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EDP 2008 – Standardization & Virtualization

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WHAT?

What are we talking about? Full System Simulation

WHY?

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Because Hardware Is...

Not yet available

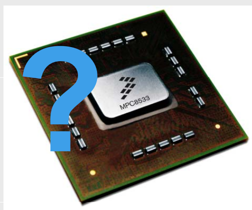
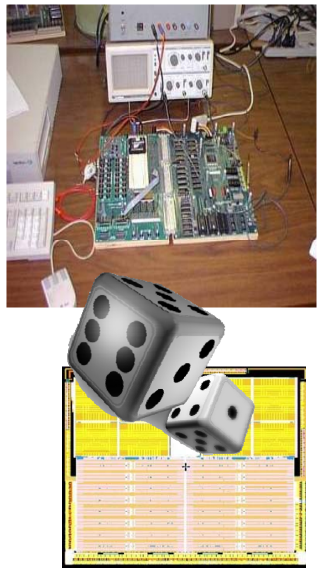


Photo: Freescale

Flaky prototype stage



Not available anymore

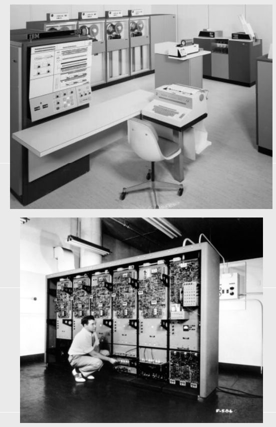


Photo: Computer History Museum

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Because Hardware Is...

Inconvenient

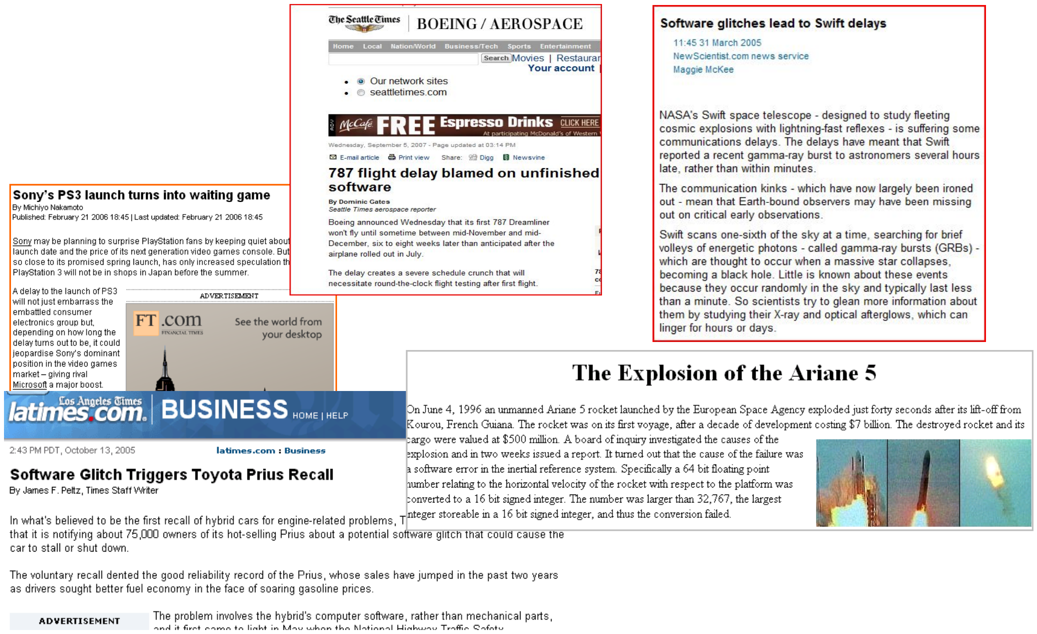
Dangerous

Photo: www.mil.se, Bromma Conquip

Inaccessible

Photo: ESA

The Software Crisis!



Sony's PS3 launch turns into waiting game

By Michiyo Nakamoto
Published: February 21 2006 18:45 | Last updated: February 21 2006 18:45

Sony may be planning to surprise PlayStation fans by keeping quiet about launch date and the price of its next generation video games console. But so close to its promised spring launch, has only increased speculation th PlayStation 3 will not be in shops in Japan before the summer.

A delay to the launch of PS3 will not just embarrass the embattled consumer electronics group but, depending on how long the delay turns out to be, it could jeopardise Sony's dominant position in the video games market – giving rival Microsoft a major boost.

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Wednesday, September 5, 2007 - Page updated at 03:14 PM

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787 flight delay blamed on unfinished software

By Dominic Gates
Seattle Times aerospace reporter

Boeing announced Wednesday that its first 787 Dreamliner won't fly until sometime between mid-November and mid-December, six to eight weeks later than anticipated after the airplane rolled out in July.

The delay creates a severe schedule crunch that will necessitate round-the-clock flight testing after first flight.

Software glitches lead to Swift delays

11:45 31 March 2005
NewScientist.com news service
Maggie McKee

NASA's Swift space telescope - designed to study fleeting cosmic explosions with lightning-fast reflexes - is suffering some communications delays. The delays have meant that Swift reported a recent gamma-ray burst to astronomers several hours late, rather than within minutes.

The communication kinks - which have now largely been ironed out - mean that Earth-bound observers may have been missing out on critical early observations.

Swift scans one-sixth of the sky at a time, searching for brief volleys of energetic photons - called gamma-ray bursts (GRBs) - which are thought to occur when a massive star collapses, becoming a black hole. Little is known about these events because they occur randomly in the sky and typically last less than a minute. So scientists try to glean more information about them by studying their X-ray and optical afterglows, which can linger for hours or days.

Los Angeles Times latimes.com | BUSINESS HOME | HELP

2:43 PM PDT, October 13, 2005 latimes.com : Business

Software Glitch Triggers Toyota Prius Recall

By James F. Peltz, Times Staff Writer

In what's believed to be the first recall of hybrid cars for engine-related problems, T that it is notifying about 75,000 owners of its hot-selling Prius about a potential software glitch that could cause the car to stall or shut down.

The voluntary recall dented the good reliability record of the Prius, whose sales have jumped in the past two years as drivers sought better fuel economy in the face of soaring gasoline prices.

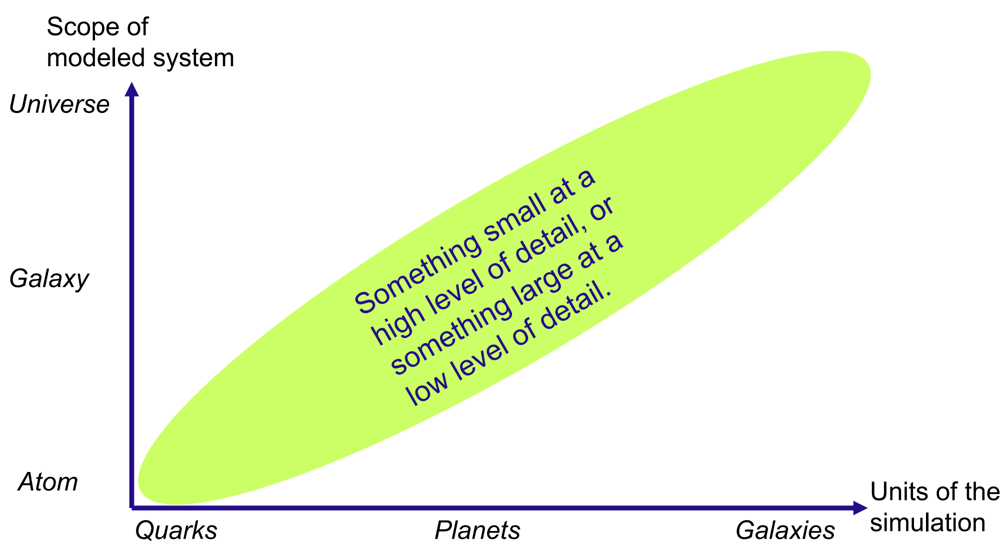
The problem involves the hybrid's computer software, rather than mechanical parts,

The Explosion of the Ariane 5

On June 4, 1996 an unmanned Ariane 5 rocket launched by the European Space Agency exploded just forty seconds after its lift-off from Kourou, French Guiana. The rocket was on its first voyage, after a decade of development costing $7 billion. The destroyed rocket and its cargo were valued at $500 million. A board of inquiry investigated the causes of the explosion and in two weeks issued a report. It turned out that the cause of the failure was a software error in the inertial reference system. Specifically a 64 bit floating point number relating to the horizontal velocity of the rocket with respect to the platform was converted to a 16 bit signed integer. The number was larger than 32,767, the largest integer storeable in a 16 bit signed integer, and thus the conversion failed.

HOW?

Cardinal Rule of Simulation



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Full-System Simulation with Speed!

- Detail level determines speed
  - The more detail, the slower the simulation
- Abstraction: timing precision, implementation details
- Functionality must always be correct!

Simulation detail level	Typical slowdown	Approximate speed in MIPS	Time to simulate one real-world minute
Gate-level simulation	1000000	0.002	2 years
Computer architecture	10000	0.2	7 days
Cycle-approximate simulation	500	4	8 hours
Fast full-system simulation	5	400	5 minutes

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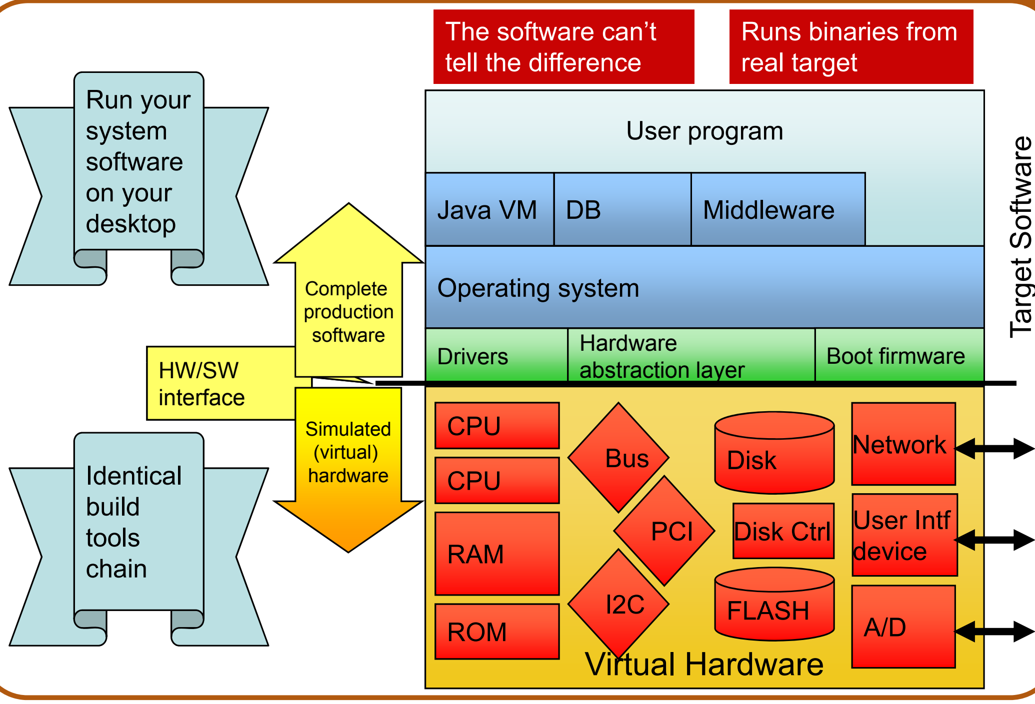
No Impact on the Target Software



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Units of Simulation

Processor Cores	Devices
• The CPUs running code • Special case to gain performance, simulated using ISS, JIT, API, etc. – buy or borrow! • Comparatively limited in variants, compared to devices	• Anything that the system contains that does things and that is not a user-programmable CPU • Examples: Timers, interrupt controllers, ADC, DAC, network interfaces, I^2C controllers, serial ports, LEDs, displays, media accelerators, pattern matches, table lookup engines, memory controllers, ...
Memories	**Interconnects**
• RAM, ROM, FLASH, EEPROM, ... • Store code and data • Usually special simulation case for performance reasons, closely integrated with processor core simulators	• Connecting devices, chips, boards, cabinets, systems together • I^2C, Serial, Ethernet, PCI, PCIe, RapidIO, ATM, CAN, FireWire, USB, MIL-STD-1553, MII, VME, HyperTransport, memory bus, ...

Units of Simulation: In Practice

Processor Cores	Devices
●The CPUs running code ●Spec… …ted using l… ●Com… …ed to device… **Complex: reuse existing simulators and the efforts of experts**	●Anything that the system contains that does things a… …CPU ●Exam… …C, DAC, n… …al ports, L… …attern matche… controllers, ... **Most of the modeling work here! Where possible, reuse existing models .**
Memories	**Interconnects**
●RAM, ROM, FLASH, EEPROM, ... ●Store… ●Usua… …h perfor… proces… **For most purposes, very generic and reusable. You should not need to model this.**	●Connecting devices, chips, boards, cabinets, systems… ●I²C, S… …ATM, CAN, Fi… …ME, HyperT… **Comparatively few and standardized, often possible to reuse existing simulators.**

STANDARD?

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Technology Matrix

For embedded software work, FSS and API-level sim are really the best options

	Desktop/Server Virtualization	Para-virtualization	Emulation	ISS	API-Level Simulation	Full-system simulation
Scope of exec	System	System	Application	Processor	Application	System
CPU A on A	Yes	Yes	Yes	Yes	Yes	Yes
CPU B on A	No	No	Yes	Yes	No	Yes
Run full OS	Yes	Yes	No	No	No	Yes
OS A on A	Yes	Yes	Yes	N/A	Yes	Yes
OS B on A	Yes	Yes	No	N/A	Yes	Yes
Run unmodified software stack	Yes	No	No	No	No	Yes
Custom devices & drivers	No	No	No	No	No	Yes
Deterministic	No	No	No	Yes	No	Yes
Complexity	Medium	Low	High	Medium	Low	High
Example	*VmWare, LPAR, kvm*	*Xen*	*Rosetta*	*gdb ISS*	*VxSim*	*Simics*

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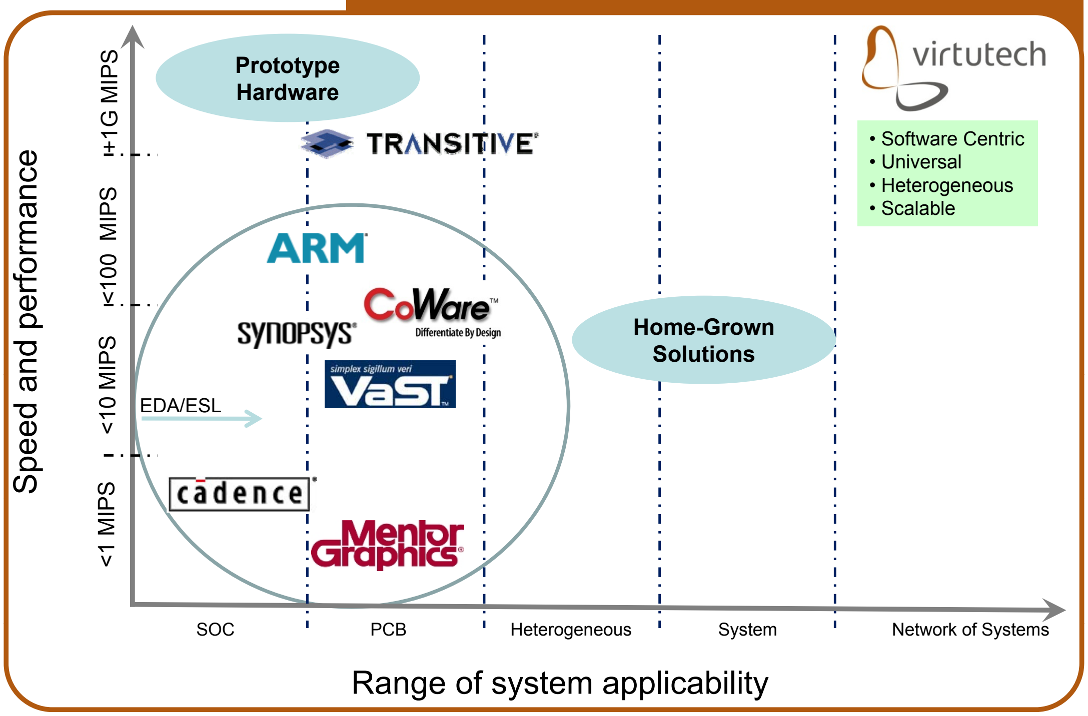
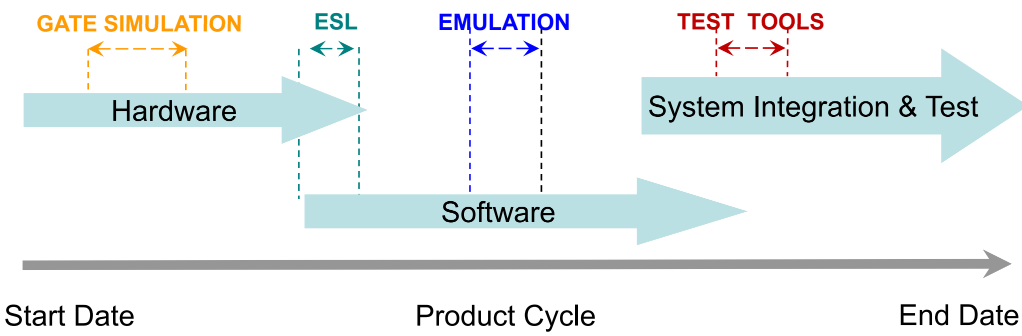
Industry Positioning



Point Tools Can Only Improve Parts Of The Process

- RTL simulation speeds chip design and verification, but does nothing for software
- ESL smoothes interaction between hardware and software development (SOC mostly)
- Emulation helps speed hardware-specific coding, but at the expense of accuracy
- Further new point tools can make only incremental, localized improvements



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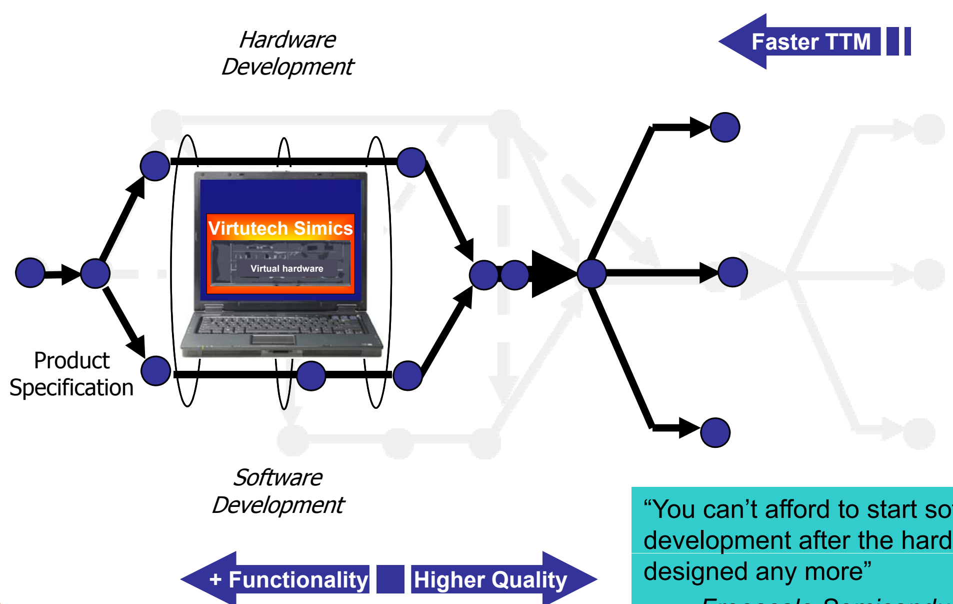
Full Systems Development



"You can't afford to start software development after the hardware is designed any more"
---- *Freescale Semiconductor*

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Standardization Effort

Model Development Strategy — virtutech DML, SystemC TLM 2

Compose Virtual Platform and Exchange IP — python, IP-XACT

Streamline solution for Power Architecture™ — Power Source

User Experience and Workflow — eclipse

Promote Open Source Initiative — GreenSocs

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EXEMPLES?

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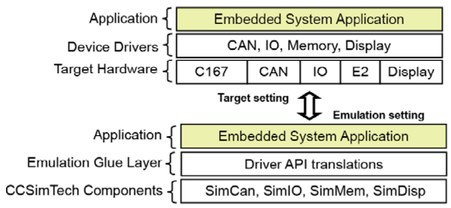
CC SimTech



Pictures: CC-Systems, www.cc-systems.se

- For vehicle systems
  - Control & User Interface
  - Handful of compute nodes
- API-level simulation
  - Special middleware API hides details of RTOS
  - Compiles all program code for the host
  - No target timing
- Connects to physical CAN and real-world control panels

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Google Android Emulator

- Full-system simulator
  - Qemu-based, ARM9 ISS
  - Single-processor
  - Touch screen & keyboard
- Not a model of a real board, rather an idealized mobile phone
  - Simpler device programming interfaces
  - Faked mobile connection
- Special BSP for emulator

Virtutech Simics Telecom Rack

- Full-system simulator
  - PowerPC & DSPs (10+ types)
  - 2-70 boards
  - 20-500 processors
  - Rack backplane
  - Multiple board types
- Some boards stubbed
- Some boards simplified with partial stubs
- User interface
  - Serial consoles
  - Ethernet to physical world
    - O&M, traffic, SCTP, ...

BENEFITS?

Nice Debugger Features

Synchronous stop for entire system

Reverse execution

Scripting

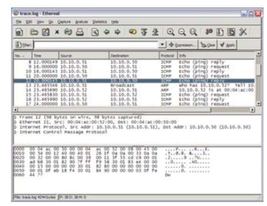
```
...
con0.wait-for-string "=>"
con0.input "bootm\n"
con0.wait-for-string "login:"
con0.input "root\n"
...
```

Determinism

Unlimited and advanced breakpoints

```
break -x 0x0000->0x1F00
break-io uart0
break-exception int13
```

Arbitrary tracing



Value Proposition

Replace	Accelerate	Optimize
Test & Configuration	Early SW Development	Enhance System Debug
Capital Expenditure Reduction	Time To Market	Cost of Recall & Maintenance

Thank You

Back-up slides

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About Virtutech

- Founded in 1998
- Locations:
  - Headquarters in San Jose California, USA
  - R&D Center in Stockholm, Sweden
  - Field operations in US, EMEA, and APAC
- Privately owned and funded by European and US venture capital
- Targeted Industry: Embedded applications
- Targeted Market Segments:
  - High Performance Computing
  - Aerospace, Defense, and Space
  - Datacom & Telecom
  - Semiconductors
  - Other Embedded

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What Virtutech Does

- 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, not just processor cores, or SoCs, or boards
    - Complete machines, networks, backplanes
- The true value of Simics is through enablement of process change: Virtualized Software Development

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Proven Success: Industry-Leading Customers

- Cisco Systems
- IBM
- Boeing
- Ericsson
- freescale semiconductor
- AMCC
- Huawei
- National Aeronautics and Space Administration
- Iridium
- Northrop Grumman
- Nortel
- Northrop Grumman
- Honeywell
- montavista
- ProLogic Incorporated
- GE
- BAE Systems
- Wind River
- Lockheed Martin — We never forget who we're working for
- General Dynamics

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Simics Libraries

Target Devices

Memory and system controllers
Interrupt & DMA controllers
Ethernet controllers
PCI and PCI-express
Serial ports
USB devices and disks
SCSI controllers and devices
I2C controllers and devices
RapidIO controller and devices
Arbitrary communication devices such as those for Firewire, Spacewire, etc

Target Operating Systems

Linux
VxWorks
OSE
Integrity
QNX
RTEMS
Windows (including Vista)
Solaris
AIX
NetBSD, FreeBSD
In-house RTOSes

Target CPU Architectures

PowerPC Architecture
Freescale PowerQUICC II (82xx)
Freescale PowerQUICC II Pro (83xx)
Freescale PowerQUICC III (85xx)
Freescale MPC603e
Freescale MPC755
Freescale MPC74xx
Freescale MPC86xx
Freescale MPC86xxD
IBM/AMCC PowerPC 405
IBM/AMCC PowerPC 440
IBM PowerPC 403
IBM PowerPC 750(fx,gx)
IBM PowerPC 970, 970MP
IBM Power6

SPARC Architecture
SPARC-V8
SPARC-V9

Renesas
H8S microcontroller

Texas Instruments
MPS430 microcontroller
TMS320C64 DSP

x86 Architecture
Intel 80386
Intel 80486
Intel Pentium
Intel P4 (32 & 64)
Intel Core Duo
Intel Core 2 Duo
AMD Athlon
AMD Athlon64
AMD Opteron

MIPS Architecture
MIPS 4K
MIPS 5K
PMC RM7000
PMC E9000
Cavium OCTEON

ARM Architecture
ARM 5TE
ARM 9E
ARM 9EJ
ARM 11

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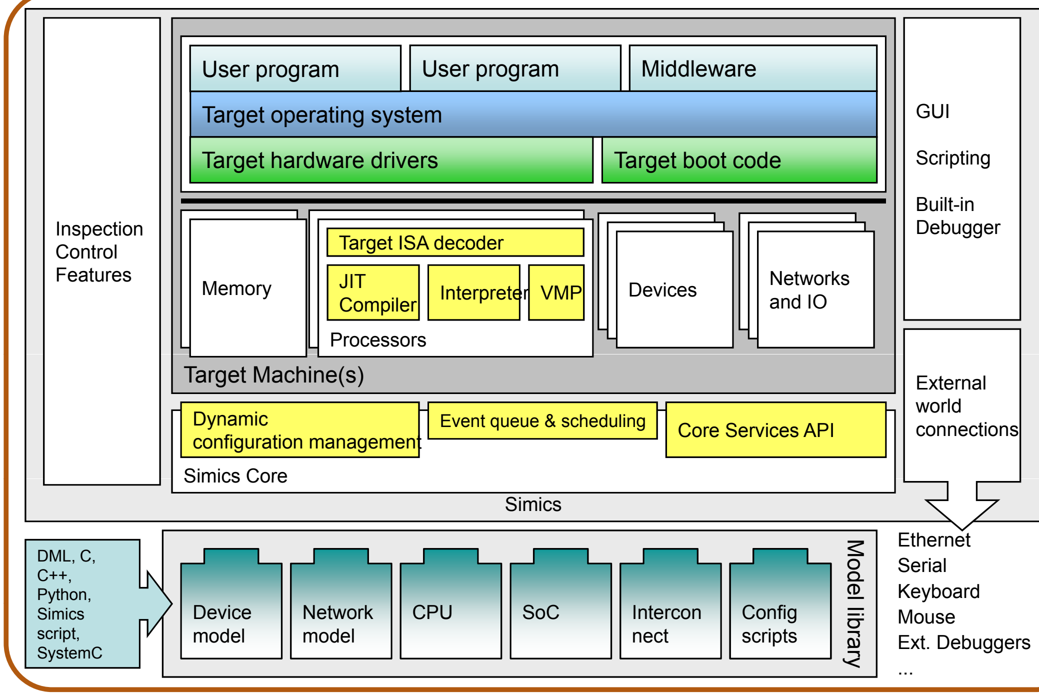
Simics Architecture



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Simics Capabilities Deliver a Shortened Development Cycle