Tuning Embedded Linux for Low Power

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Introduction

Extinction

Extinction

- On a stock constructor distribution, 16 seconds of boot time
- Boot time can be optimized (NXP optimization study on i.MX8)
- 90 % of power saving

Suspend to idle

Suspend to idle

- Lightest implementation
- Freeze the userspace
- Wake-up in 0.7 seconds
- 12.5 % of power saving

Suspend to RAM

Suspend to RAM

- Saving system state in RAM
- Whole system except the RAM is in standby mode
- Wake-up in 0.7 seconds
- 50 % of power saving

Suspend to disk

Suspend to disk

- Saving system state in disk
- Whole system is powered off
- Wake-up in 2-3 seconds
- 90 % of power saving

Comparison

Suspend mode comparison on an i.MX8 with stock constructor distribution

	Reduced energy consumption when the mode is activated	Wake-up time between demand and an operational system
Extinction	90%	16 seconds (but could be optimized to 3.8 seconds according to NXP)
Suspend to idle	12.5%	0.7 seconds
Suspend to ram	50%	0.7 seconds
Suspend to disk	90%	2-3 seconds

Turn down peripherals

Turn down USB device

- Dynamic management of power is disabled by default
- This need to be tested as some issues have been detected when reconnecting on some devices (see Documentation/driver-api/usb/power-management.rst)
- 56 % of power saving when turn down a USB modem

Disabling connectivity devices

- Connectivity devices are very power consuming
- When unneeded, it is recommended to disable them (via ifconfig, ip, nmcli...)
- 52 % of power saving when turn down wifi, ethernet and modem

CPUFreq

Available CPUFREQ

- Ondemand: adjust frequency based on current load
- Conservative: same as ondemand but more gracefully
- Powersave: set to lowest frequency
- Performance: set to highest frequency
- Userspace: allow any root userspace program to set frequency
- Schedutil: adjust frequency based on kernel scheduler

Impact of CPU frequency

- Improvement only on high load
- 23% of power saving on 100% load between max and min CPU frequency

Conclusion

Thank you for your attention

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