Laptop 2.0

Timo Hönig, Holger Macht, Helmut Schaa

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1 Power Management
- The Complete Disaster
- The Results
- Conclusion

2 Fingerprint Reader Support
- Hardware
- Software
Content

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   - Hardware
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Recap: LinuxTag 2007

- The suspend challenge openSUSE, Mac OS X and Windows Vista
- Hardware: Apple MacBook, Intel Core 2 Duo (1,83 GHz), 2 GByte RAM
- openSUSE lost all disciplines
The Challenge

- Suspend to disk right after booting the system
- Suspend to disk with many applications running
  - Firefox
  - Thunderbird
  - GIMP
  - OpenOffice Writer
  - RealPlayer
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Suspend to Disk (Fresh Boot) – Plain Numbers

Last year (LinuxTag 2007)
Suspend to Disk (Fresh Boot) – Plain Numbers

This year (LinuxTag 2008)
Suspend to Disk (Applications Running) – Plain Numbers

Last year (LinuxTag 2007)
Suspend to Disk (Applications Running) – Plain Numbers

This year (LinuxTag 2008)
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Suspend to Disk (Applications Running) – Commented

- Last year: Mac OS X suspends and resumes only a little bit faster than Vista, openSUSE needs about two times longer
- This year: openSUSE takes the crown!
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2. Fingerprint Reader Support
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Supported platforms

- UPEK/SGS Thomson Microelectronics fingerprint reader (USB ID 0483:2016)
- Supported laptops
  - ASUS
  - Dell
  - IBM/Lenovo
  - Toshiba
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openSUSE Integration

- openSUSE 11 ships with full support for GNOME (GDM, gnome-screensaver)
- KDE3/KDE4 support is almost ready, will need some online update or build service update
3 Trying to Improve

4 Power Management
- CPU Power Management
- Running Battery powered...
- Wireless
- Storage
- Sound
- Summing Up...

5 Dock Stations and Bay Devices
- GNOME Docker
Laptop Database

- Internal laptop database containing information about ACPI support, PCI information, etc.
- With openSUSE 10.3: Extended with test data regarding the Energy Star specification
Energy Star Compliance

Software and Hardware Involvement

- Systems must meet a certain software configuration
- Power Consumption must not need exceed certain limits

Operational Mode: \textit{Idle}

- System AC Powered
- Display is off
- Idle limit for laptops with powerful graphic cards: 22.0 Watt
- Idle limit for all other laptops: 14.0 Watt
Power Consumption Comparison: Lenovo ThinkPad T61

openSUSE 10.3

- Idle power consumption: 14.35W
- 0.35W above the Energy Star limit
Power Consumption Comparison: Lenovo ThinkPad T61

<table>
<thead>
<tr>
<th>openSUSE 10.3</th>
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<th>Version</th>
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**How comes?**
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Known Techniques

CPU Frequency Scaling (ACPI P-States)
- Reduce CPU frequency when not needed
- Intel SpeedStep, AMD PowerNow, etc.

CPU idle states (ACPI C-States)
- Set CPU to low power mode if no instructions are executed
Intel Core 2 Duo T7700 Power Consumption

Conclusion

- Huge potential in deepest sleep mode
- Common goal: Be idle as long as possible!
- Policy also knows as race to idle
Bad Boys

Processes are waking up the CPU

- Desktop applications
- System daemons
- Kernel threads

Solution: Fix applications and kernel

- Applications must not unnecessarily wake up the CPU
- Ongoing process over the last couple of month (cf. PowerTop)
- It seems to pay off!
3. Trying to Improve

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Laptop 2.0
Not polluting the environment when on AC is good, but...

...isn’t there something we can do for typical laptop use cases?

Users do accept a certain amount of performance loss in favour of longer battery runtimes
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Trying to Improve

Power Management

Dock Stations and Bay Devices

Wireless

Basic approach of IEEE 802.11 specification

- Most power is spent when packages are submitted
- Consequence: Short bursts of submission, afterwards clients go to sleep
- cf. race to idle

Clients: Two modes

- Active: Radio always on
- Sleep mode: Intermittently turning off the radio
  - Periodic wake-ups to check if packages are available
Supported Drivers
- IWL3945 and IWL4945

Example: Intel PRO/Wireless 3945ABG, no traffic
- Full power: $\approx 1.15\, W$
- Sleep mode, but fully functional: $\approx 0.3\, W$

```
$ echo 6 > /
sys/bus/pci/drivers/iwl*/000*/power_level
```
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SATA: Aggressive Link Power Management

- SATA link to the disk is put into low power mode when no IO
- Automatically woken up when requests arrive

Example: Fujitsu hard disk with 80 GB (SATA)

- Full power: $\approx 2.5 W$
- ALPM enabled: $\approx 1.8 W$

$\$ echo {min/medium}_power > \\ /sys/class/scsi_host/$HOST/link_power_management_policy$

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Power Management

Dock Stations and Bay Devices

Sound

Shutdown when Idle

- Disable sound cards after time out period
- Short wakeup delay
- Power savings: \( \approx 0.5 \text{Watt} \)

```bash
$ echo 10 > \\n/sys/module/snd_hda_intel/parameters/power_save
```
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## Possible Power Savings

<table>
<thead>
<tr>
<th>Component</th>
<th>Power Saving</th>
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<tbody>
<tr>
<td>Hard disk</td>
<td>≈ 0.7 W</td>
</tr>
<tr>
<td>Wireless</td>
<td>≈ 0.8 W</td>
</tr>
<tr>
<td>Sound card</td>
<td>≈ 0.5 W</td>
</tr>
<tr>
<td><strong>CPU</strong></td>
<td><strong>Unsafe coefficient</strong></td>
</tr>
<tr>
<td></td>
<td>2.0 W + CPU</td>
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Power Consumption Comparison: Lenovo ThinkPad T61

Prerequisites
- Battery powered
- Display off

openSUSE 10.3
- Idle power consumption: 11.11W
Power Consumption Comparison: Lenovo ThinkPad T61

**Prerequisites**
- Battery powered
- Display off

**openSUSE 10.3**
- Idle power consumption: 11.11W

**openSUSE 11.0**
- Idle power consumption: 8.51W
- Makes up ≈ 23%
- Power savings: 11.11W − 8.51W = 2.6W
Trying to Improve Power Management

Dock Stations and Bay Devices

Summing Up...

Power saving distribution

Power Savings

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<td>(\approx 0.6,\text{W})</td>
</tr>
<tr>
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<td>(\approx 2.6,\text{W})</td>
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</table>
Dock Stations and Bays

Ongoing development efforts

- Lot of work supporting dock stations and bay devices in a generic way
- Always considered as: "Does not work anyway"

With 11.0...
Everything which does not work is considered a bug. So file it!
Trying to Improve

Power Management

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Dock Stations and Bay Devices

 GNOME Docker
Dock station applet caring about:
- User notifications
- Hotkeys (e.g. FN-F9)
- External displays connected to the dock (xrandr)

GNOME Docker will care about:
- Safely removing devices in the dock
6 Wireless
  ■ The New Wireless Stack mac80211
  ■ Overview of Wireless Drivers
  ■ Which Card Works Reliable?
  ■ What Next?

7 NetworkManager
  ■ Features
Content

6 Wireless
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7 NetworkManager
   ▪ Features
Devicescape released the d80211 stack in 2006 to the open source community.

The stack was cleaned up and renamed to mac80211 for inclusion in the Linux kernel 2.6.22.

It implements functions of the 802.11 specification needed by nearly all wireless drivers.
Former Architecture

User space

Driver (madwifi)
Hardware

Driver (IPW2200)
Hardware

Driver (orinoco)
Hardware
Architecture with mac80211

User space

mac80211

Driver (iwlwifi)
Hardware

Driver (ath5k)
Hardware

Driver (rtl8187)
Hardware

Driver (orinoco)
Hardware
Advantages

- No need to reinvent the wheel for every device driver again ⇒ wireless driver development is much less work
- New device drivers obtain all implemented features at once ⇒ WPA support ⇒ AP mode support
- All mac80211 based device drivers behave the same ⇒ user space does not need driver specific quirks anymore
- Better test coverage due to being used by more than one driver
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# Overview of mac80211 Based Device Drivers

<table>
<thead>
<tr>
<th>Driver</th>
<th>Supported Devices</th>
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</thead>
<tbody>
<tr>
<td>ath5k</td>
<td>Atheros chipsets, replaces madwifi</td>
</tr>
<tr>
<td>rt2x00</td>
<td>RaLink chipsets</td>
</tr>
<tr>
<td>iwlwifi</td>
<td>Intel PRO/Wireless 3945 and 4965, replaces ipw3945</td>
</tr>
<tr>
<td>b43</td>
<td>Broadcom PCI chipsets, replacement for bcm43xx</td>
</tr>
<tr>
<td>rndis_wlan</td>
<td>Broadcom USB chipsets</td>
</tr>
<tr>
<td>rtl818x</td>
<td>Realtek USB chipsets</td>
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Which Card Works Reliable?

**Built-in PCI Devices**
- Intel PRO/Wireless 3945/4965

**PCMCIA Cards**
- Atheros

**USB Sticks**
- Zydas ZD1211
- RaLink rt2570
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Future of mac80211

- Wireless drivers and stack are still under heavy development
  ⇒ Support for even more devices is on its way

- Features currently worked on:
  ⇒ Mesh networking (802.11s)

Additional information: http://wireless.kernel.org
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New Features

- Multiple active connections (e.g. wireless and wired connection)
- Support for UMTS and GSM connections
- Static IP configuration
- Support for a broader range of wireless setups
Thanks for coming!