Linux 802.11 Solutions for Mobile Platforms

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What are we talking about?

- Mobile platforms: Phones, MIDs, tablets, PDAs.
- Linux solutions: kernel.org drivers.
- Full MAC vs Soft MAC devices.
Soft MAC 802.11 devices

- 802.11 partly done in kernel.
- 802.11 partly done in HW.
- Hardware talks 802.11.
- Smaller chips.
- Typical 802.11 design.
Full MAC 802.11 devices

- 802.11 fully done in HW.
- Hardware talks 802.11 or 802.3.
- Fat chips.
- Unusual designs.
Mobile 802.11 specific requirements

- **Power consumption**
  - Battery killer.
  - Idle, associated, full speed.

- **Roaming**
  - Streaming while moving around APs.

- **Radio coexistence**
  - One antenna, several radios.

- **Throughput**
  - Use cases driven: WWW, VoIP, video streaming.
  - More is not better.
Host and target power savings

- **Host controller power savings**
  - Low footprint host controllers: Serial, SPI, SDIO.
  - High speed clocks, small packet overhead.

- **Target power saving**
  - Target deep sleep for idle and associated modes.
  - Partial sleep while traffic is running.
802.11 power savings

• 802.11 power save mode (PSM)
  – The client initiates PSM and notifies the AP about it.
  – The AP starts buffering all frames.
  – Unicast frames: The client sends a PS-Poll frame to fetch them.
    • TIM bits in every beacon (Traffic Indication Message)
  – Broadcast frames: The AP sends them right after DTIM beacon
    • DTIM bits every N beacon (Delivery Traffic Indication Message)
802.11 power savings: Unicast case

AP

TIM: 0
TIM: 1
TIM: 0
TIM: 0
TIM: 0
TIM: 0
TIM: 0
TIM: 0

DTIM: 0
TIM: 0
TIM: 0
TIM: 1
TIM: 1
TIM: 0
TIM: 0
TIM: 0
TIM: 0

Client

wakeup
wakeup
wakeup
wakeup
wakeup

PS-Poll

Unicast
802.11 power savings: Broadcast case

AP

DTIM: 0  TIM: 0  TIM: 0  DTIM: 1  TIM: 0  TIM: 0  DTIM: 0  TIM: 0  TIM: 0  TIM: 0
Beacon  Beacon  TIM: 0  Broadcast  TIM: 0  TIM: 0  TIM: 0  TIM: 0  TIM: 0  TIM: 0

Client

wakeup  wakeup  wakeup
802.11 power savings

- Client must wake up for every DTIM beacon.
- Client can sleep between DTIM beacons.
- Client decides when to wake up for unicast frames.
- Broken AP, broken FW: packet losses.
- Biggest power saver.
mac80211 power savings

• Only for Soft MAC devices.

• Beacon filtering
  – Firmware only forwards relevant beacons:
    • DTIM or TIM changes.
    • Host stays asleep, target wakes up.
  – Beacon losses notification.
  – Significant power savings.

• DPSM (Dynamic Power Save Mode)
  – Host and target stay awake for a while after the last TX.
  – Helps throughput, helps latencies, may help power saving.
Firmware power savings

• Need firmware support for beacon filtering and DPSM.

• Full MAC devices:
  – Scanning: Only get new scan results.
  – DTIM and beacon filtering.
  – Packet filtering: Much less traffic when idling.

• Packet aggregation
  – Keep the host awake longer, but less often.
  – Helps throughput and saves power.
Roaming

- Roaming is scanning:
  - Periodic background scanning for fast roaming.

- Roaming decision:
  - Soft MAC: All the way from HW to user space.
  - Full MAC: Can live in HW, user space notified asynchronously.

- Full MAC advantages:
  - Scanning and roaming in HW: Faster and lighter on your battery.
Radio Co-existence

- Typical use cases: WLAN/Bluetooth coexistence.
- One antenna:
  - 2 radios: Needs MAC and HW support.
  - 1 radio: Integrated MACs, needs full MAC.
- Radio broker for mac80211.
## The winners

<table>
<thead>
<tr>
<th>Driver</th>
<th>MAC</th>
<th>Bus</th>
<th>802.11 PSM</th>
<th>Coexistence</th>
<th>Roaming</th>
<th>Manufacturer support</th>
</tr>
</thead>
<tbody>
<tr>
<td>iwmc3200</td>
<td>Full</td>
<td>SDIO (SPI)</td>
<td>Yes</td>
<td>Yes ¹</td>
<td>Yes</td>
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<td>wl12xx</td>
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<td>Yes</td>
<td>Yes ²</td>
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<td>libertas</td>
<td>Full</td>
<td>SDIO SPI</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

¹ MAC support for BT/WiFi/WiMAX coexistence.
² Firmware support for Bluetooth coexistence with 802.15.2 compliant BT modules.
³ Firmware can provide beacon losses and low signal events.
The losers

- **ar6k**: Atheros Full MAC SDIO device
  - Atheros working on an upstream mergeable version.
  - Openmoko driver.

- **P54spi (a.k.a. cx3110x)**: Discontinued HW.

- **bcm4325**: Broadcom Full MAC SPI/SDIO device
  - Some open source driver laying around.
  - Upstream hopeless.
Questions?
Questions?

- http://wireless.kernel.org/
- linux/drivers/net/wireless/iwmc3200wifi/
- linux/drivers/net/wireless/wl12xx/