Virtualized Systems Development with Simics – FSW Pasadena 2010

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What is Simics?

Simics® - an adaptive **virtual platform** that enables customers to **define** , **develop** and **deploy** electronics systems more efficiently

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What is a Virtual Platform?

- A piece of software
- Running on a regular PC, server, or workstation
- Functionally identical to the target hardware
- Runs the same software as the physical hardware system
  - Production binary
  - ”Test as you fly, fly as you test”

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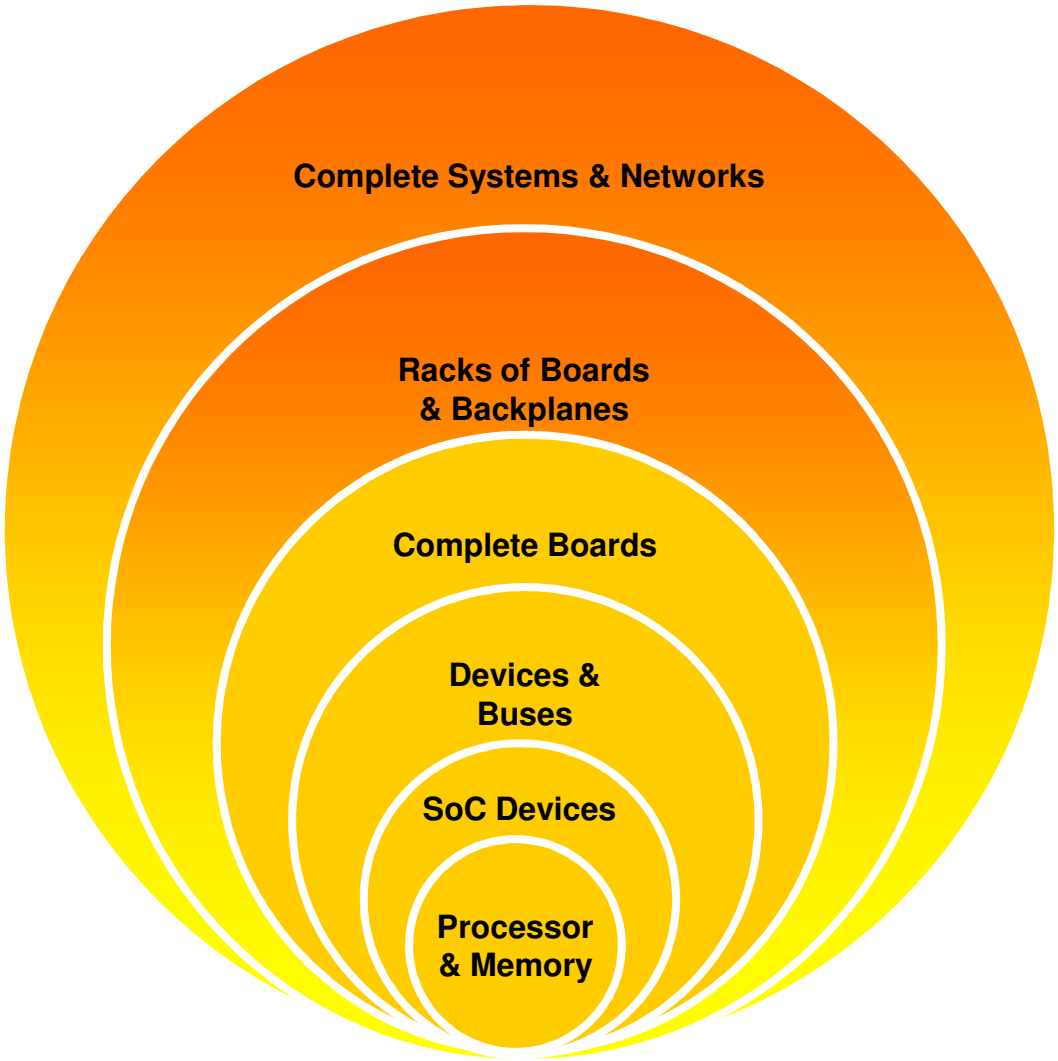
Simics Scales



Examples

- Satellite constellation, telecom network
- Telecom rack, avionics bay, blade server
- C-W SVME183, VPX6-187 GE-IP VG5, …
- PCIe, RapidIO, I^2C, Custom FPGA
- PPC440GP, P4080, OMAP, Octeon CN3860
- PPC750, Core 2, e500mc, POWER6 , MIPS64

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Key Characteristics Of Simics

- Wind River is the provider of Simics: a high-performance, high fidelity, full system simulator
  - **High Performance** – fast enough to run ***real*** software loads (typically 100's of MIPS, up to multiple GIPS)
  - **High Fidelity** – run full production software, including firmware, device drivers, hypervisor, RTOS/OS, application software
  - **Full System** – simulate entire systems with complete machines, networks, backplanes, etc, not just processor cores, or SoCs, or boards
  - **Development Environment** – provide the most powerful and effective develop, debug and test platform via tools and system control and visibility
- The true value of Simics is through enablement of process change: Virtualized Software Development

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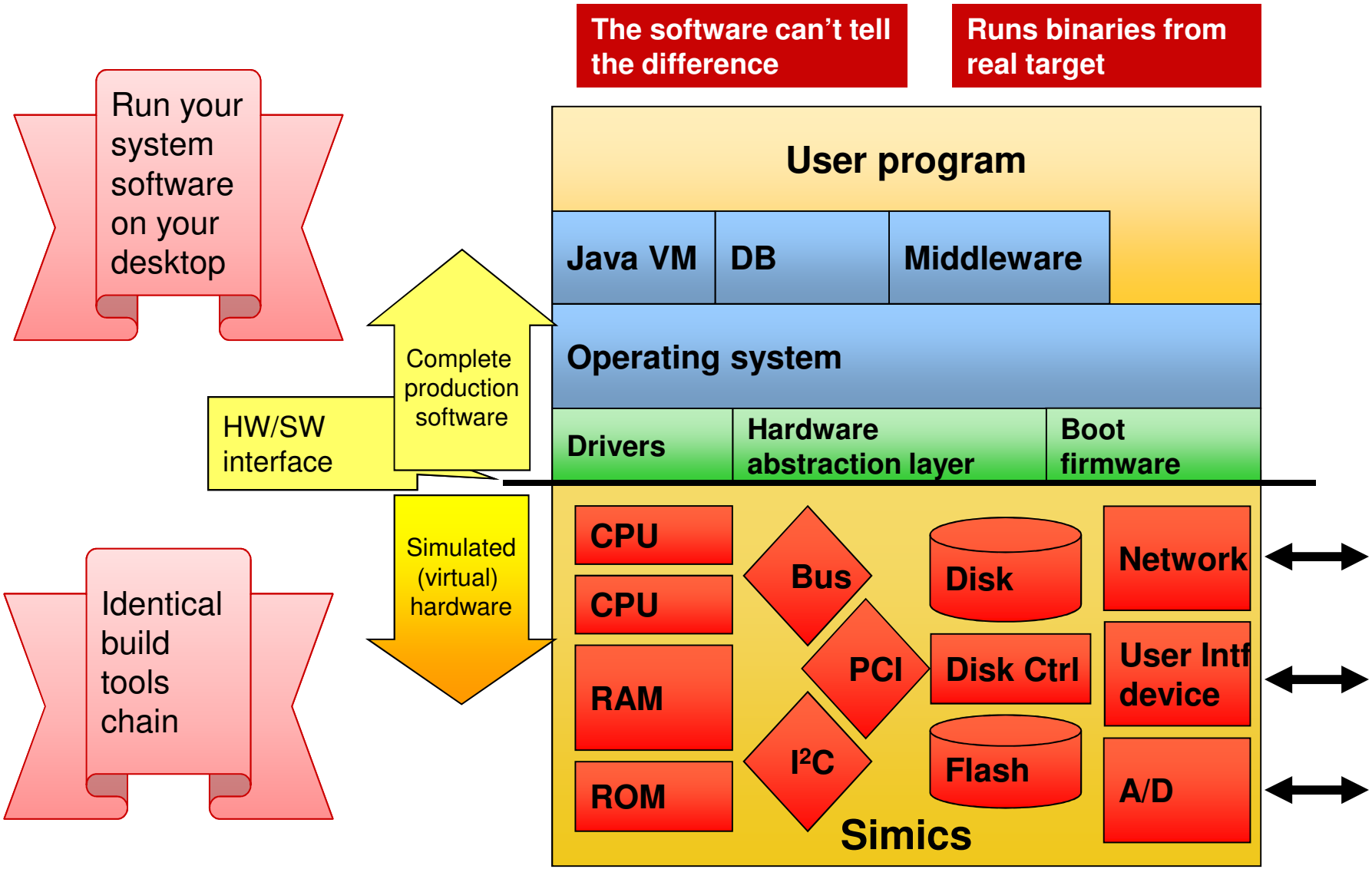
Simulating the Electronic System



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Three Steps of Debugging

1. Provoking errors
   - Forcing the system to a state where things break

2. Reproducing errors
   - Recreating a provoked error repeatedly and reliably

3. Isolating the source of the errors
   - Investigating the program flow and data
   - Depends on success in reproduction for efficiency
   - Identifying the line of code causing the problem

Virtual hardware helps with all three steps

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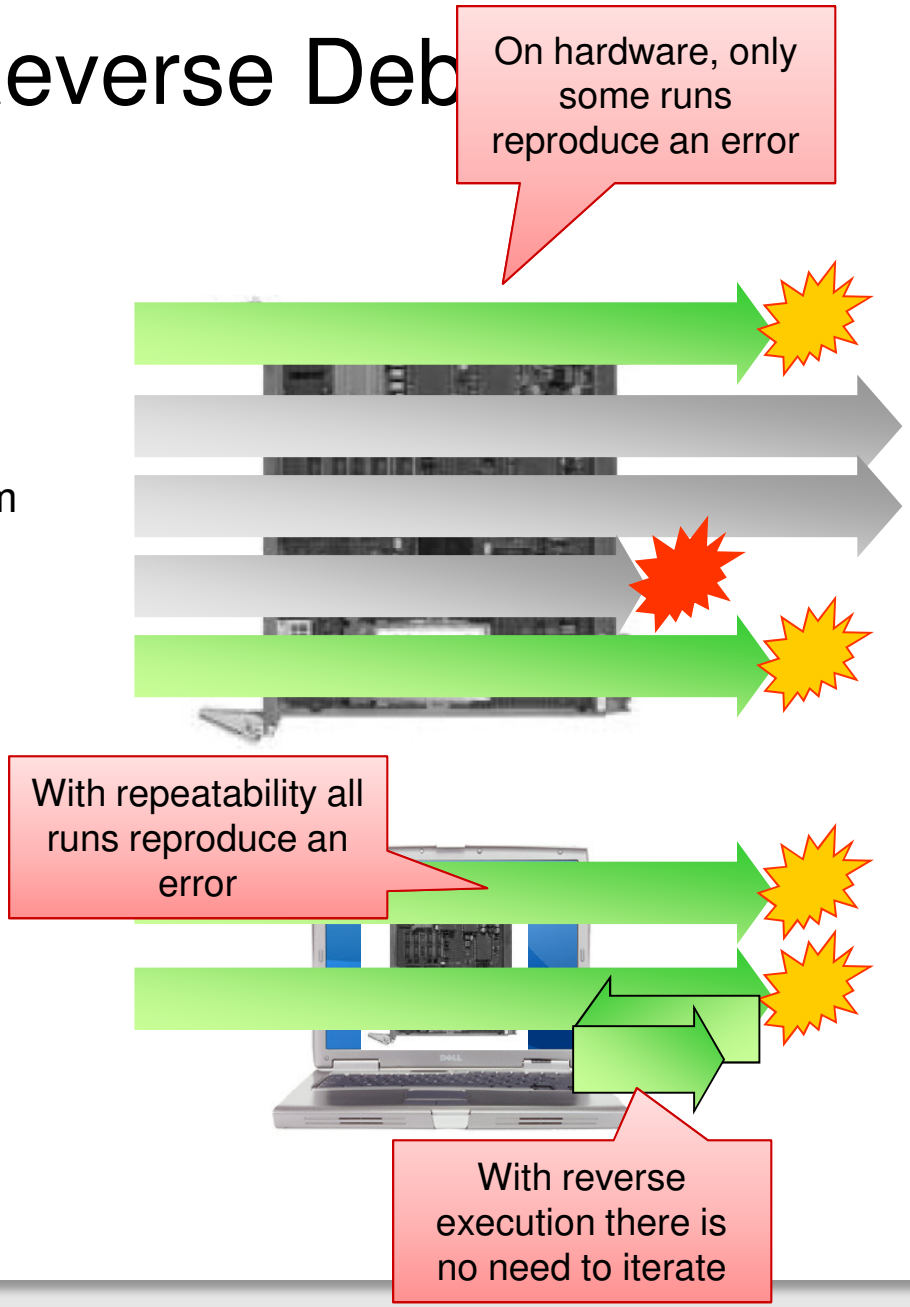
Repeatability and Reverse Deb

- Repeat any run trivially
  - No need to rerun and hope for bug to reoccur
- Stop & go back in time
  - Instead of rerunning program from start
  - Breakpoints & watchpoints backwards in time
  - Investigate exactly what happened this time
- This control and reliable repeatability is very powerful for parallel code!



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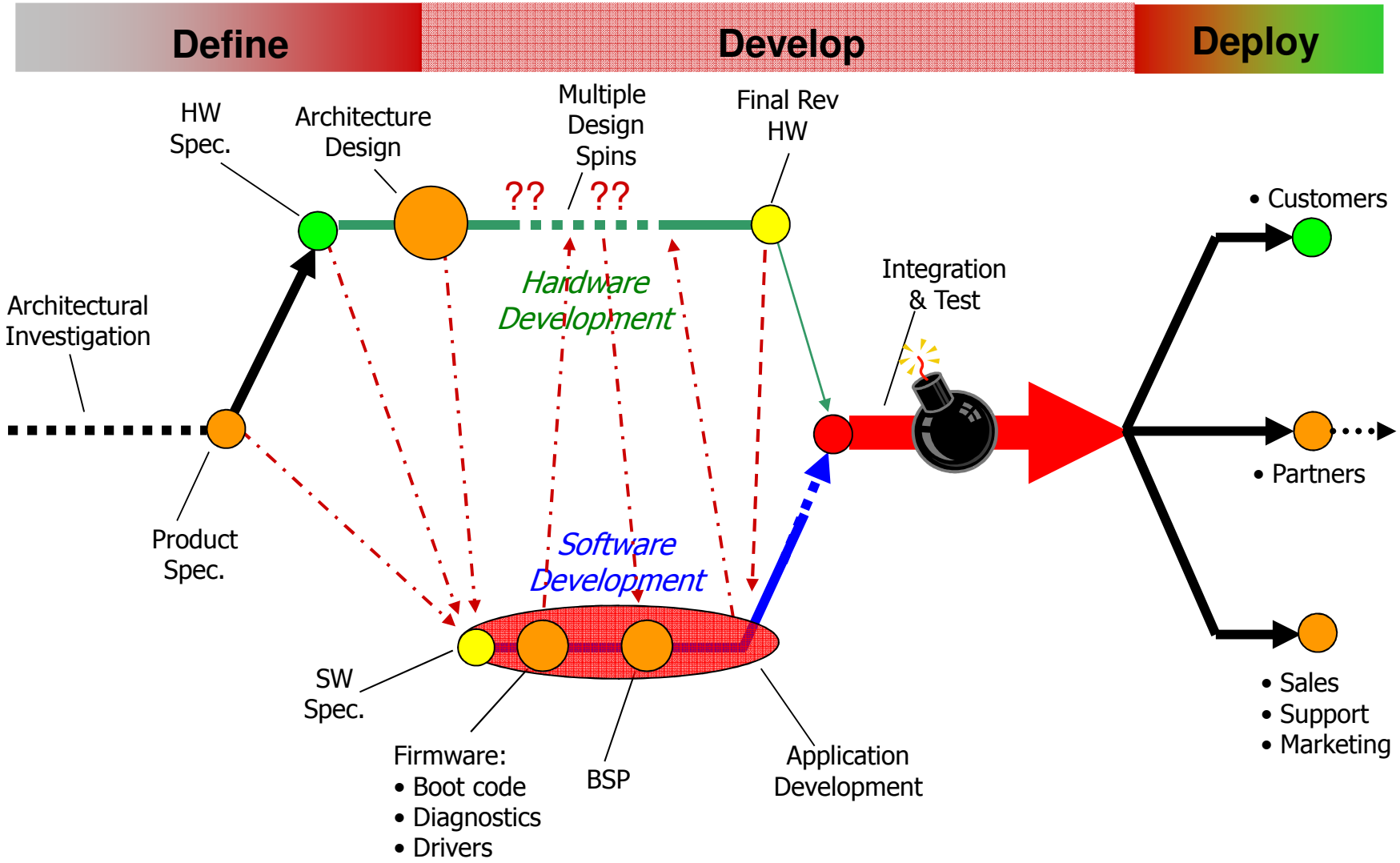
Multi-* & Debug

- Limited visibility into hardware
  - Single debug port, multiple processors
  - High speed, concurrent execution
- Timing-sensitive chaotic behavior
  - Small changes in timing alters system behavior radically
  - Hardware variations impact software behavior
- Lack of determinism
  - Rerunning a program gives different results
  - Hard to reproduce bugs
- Heisenbugs
  - Inserting probes to trace behavior alters behavior
  - Bugs hide when they are being debugged
- System keeps running even if one core stopped

Traditional Hardware/Software PLC – Simplified



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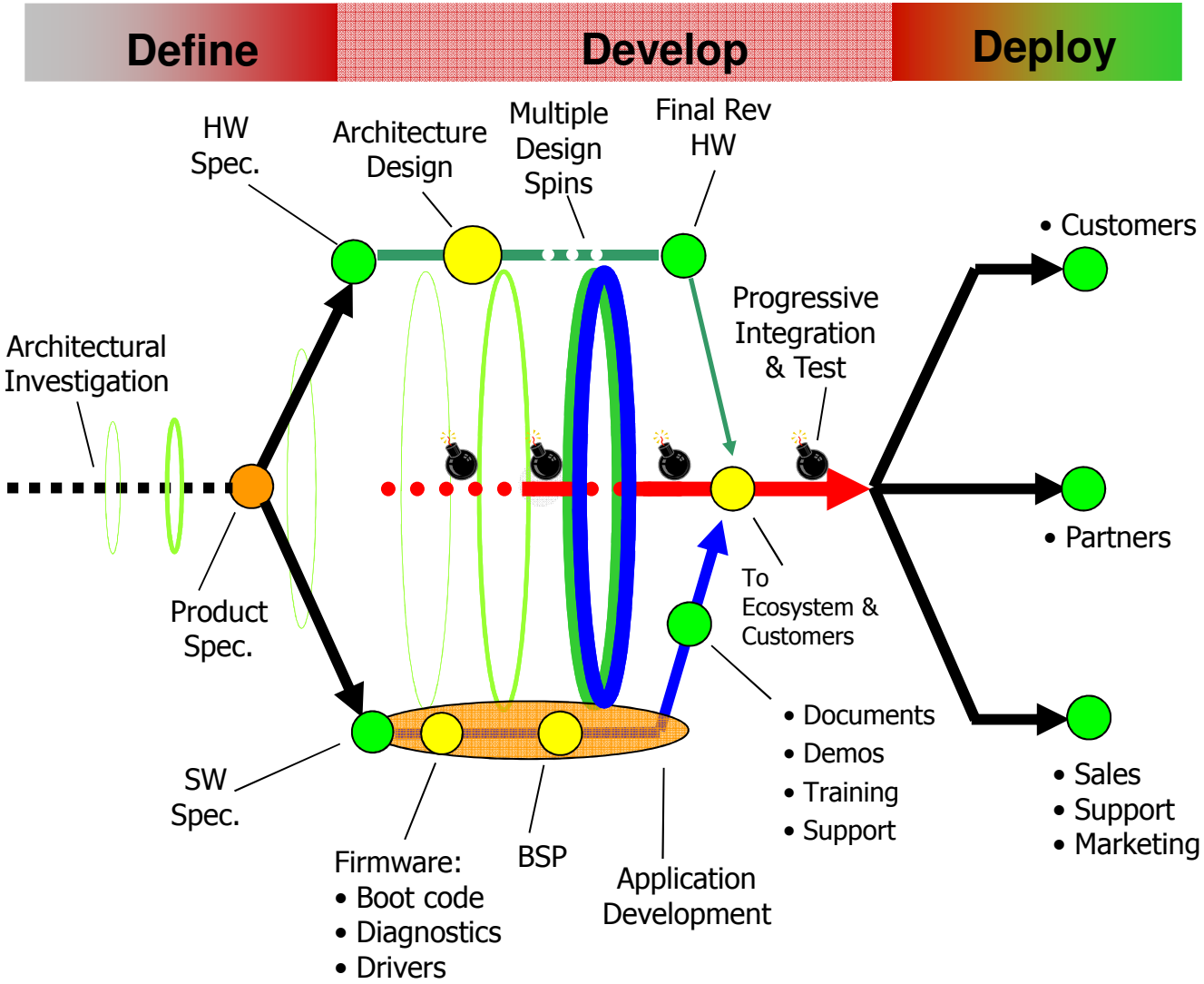
VSD-based PLC



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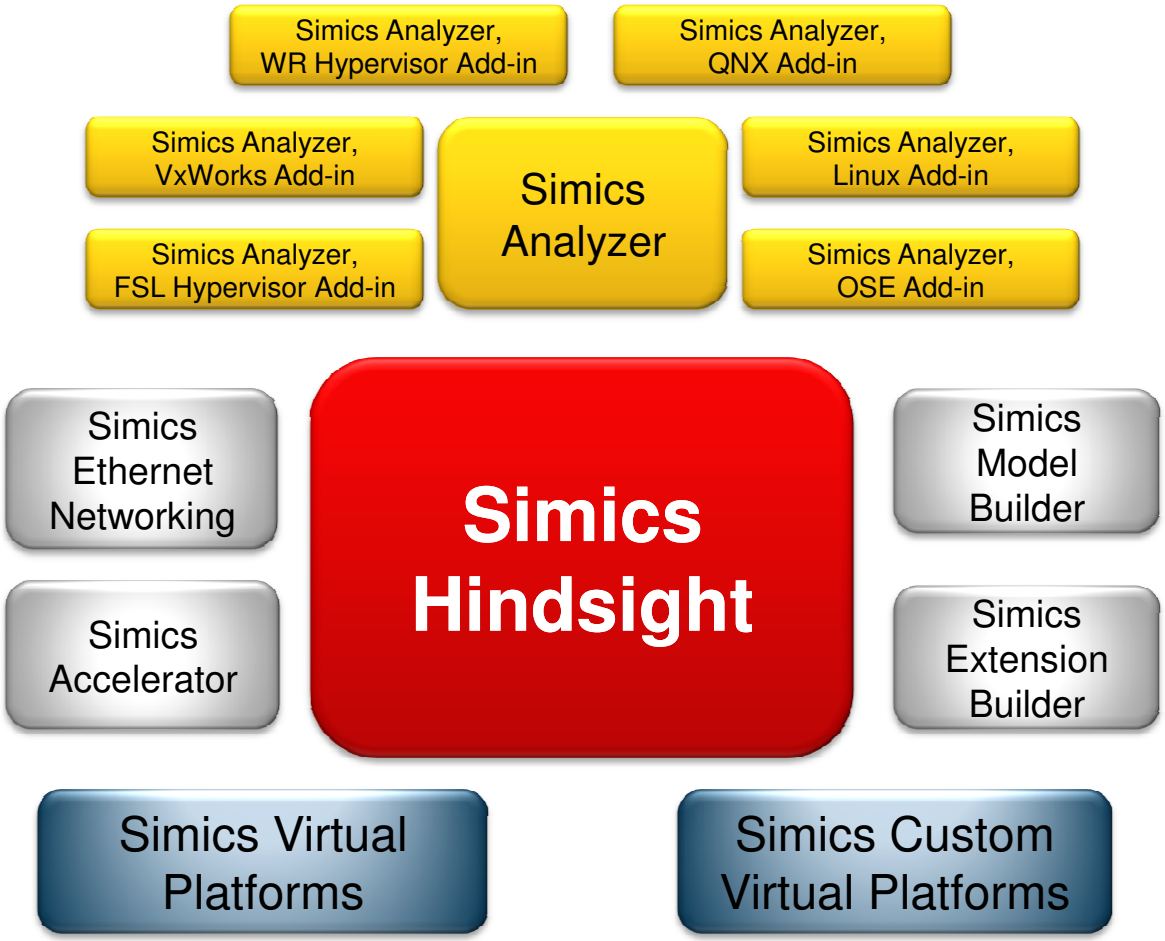
Simics 4.4 Overview

- First Customer Shipment (FCS): May 19, 2010
- General Availability (GA): May 31, 2010
- Simics 4.4 Highlights
  - Simics Analyzer for debugging, analyzing and verifying target software applications
  - Simics Extension Builder for extension plug-ins, integration to enterprise tools and additional work flows. Integrations with 3rd party simulators (ISS).
  - Mix C, C++, SystemC and DML models
  - Eclipse DML Editor improvements
  - Performance improvements
  - Freescale QorIQ P1/P2 Virtual Platform
  - Intel Core i7 Virtual Platform (Nehalem / Tylersburg)

Simics 4.4 Product Family



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Simics Analyzer

Software debug & analyze

- Graphical time line view
  - What runs where and when
  - Eclipse view
  - Run time execution details
  - Software context – processes and functions
- Full system process list
  - OS Awareness information
  - List of machines, CPUs, OSs, processes & status
  - Eclipse view

For heterogeneous systems

- Full system solution
- Particularly good for multicore systems
- Mixed architectures
  - Power PC, IA, ARM, MIPS, etc
- Mixed OSs
  - VxWorks, Wind River Linux, Wind River Hypervisor, Linux, OSE, QNX, FSL Hypervisor

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Simics Analyzer (cont)

Software verification

- Code Coverage
  - Non instrumented code (exact same binaries that goes into the end system)
  - Statement coverage
  - Both C level and asm level coverage data

Available in Simics workflow

- No need to switch to other tool / workflow
- Presented in standard web browser
- Coverage data also available in pure text format for integration purposes

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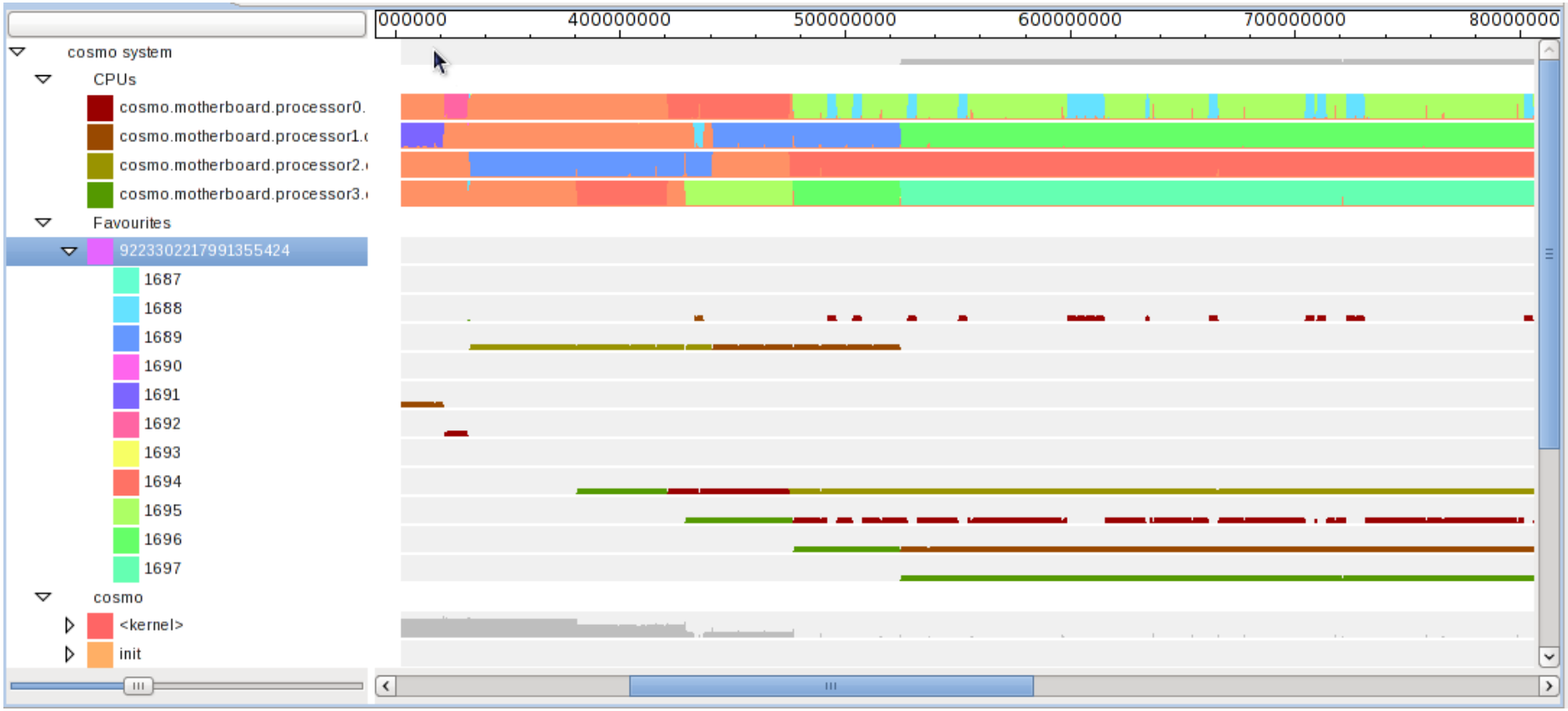
Simics Analyzer – Graphical Time Line View



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Simics Analyzer – Code Coverage

File Edit View History Delicious Bookmarks Tools Help

file:///home/david/simics/4.4/logs/test/amd64-linux/t900_coverage/generic/scratch/run-1/htm

Coverage analysis

Binary: ebony-simpletr

Source Files | Disassembly | /home/david/simics/4.4/test/t900_coverage/tr.c

Covered 4 of a possible 8 lines (50.0%).

```
1  #include "tr.h"
2
3  static unsigned char table[256];
4
5  void add_translation(unsigned char from, unsigned char to)
6  {
7          table[from] = to;
8  }
9
10 unsigned char tr(unsigned char c)
11 {
12         if (table[c])
13                 return table[c];
14         else
15                 return c;
16 }
```

Done

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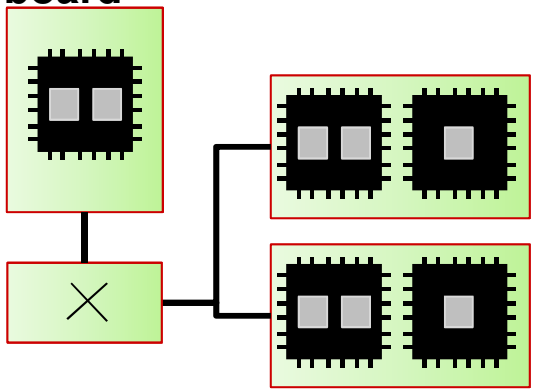
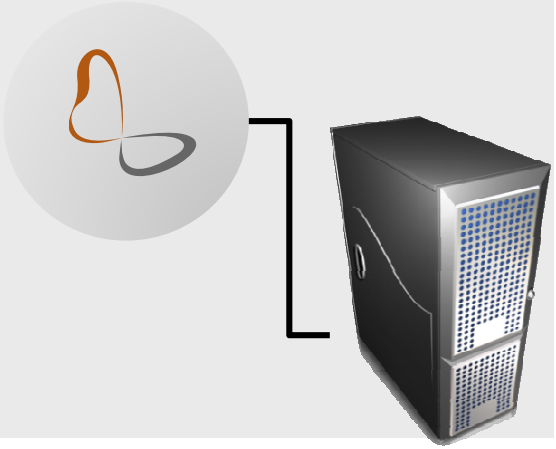
System-Level Simulation Benefits

Checkpoint and restore

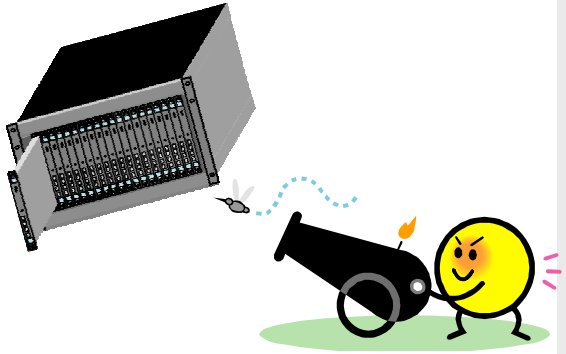
Multicore, processor, board



Real-world connections



Repeatable fault injection on any system component



Scripting

```
con0.wait-for-string "$“
con0.record-start
con0.input "./ptest.elf 5\n"
con0.wait-for-string "."
$r = con0.record-stop
if ($r == "fail.”) {
   echo ”test failed”
}
```

Mixed endianness, word sizes, heterogeneity

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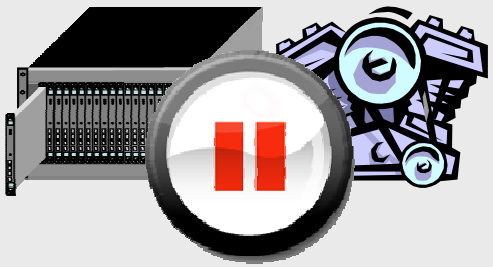
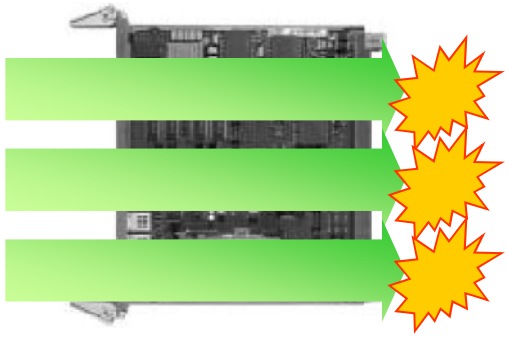
Simics Software Debugging Benefits

Synchronous stop for entire system



Determinism and repeatability

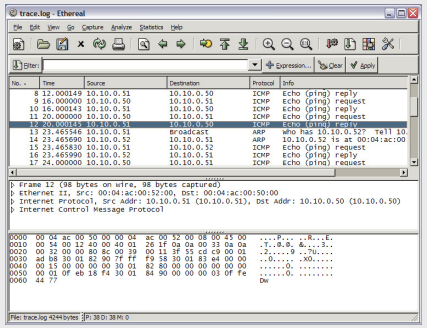


Reverse execution

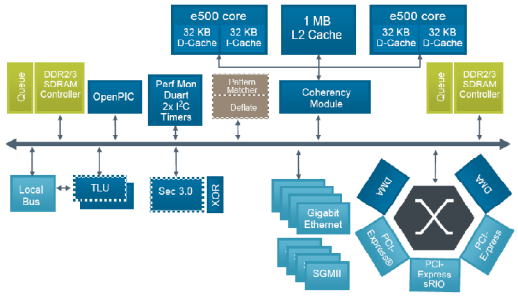
Unlimited and powerful breakpoints

```
break -x 0x0000->0x1F00

break-io uart0

break-exception int13
```

Trace anything



Insight into all devices



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Thank you

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