Peak Current Management in x86 based Smartphones

Durgadoss R
Intel
ELC-2012
Acknowledgements

• Hari, Rajeev, Ramesh
• Brad, Darren, Reed
• Pascal, Renaud, Yaney
• Jenny, Pavan, Rama, Saranya
Agenda

• Peak Current issues on phones
• Addressing Peak Current on x86 phones
• Proposed Extensions..
• Call to Action
Peak Current issues on phones

- ~1500mAH, Single cell Li-ion Battery
- ~7000mAH, dual cell battery
Peak Current issues on phones...

All components are active, almost all time!!
Peak Current issues on phones...

IBATT: The maximum current the battery can sustain
Peak Current issues on phones...

High Ct transient causes Voltage to droop (GSM burst etc)...

On Low batt charge (~20%) High transient Ct can cause system shutdown (resulting Instability)
Peak Current issues on phones...

“Take a Picture with a Flash, while playing Audio in the Speakers”

<table>
<thead>
<tr>
<th>Phone</th>
<th>What we observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phone 1</td>
<td>Audio Playback stops when <em>we open Camera App</em>, but resumes once picture is taken.</td>
</tr>
<tr>
<td>Phone 2</td>
<td>Picture taken <em>without a Flash</em>. Audio stops <em>but does not resume</em>.</td>
</tr>
<tr>
<td>Phone 3</td>
<td>Audio Playback stops when we open Camera App, but does not resume once picture is taken.</td>
</tr>
<tr>
<td>Phone 4</td>
<td>The volume suddenly reduces for that time span and then after the flash, the volume returns to its original level.</td>
</tr>
</tbody>
</table>
Additional Constraints...

- Burst occurs for a very short period of time
- Completely Unpredictable !!
- Degree of adversity varies with Bat. Capacity
# Addressing Peak Current

<table>
<thead>
<tr>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>HW + OS + User Space policy management</td>
</tr>
<tr>
<td>HW + OS (notification + configuration)</td>
</tr>
<tr>
<td>HW + OS (notification only)</td>
</tr>
<tr>
<td>HW only</td>
</tr>
</tbody>
</table>
Addressing Peak Current

- HW + OS + User Space policy management
- HW + OS (notification + configuration)
- HW + OS (notification only)
- HW only

- OCDE + OCD Driver + Service
- OCDE + enhanced OCD Driver
- OCDE + OCD Driver
- OCD Engine

What is the Enhancement??
Overview of OCD Driver

• Now, a Platform driver...
  – http://comments.gmane.org/gmane.linux.drivers.platform.x86.devel/1197
  – drivers/platform/x86/intel_mid_ocd.c
• Handles the interrupt from the OCD Engine
• Stores three sets of data for three different Bat. levels
• Exposes sysfs:
  – current_warning/shutdown
  – Timer_warning/shutdown
  – Warning_count
  – Crit_shutdown (bool)
  – Action_mask
  – Batt_level (user space talks to this interface)
Hwmon Feedback...

• Initially submitted to hwmon..
  • http://lists.lm-sensors.org/pipermail/lm-sensors/2010-November/030623.html
  • http://lists.lm-sensors.org/pipermail/lm-sensors/2010-November/030628.html

• No mechanism for reporting instantaneous current draw

• “Seems to be a lot of chip specific stuff, Nothing genericisable” -- comment

• What we lacked?
  – Problem not really noticed/understood by many
  – Many HW pieces not doing this kind of thing..
Regulator Feedback...

• Battery → Not a regulated Supply
• Current limits generally have single trip point
  – But, we need more (ABI change)
• Regulator drivers don’t do current ‘limiting’
• Other ‘current’ drivers need Registration and notification support
• Need to talk to power-supply subsystem
• Not all devices have regulators
Platform drivers..

• Revisiting this, one year later....
• Platform-drivers not a good option:
  – Now, more platforms with this kind of engine
  – Hence, more maintainability and code duplication
  – No standard API/ABI
• We are able to generalize certain things ... !!
Proposed OCD Framework

• Generic Framework:
  – Creates sysfs interfaces, with standardized ABI’s
  – Handles configurable policies
  – Every platform specific driver registers with this
  – Standard interface for other drivers to register & receive notifications (In-kernel notifications)
  – Register & Receive power-supply notifications
  – User Space notifications, if needed
Call To Action..

• Initial Discussions:
  • http://www.spinics.net/lists/linux-embedded/msg03667.html
  • http://www.spinics.net/lists/linux-embedded/msg03671.html
  • http://www.spinics.net/lists/linux-embedded/msg03678.html
  • http://www.spinics.net/lists/linux-embedded/msg03679.html

• Mail me @ durgadoss.r@intel.com
Q & A

• Mail me @ durgadoss.r@intel.com
Back up

- A HW engine → monitors platform current consumption
- Has Programmable registers, Raises signals or interrupts on a current violation
Back up

• How are the other platforms solving it?
• http://www.theinquirer.net/inquirer/news/21
• Most phones do not have Camera Flash (A major current consumer)