Beyond Virtualization:
A Novel Software Architecture for Multi-Core SoCs

Jim Ready
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How HW guys view the world
How SW guys view the world
The SoC “Software Crisis”

SW costs dominate SoC Development

We really need to know why this is happening and what can be done about it.
The recurring “Software Crisis”: 1968 – 2012...
(We’ve seen this movie before...)
“There is no single development, in either technology or management technique, which by itself promises even one order of magnitude improvement in productivity, in reliability, in simplicity.”

“Skepticism is not pessimism, however. Although we see no startling breakthroughs, and indeed, believe such to be inconsistent with the nature of software, many encouraging innovations are underway....There is no royal road, but there is a road”.

Frederick P. Brooks
“No Silver Bullet – Essence and Accident in Software Engineering”
Accidental Complexity is the difficulty of transforming the conceptual representation of software into the reality of running on a particular piece of hardware. The single largest gain in software productivity has been made by the introduction of high-level languages, which automated this transformation process.

Accidental complexity is amenable to tooling solutions.

Essential Complexity is what’s left – the really hard part. Solutions that attack essential complexity include:

– Buy versus build
– Requirements refinement & rapid prototyping
– Incremental development
– Great Designers

A new SoC:

Generates substantial Accidental Complexity -> New Tools

Can benefit from “outside” SW technology to reduce Essential Complexity -> OSS and SW IP

*From Frederick P. Brooks
“No Silver Bullet – Essence and Accident in Software Engineering”
The SoC software challenge
(CW: SoC = Multi-Core + Virtualization)

• Use Cases for virtualization in the IT world
  – Server consolidation
  – Underutilization
  – Management of numerous OSs and dependant applications

• Hardware Considerations
  – Very uniform server hardware platforms, esp. I/O
  – Extensive processor support for virtualization

• Huge uniform market
  – Numerous successful companies of very large scale
Embedded is different yet again

- Embedded devices are already highly optimized
  - Size, power consumption, cpu utilization etc.

- No layer of software makes a processor go faster

- So far not a big $$$ market

- Multi-core does NOT automatically mean:
  - RTOS for data plane
  - Hypervisors/virtualization
  - Multiple OSs
  - Many-core

The real SoC trend will be a small number of cores + extensive application-specific hardware acceleration. What does this mean for software?
“If you are going to have Linux on your device anyway, why not just have Linux do it all?”
Linux Resources for Supporting Complex SoCs
Linux
Linuxes on KVM
Linux on Containers
Linux “Bare Metal”

- High performance, ultra low overhead Linux
  - “Bare-metal-like” performance
  - Goal: ~99% of CPU is dedicated to the process
  - Real Time scheduling for prioritized execution, ultra low latency
  - RTOS replacement
- User mode environment with direct access to hardware
  - No kernel mode programming required
  - All development done in user mode
- Specific enhancements
  - Processor affinity
  - Cgroups
  - Interrupt vectoring
  - Memory mapping – especially I/O
  - Tickless configuration
    - Only get timer interrupts when needed instead of periodically
Example: MontaVista Bare Metal Engine
(Similar results from Tilera and others)

- Equal level of performance as semi’s dedicated run-times, >99%

<table>
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<th>Forwarding Performance (% line rate, 64byte frames)</th>
<th>% Difference</th>
<th>Avg Latency (ns)</th>
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Following are numbers on the revision 2.1 63xx board, with SDK 2.1 toolchain configurations.
EP6300C board revision major: 1, minor: 1, serial #: 97800
OCTEON CN6335-AAP pass 2.1, Core clock: 1250 MHz, IO clock: 800 MHz, DDR clock: 533 MHz (1066 Mhz data rate)
Thanks