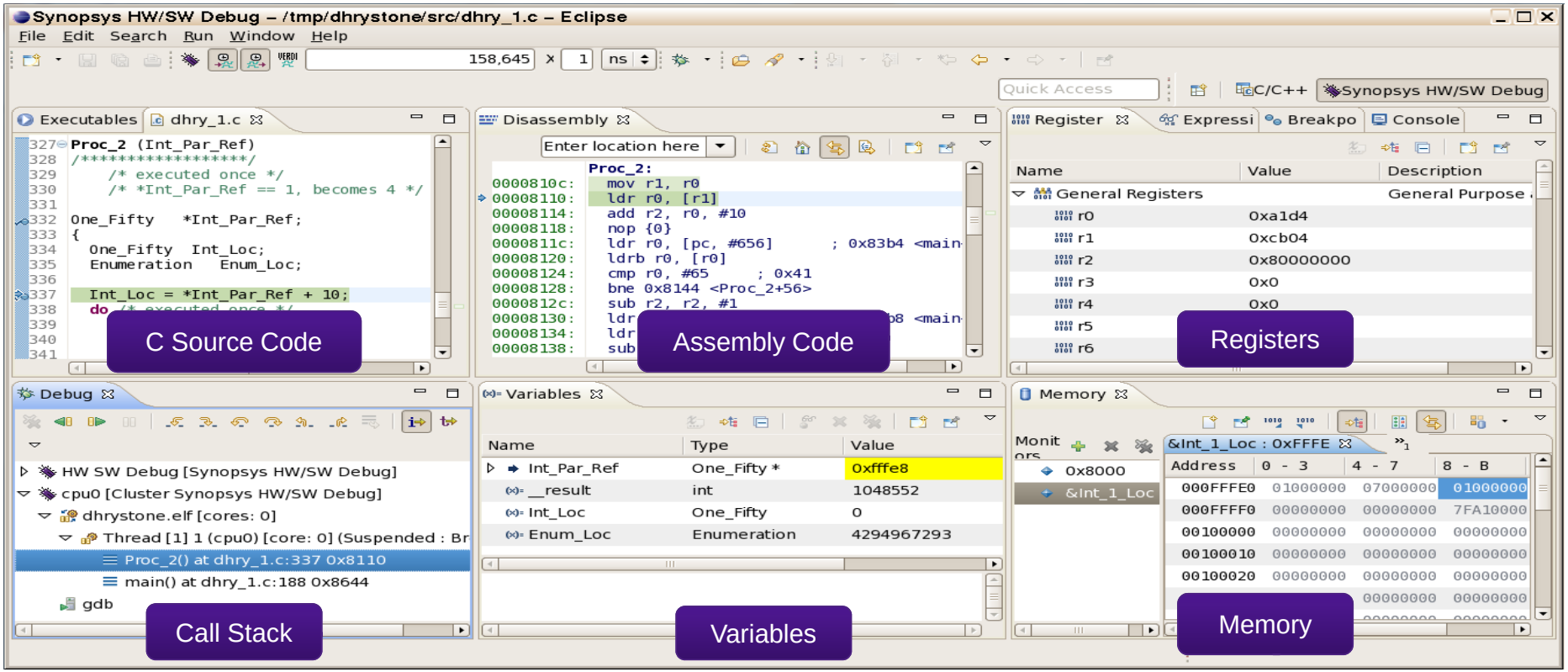

Provides programmer's view of code running on simulated processor

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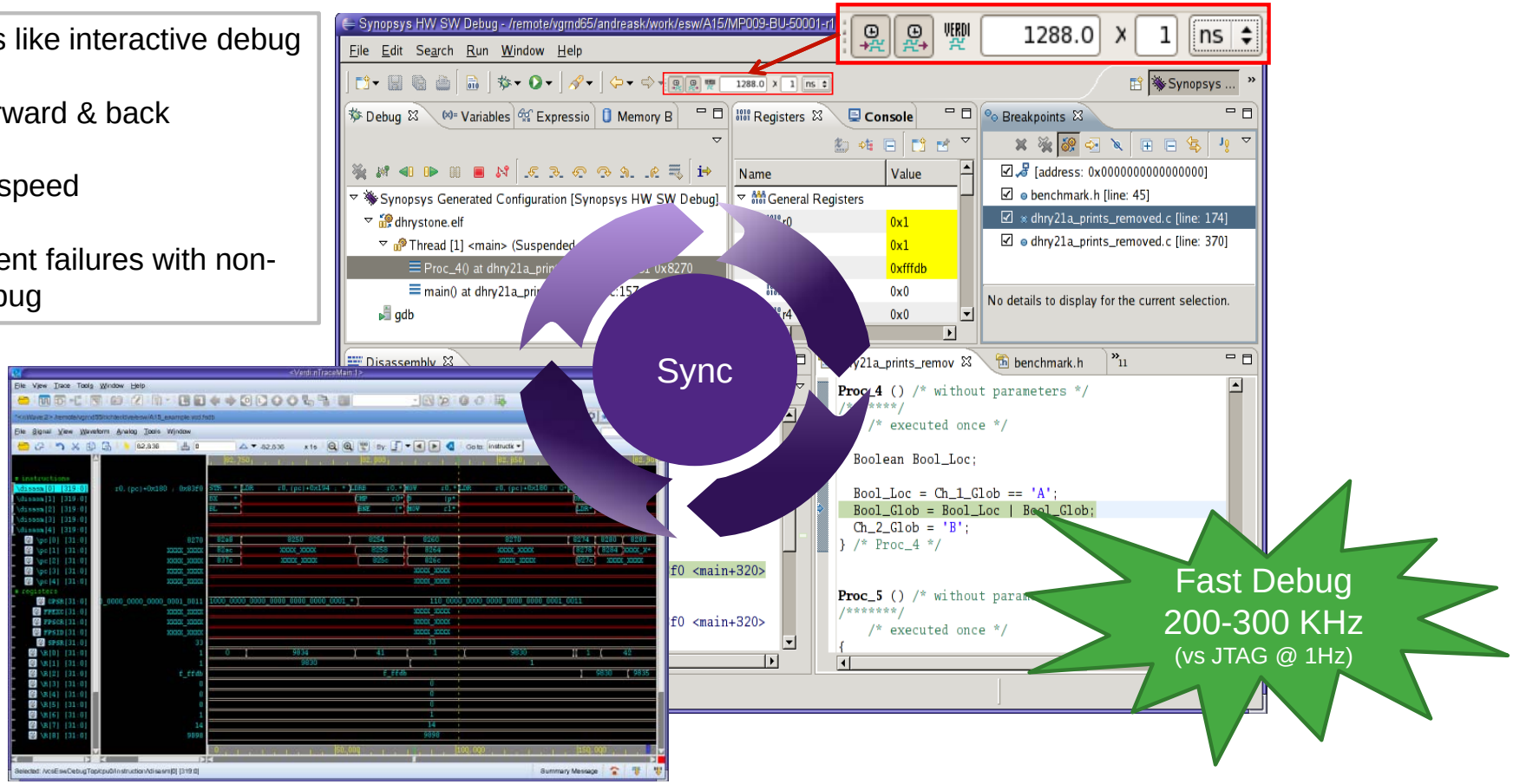
Post-Process Debug Approach

- Eclipse feels like interactive debug
- Run/step forward & back
- Fast debug speed
- Solve transient failures with non-intrusive debug



Verdi HW SW Debug

Embedded Processor Debug with Synchronized Hardware & Software

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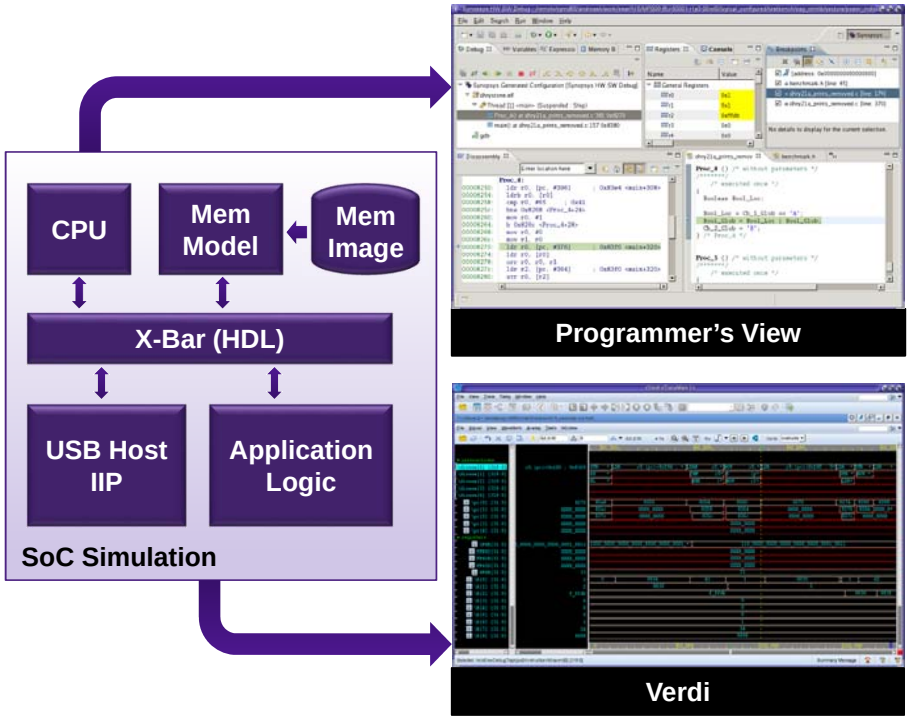
- Enables co-debug between HW & SW
- HW and SW time synchronization
- View C/Assembly source, C variables, stack, memory
- Debug multiple cores
- Simulation supports all ARM® Cortex® cores
- Easy to support additional/custom cores



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Coverage Metrics for Embedded Software

Debug Challenges of Software Tests

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Dealing with different OS – Linux , Android, RTOS etc.

How can I debug the OS code itself?

How can I debug apps running on the OS?

Data sizes are huge! 600M-1B cycles for Linux boot!

Debugging effort-intensive due to big source code base

Time-consuming test debug - multiple features tested

High speed embedded code debug with Verdi HW SW Debug

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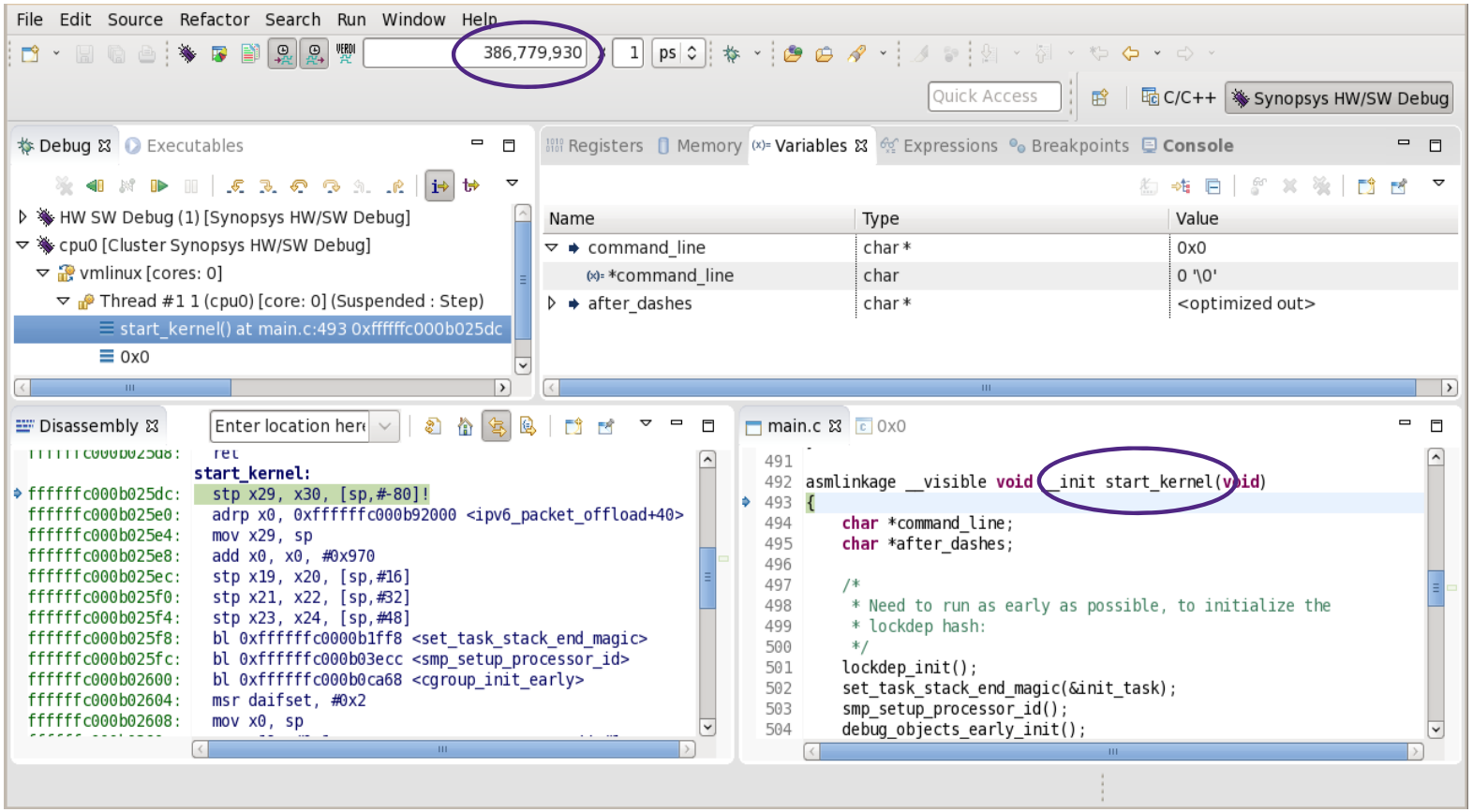
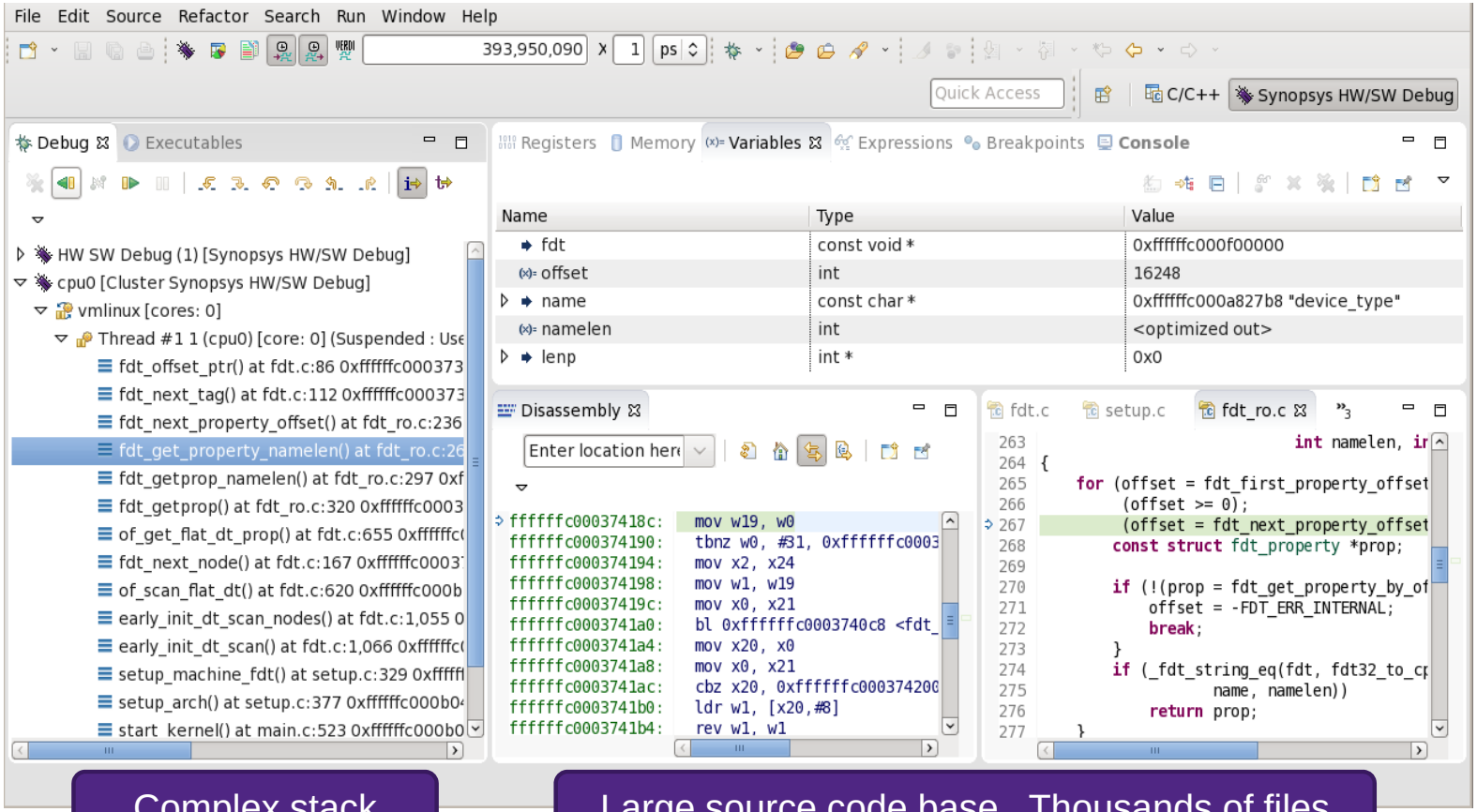
Linux Boot Debug



- Long test split into time slices
- Time slice starts at 38M cycles
- Start debug from symbol name (e.g. app_start, start_kernel)
- Slice generated from “start_kernel” symbol
- Run forwards and backwards through this time slice

Debugging a Complex Software Stack



Complex stack

Large source code base , Thousands of files

- Large source code base
- Highly complex stack with many levels
- Variables include integer, string and complex types like linked lists
- Unix console visible in window with timestamps

Verdi HW SW Debug Demonstration

Agenda

Synchronized Debug with Verdi HW SW

Practical Debug Application: Linux Boot

Performance Profiling of Embedded Software

Coverage Metrics for Embedded Software

Measuring Embedded SW Performance

- **How fast does my embedded software run?**
  - How do I measure this before silicon arrives?
  - How do I measure without modifying the embedded executable?
- **What can I do if it's not fast enough?**
  - How can I get reports of time per function, callers, etc.?
  - Software team can do this with silicon…But how can I do this now?

Really need a **standard software profiler** for embedded software

Performance Profiling

Disassembly | gprof

gmon file: /tmp/multi_core/cluster1.gmon.out
program file: /tmp/multi_core/test_sw/build64/hwsw_debug_test64.elf
timestamp: 1/23/17 6:08 AM
4 bytes per bucket, each sample counts as 1ns

type filter text

Name (location)	Samples	Calls	Time/Call	% Time
Summary	1310760			100.0%
hwsw_debug_test.c	560160			42.74%
mallocr.c	163560			12.48%
utilities.c	105720			8.07%
memset.S	95280			7.27%
memchr.c	46920			3.58%
findfp.c	46320			3.53%
fvwrite.c	44640			3.41%
hwsw_debug_test.h	41760			3.19%
makebuf.c	26040			1.99%
puts.c	23280			1.78%
fflush.c	23040			1.76%

- Eclipse Open Platform Profiler Plugin
- Performance Profile of embedded software
- Task call totals
- Assembly level detail
- Non-intrusive: No insertion of code or opcodes
- Measure performance of production firmware

Agenda

Synchronized Debug with Verdi HW SW

Practical Debug Application: Linux Boot

Performance Profiling of Embedded Software

Coverage Metrics for Embedded Software

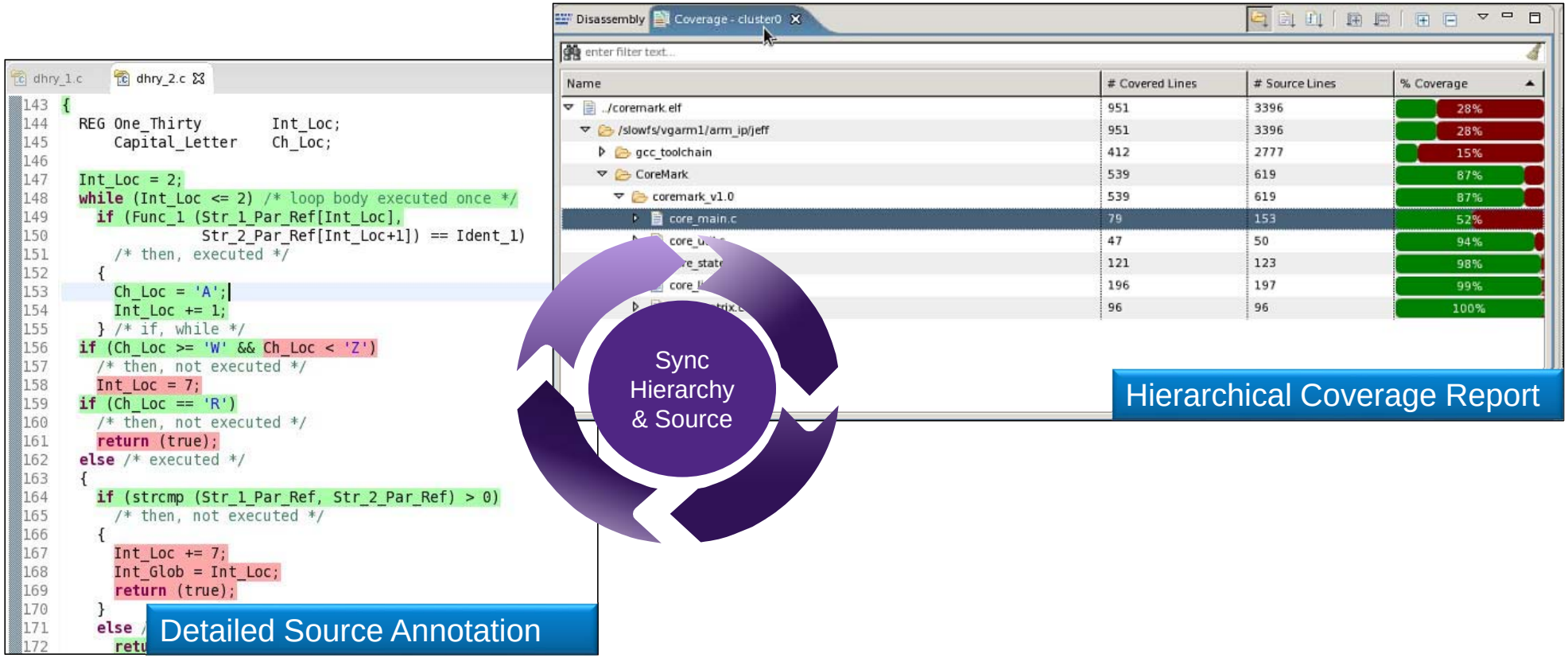
Embedded Software Code Coverage

- **How do I meet ISO 26262 Embedded Software requirements?**
  - Are any pieces of code not tested/executed?
  - Do I have dead code that I do not expect?
  - Sounds familiar for verification engineers…Think coverage!

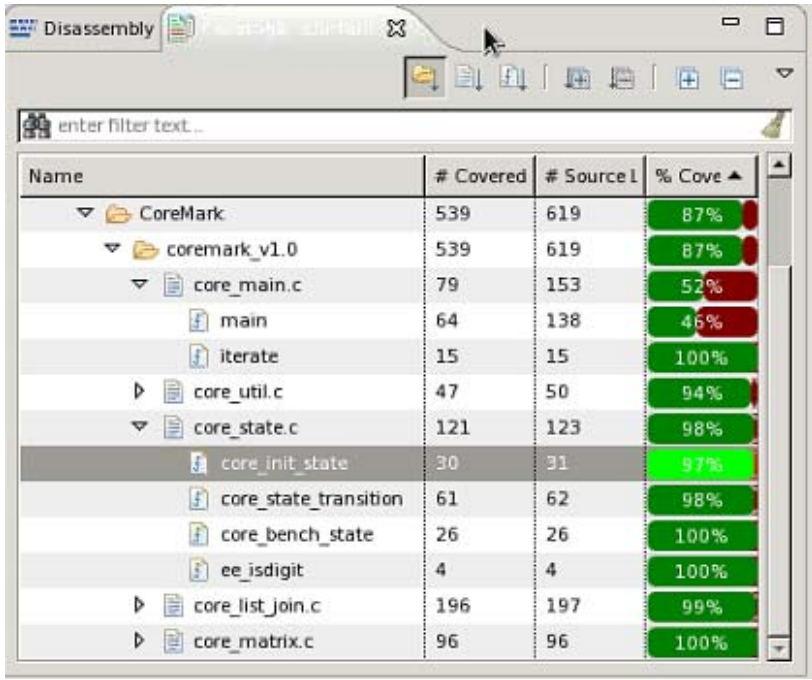
- **Line Coverage – Current method**
  - Software teams use coverage (gcov, purecov, etc)
  - Problem: gcov heavily modifies the compiled binary (Firmware, OS, App)
  - Teams want to run production image without changes

Need a **non-intrusive** way to measure line coverage

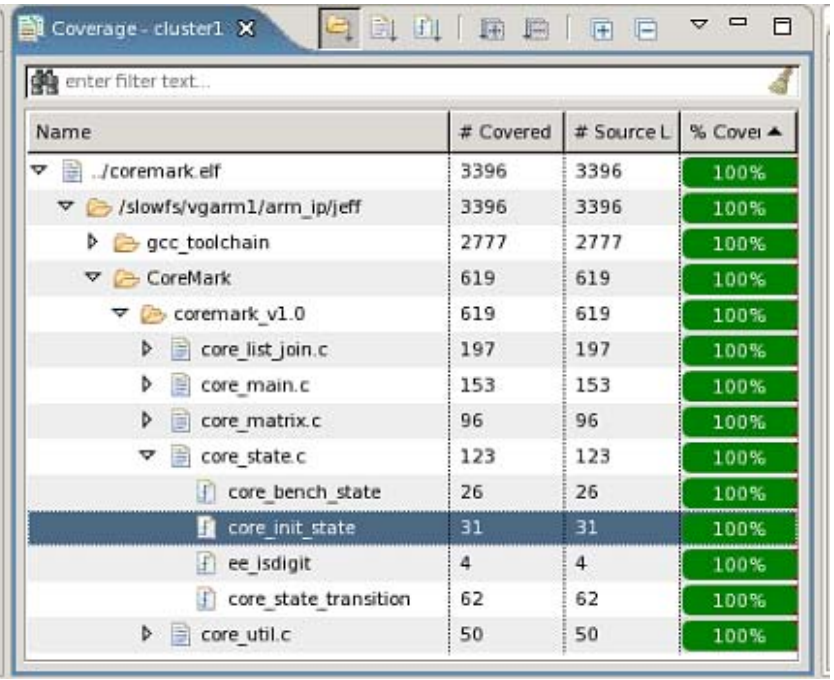
Embedded Software - Line Coverage



Embedded Code Coverage on Multiple Cores



Cluster #0



Cluster #1

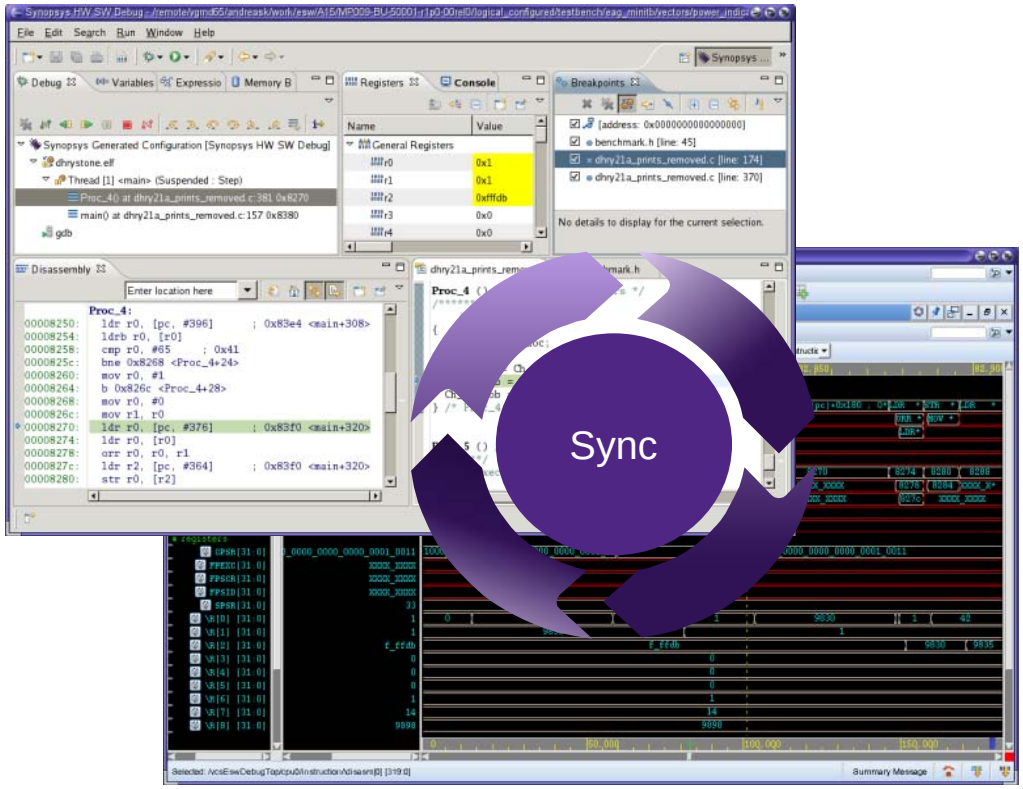
- Support for multiple clusters/cores
- Collect coverage per cluster/core
- Collect coverage per executable/elf

Verdi HW SW Debug Demonstration

Performance Profiling, Line Coverage

Verdi HW SW Debug

Boosting Debug Productivity



- **Verification Engineer Productivity**
  - Debug C-source code on embedded core
  - Debug software/hardware issues
  - Measure code coverage for ISO 26262
- **Software Engineer Productivity**
  - Full software development environment
  - Pre-silicon debug of boot and applications
  - Profile performance before silicon arrives

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