Low Power Linux

SCALEX 2009

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Agenda

- Why?
- General Concepts
- Software Approaches
- Hardware Assistance
- PM for other components
- Current Examples
- Compromises
- Measurements
- Cases
- Questions

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Why?

- Lower power, less heat!
- Longer run time
- Lower power bill
- **Green**

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General Concepts

- Turn things off!
- Switch slowly
  - CMOS power is proportional to speed
- $P \sim V^2 * f$

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Software Approaches

- APM/ACPI (x86)
  - BIOS to abstract hardware
- x86 hlt instruction
- Tickless support (NO_HZ)
- Sleep while idle
- Suspend/hibernate

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Software Approaches

- Userland
  - sleep instead of spinning
    for(i=0xffff; i;i--); vs
    sleep(20);
  - Use a kernel driver
- Avoid hard real time

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Hardware assistance

- Design for low power
  - Intel Atom
  - ARM core
  - Transmeta
- Advance instructions
  - MMX/SSE/FPU (x86)
  - Neon/VFP (ARM)
- Less memory

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Hardware assistance

- Variable frequency
  - CPUFREQ
- Variable voltage
- Wake up trigger
- Accelerators
  - Graphics
  - DSP
  - Jazelle

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PM on other parts

- SDRAM self refresh
- LCD backlight
- DPMS
  Display Power Management System
- USB as part of spec.
- PCI as part of spec.
- Power supply controller shutdown

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PM on other parts

- Bluetooth sniff/park modes
- Network Wake on LAN
- WiFi power save mode
- Shutdown input on serial driver
- Solid state storage in place of rotating media
- Hard drive PM modes

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Current design: x86
Intel Atom

- Derived from Pentium
- Lot of press coverage
- Makes chipset main power draw
- Not an SoC
- Significant improvement in power usage
- 2.5W/11.8W
- Used in MID/UMPC

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Current design: ARM
TI OMAP3

- ARM Cortex A8
- Dual core: Includes a DSP
- Variable voltage
- A SoC
  - Subsystems can be clock gated and powered off
- Less then 2W

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Trade offs

- Latency
- Tricky coding to maintain state
- Side effects
  - hlt on x86 impacted sound
- Documentation may be harder to find.
- Can be system specific

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Measurements

- Basic DMM to measure current
  - Connected in series
  - Measure at battery
  - Measure at CPU
  - Error from I*R losses and power supply losses

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Measurements

- Some boards may have measurement points designed in
  - i.MX31 PDK has a header
  - Beagle has a jumper and on board sensor
  - Can provide more details to identify hot spots

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Measurements

- New design provisions:
  - 0 ohm jumpers on power lines
  - Accessible trace
  - On board sensors
- PowerTop
  - Id power consuming processes

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Cases - 1

- 40MHz 386 acting as a home router
  - 100W measured
- "WRT54" router for $100
  - 10W power supply
- Assume $0.15/KWn

  (100W - 10W) * 24h * 30day =
  64.8KWh

  $0.15 * 64.8KWh = $9.72/month

  Payback <1 year!

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Cases - 2

TI OMAP3 based Beagle Board

Bootloader: 333mA

	Idle	Busy
No PM		
	132mA	223mA
PM - Performance (550MHz)		
	154mA	248mA
PM - Power save (125MHz)		
	127mA	145mA

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Cases - 2 (con't)

- Numbers are extremes
- Actual application would be a mix
- Governors can help
- NOHZ may help if there is IO

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Questions?

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