# Faster Resume For Energy Savings on MeeGo

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# Agenda

- Goal
- Approach
- Resume time optimizations
- Movie 1
- Early-screenshot for better user experience
- Movie 2
- Summary

# Goal

Introduce hibernation to handset devices for more energy saving

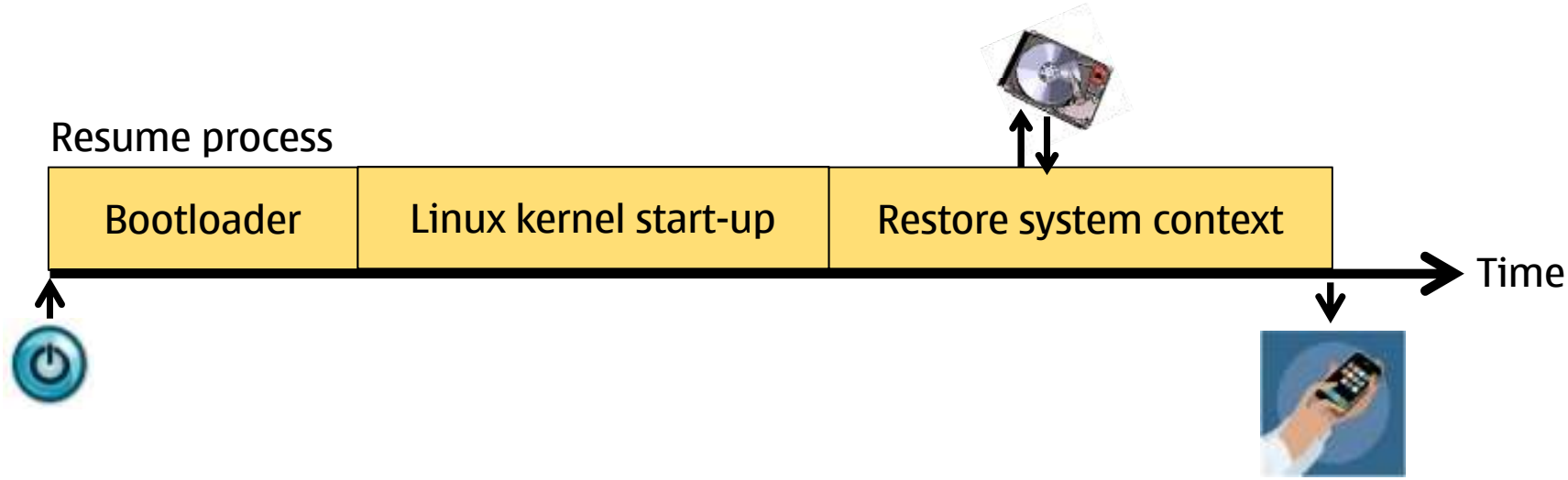
[use-cases]

- Turn off to maximize battery life while meeting, sleeping, etc
- Start using instantly when out of the package
- Keep using “simple phone mode” even under battery emergency
- Recover application context after battery run out

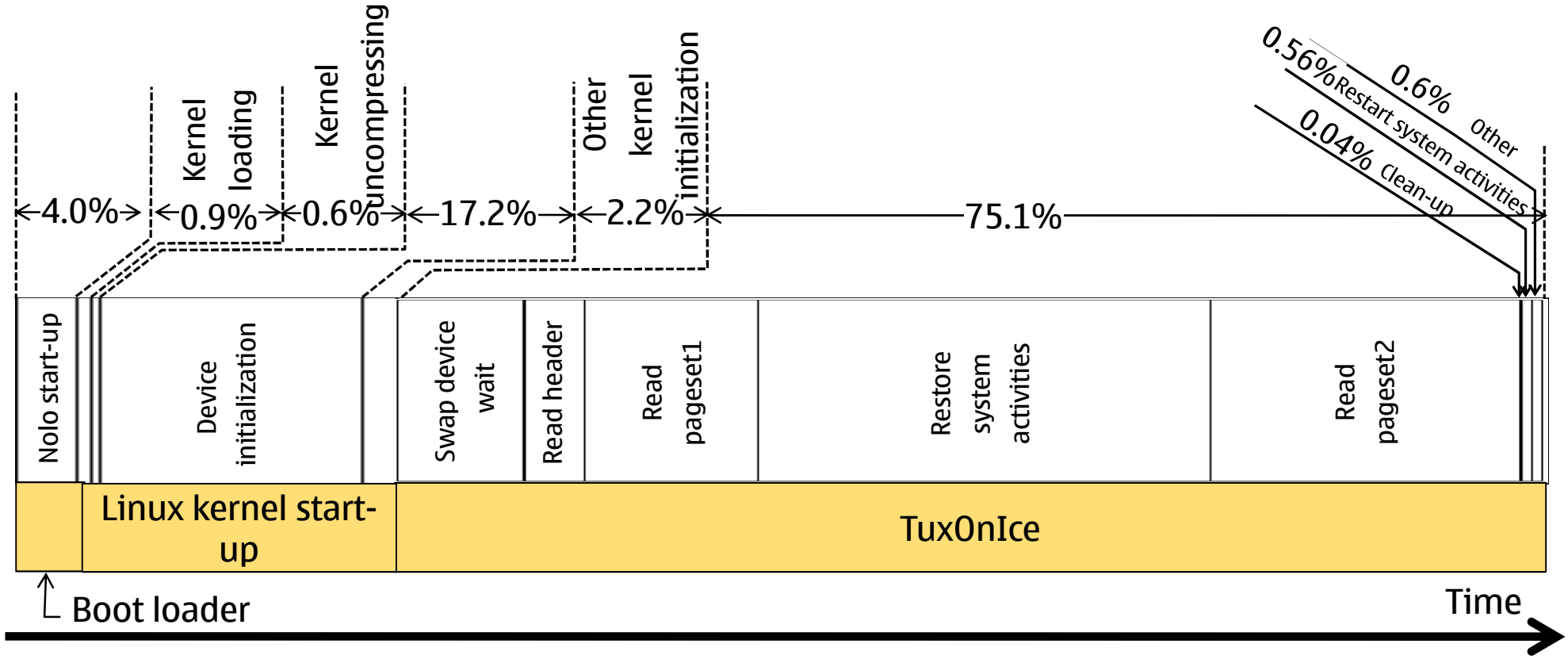
- Enable more power-off time
- Three seconds for fast resume
- Platform and application independent

# Approach

- Use TuxOnIce for hibernation
- Make resume faster
  - Speed up boot sequence
  - Minimize snapshot image size
  - Implement as generic as possible



# Resume Process Breakdown




Platform: N900 (256MB SDRAM)

Processor: TI *OMAP* 3430: ARM Cortex-A8 600 MHz

Linux kernel: 2.6.35 (MeeGO for N900) + patch sets

- Suspend-To-Disk for ARM
- TuxOnIce for 2.6.35 kernel

Snapshot image size: 23MB (70 % compression)

Snapshot image compression: LZO

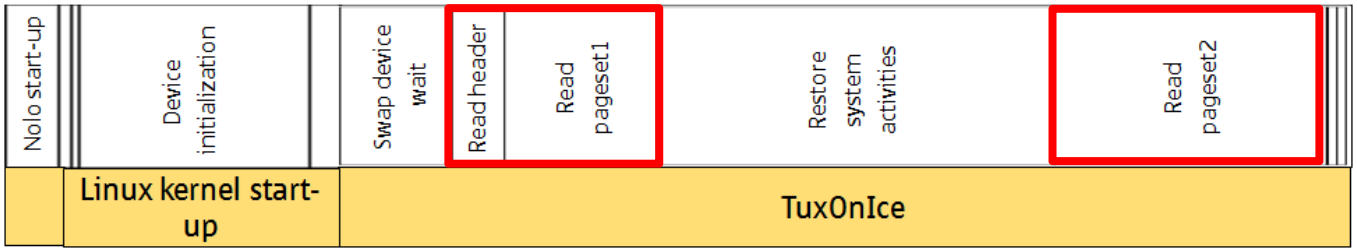
Boot device: eMMC mass storage

Resume time: about 10 seconds

# Shrink Snapshot Image Size

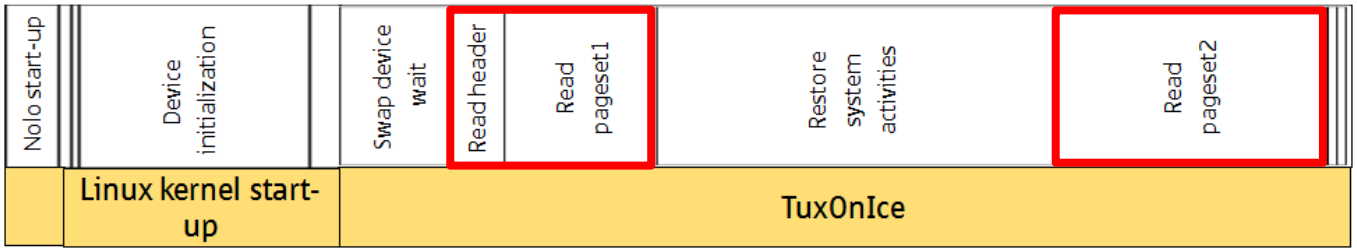
- Page out as many pages as possible before suspend process starts
  - Take advantage of asymmetric aspect in user experience
    → Resume time is more important for user rather than suspend time
  - Restored with usual page-in mechanism after resume
  - Pros
    - Resume time not proportional to the number of running applications
  - Cons
    - Slower suspend process
    - Application responses might degrade after resume

- Removing unnecessary memory area
  - Kernel text, data
  - DSPBridge buffer
  - Framebuffer data



# How to shrink snapshot image

- Reclaim pages in suspend process as much as possible
  - Modify mm/vmscan.c in order to reclaim pages aggressively
  - Execute shrink_all_memory() repeatedly certain times
- Remove kernel text & data: 4 MB (MeeGo 1.1 for N900, Linux 2.6.35)
  - Reload in kernel boot-up
- Remove a reserved region by DSPBridge: 6 MB
  - Unload before suspend and load after resume
  - Reserved even when the driver is unloaded
- Remove framebuffer area: 16 MB
  - Redraw after resume

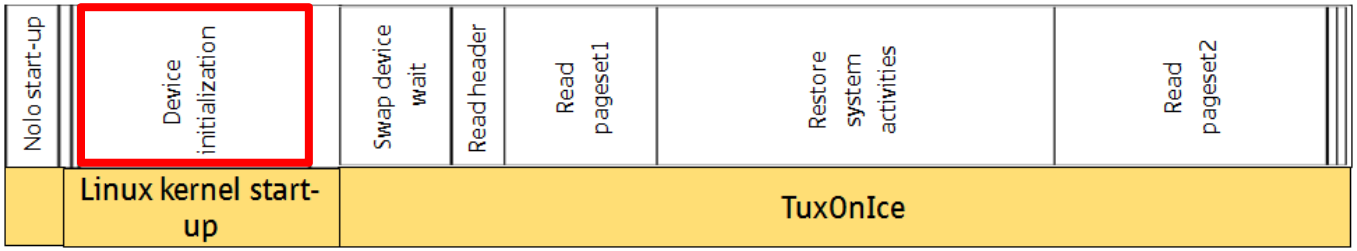


# Improve device initialization

- Remove omap-mcbsp driver initialization from boot process
  - Compile as a module with CONFIG_SND_SOC=m
- Device initialization time: about 1.4 seconds

| Driver | Description | Device initialization time |
|---|---|---|
| omap_dss | Display | 12.26% |
| Serial | Serial (UART) | 43.93% |
| onenand | NAND flash | 18.48% |
| omap-mcbsp-dai | Serial sound I/F | 16.37% |

Offloaded

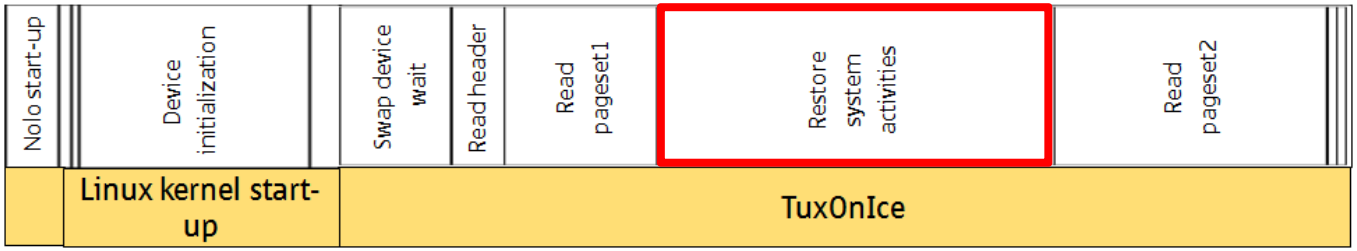


# Improve device restore

- WLAN restore is more than half of Restore System Activities
  - 332 devices are restored during resume operation
- Restore System Activities: about 1.5 seconds

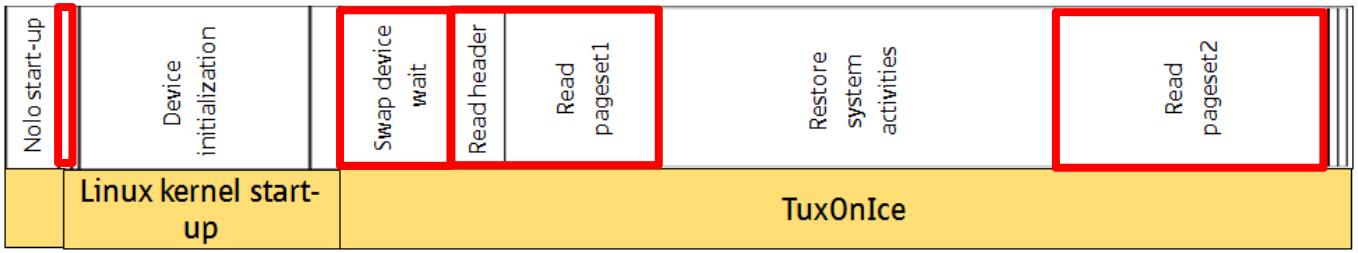
| Device | Description | Time |
|---|---|---|
| phy0 | Physical layer for 802.11 | 55% |
| omapdss | Display | 6% |

Offloaded

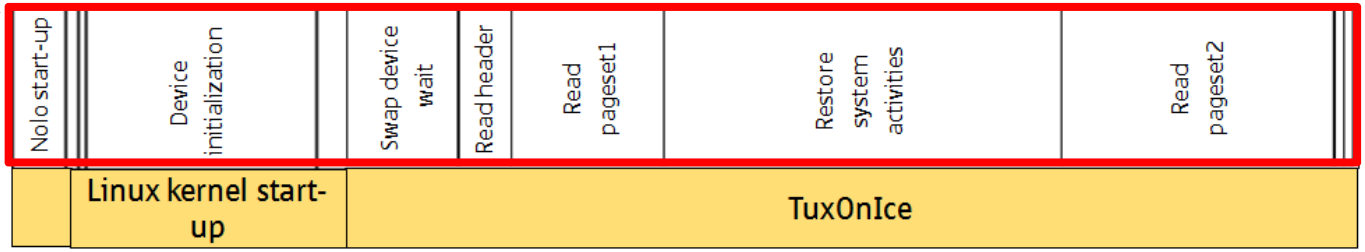


# Improve Memory Transfer

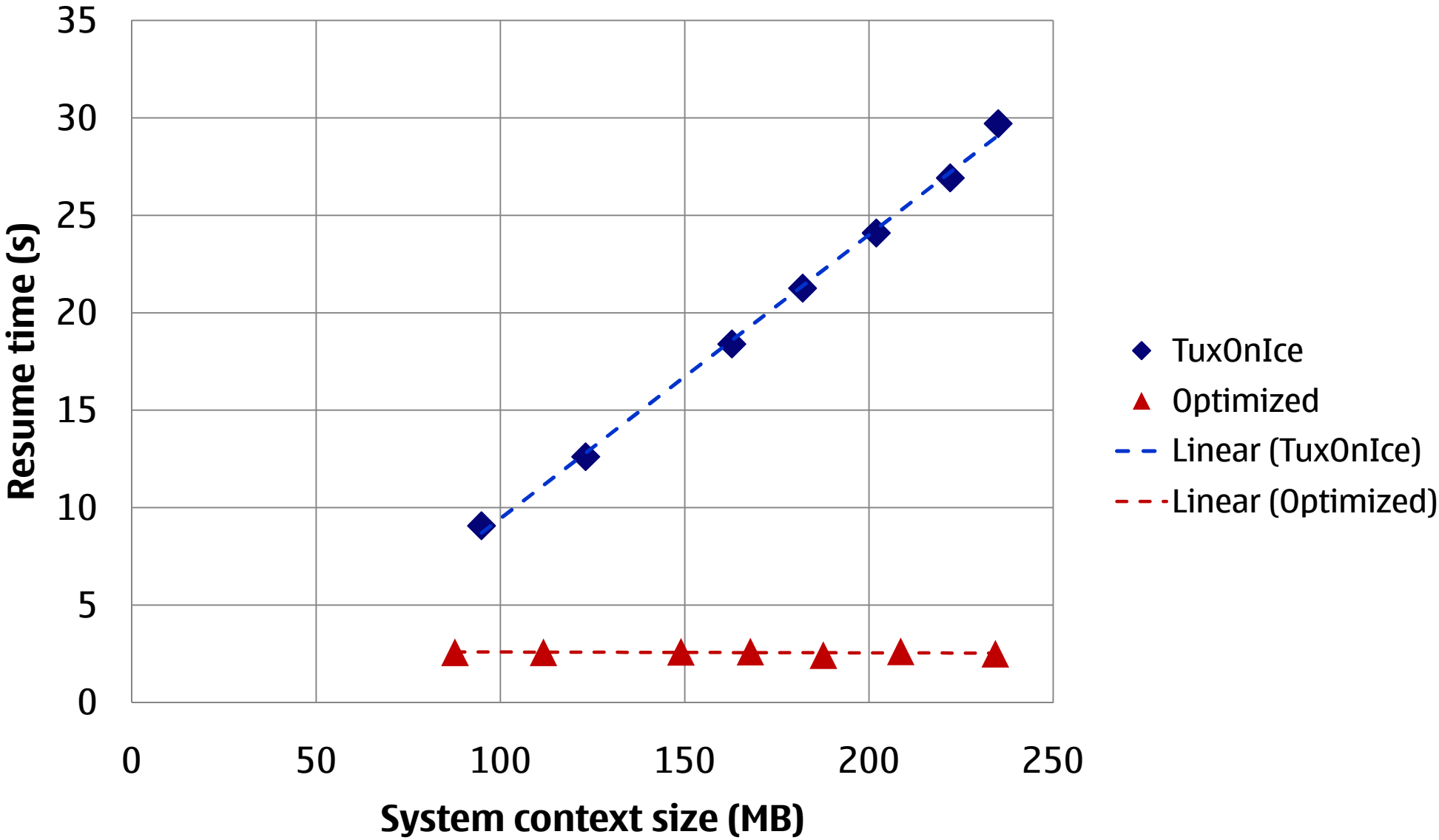
- Allocate swap space in NAND flash
  - Faster access than eMMC
    - eMMC: < 20MB/s sequential read
    - NAND flash: < 23MB/s sequential read
  - Use mtdblock instead of mtdswap
    - mtdswap is not applicable to hibernation



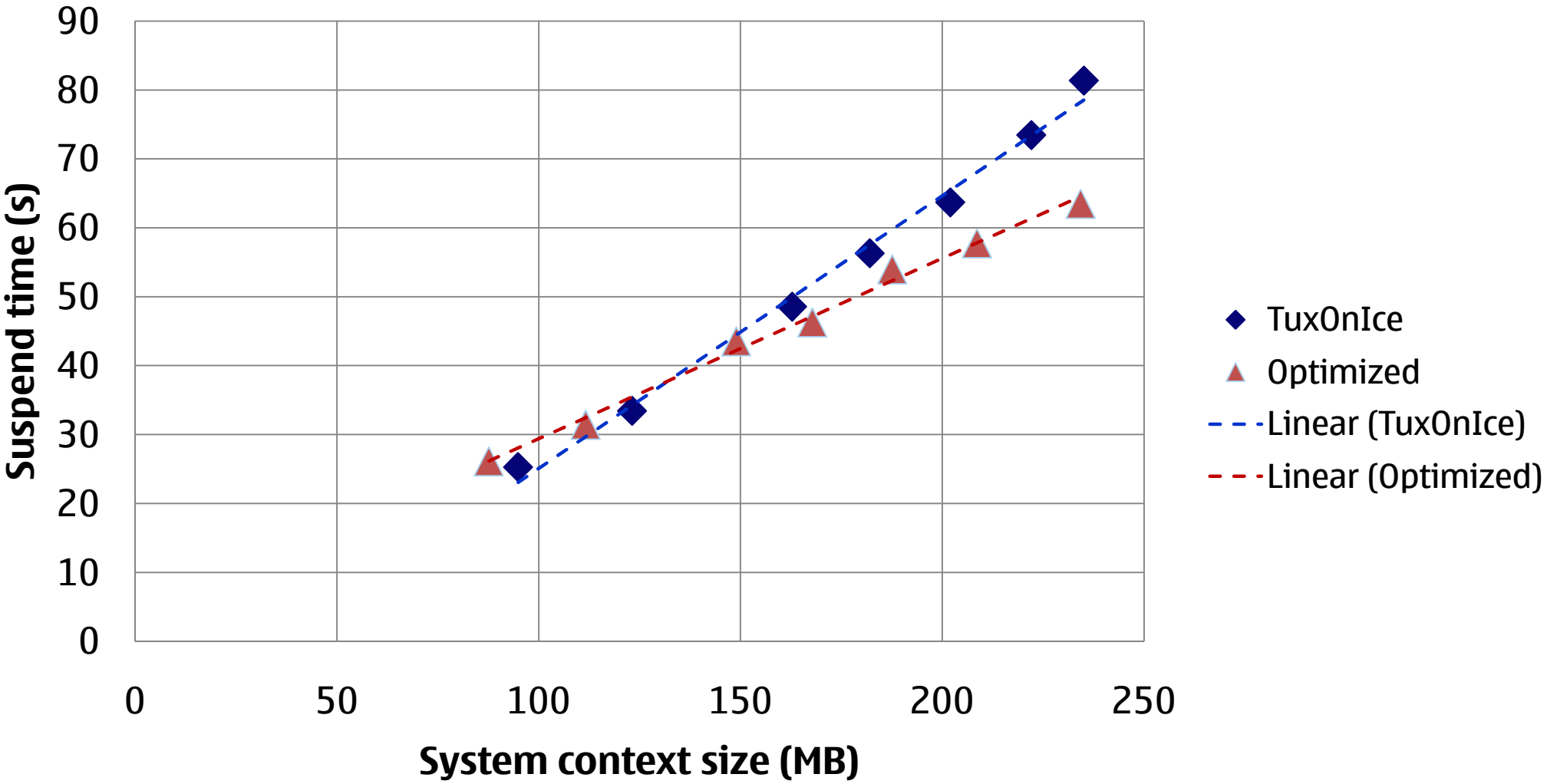

- Suppress bootloader and kernel messages
  - 'quiet' option for Linux



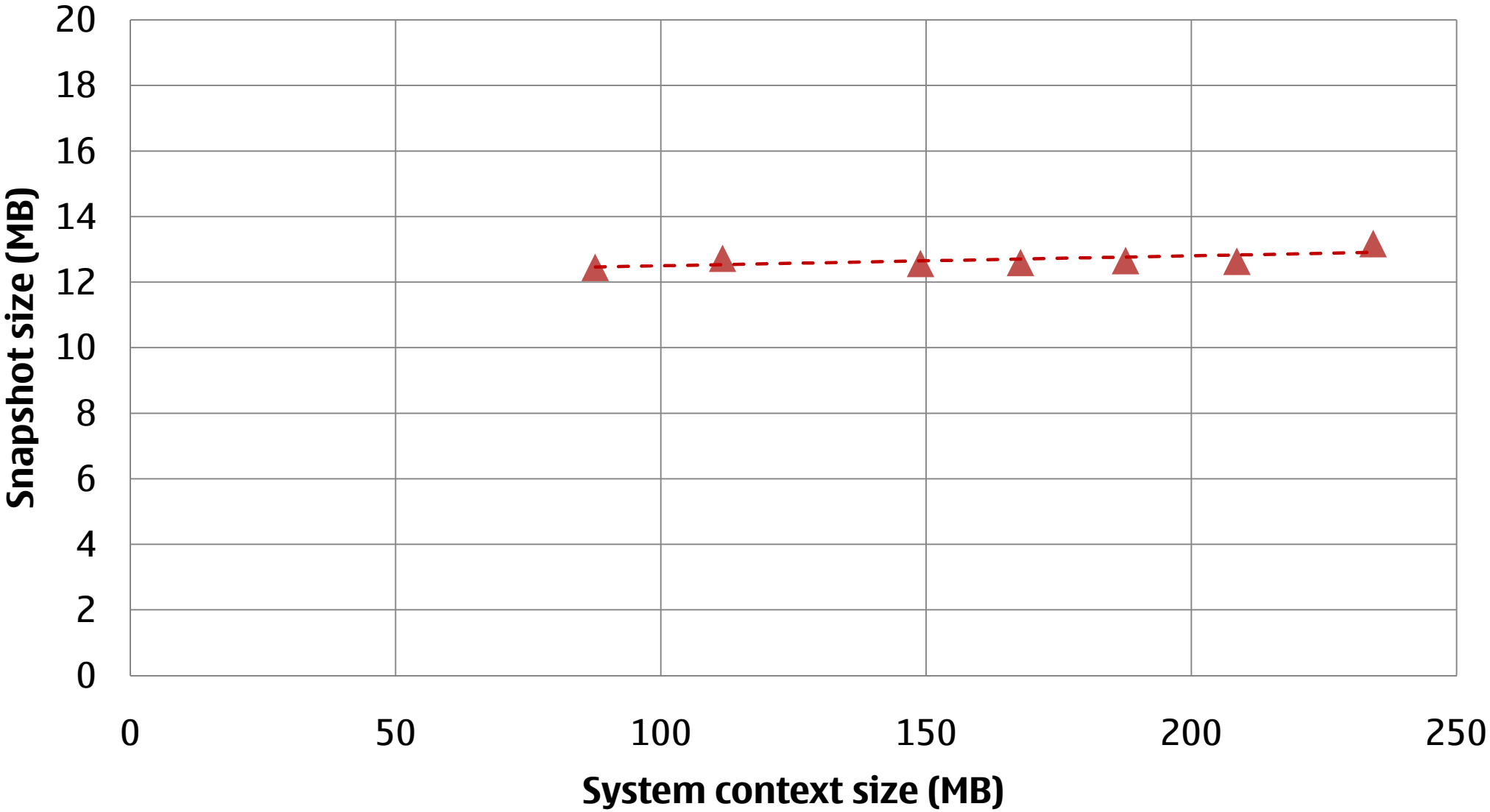
# Resume time result



# Suspend time result



# Snapshot image size shrinking result



# Movie: Optimized Snapshot boot

# Improve user experience with Early-Screenshot

- Save the last screenshot in suspend process
  - Restore the screenshot immediately in bootloader
- Visual assistance for user
  - Possible to start an action almost right after power-on
- Trade off between user experience and extra cost
  - Overhead in suspend and resume processes
    - Additional 700 ms in bootloader
    - Snapshot image gets bigger (saved as pageset3)
    - Screen data: 750 KB for 800 x 480 pixels, 16bit RGB
- Handover framebuffer settings in resume process
  - Skip part of DSS initialization with CONFIG_FB_OMAP_BOOTLOADER_INIT enabled
    - Not recommended but works

# Movie: Snapshot boot w/ early screen image

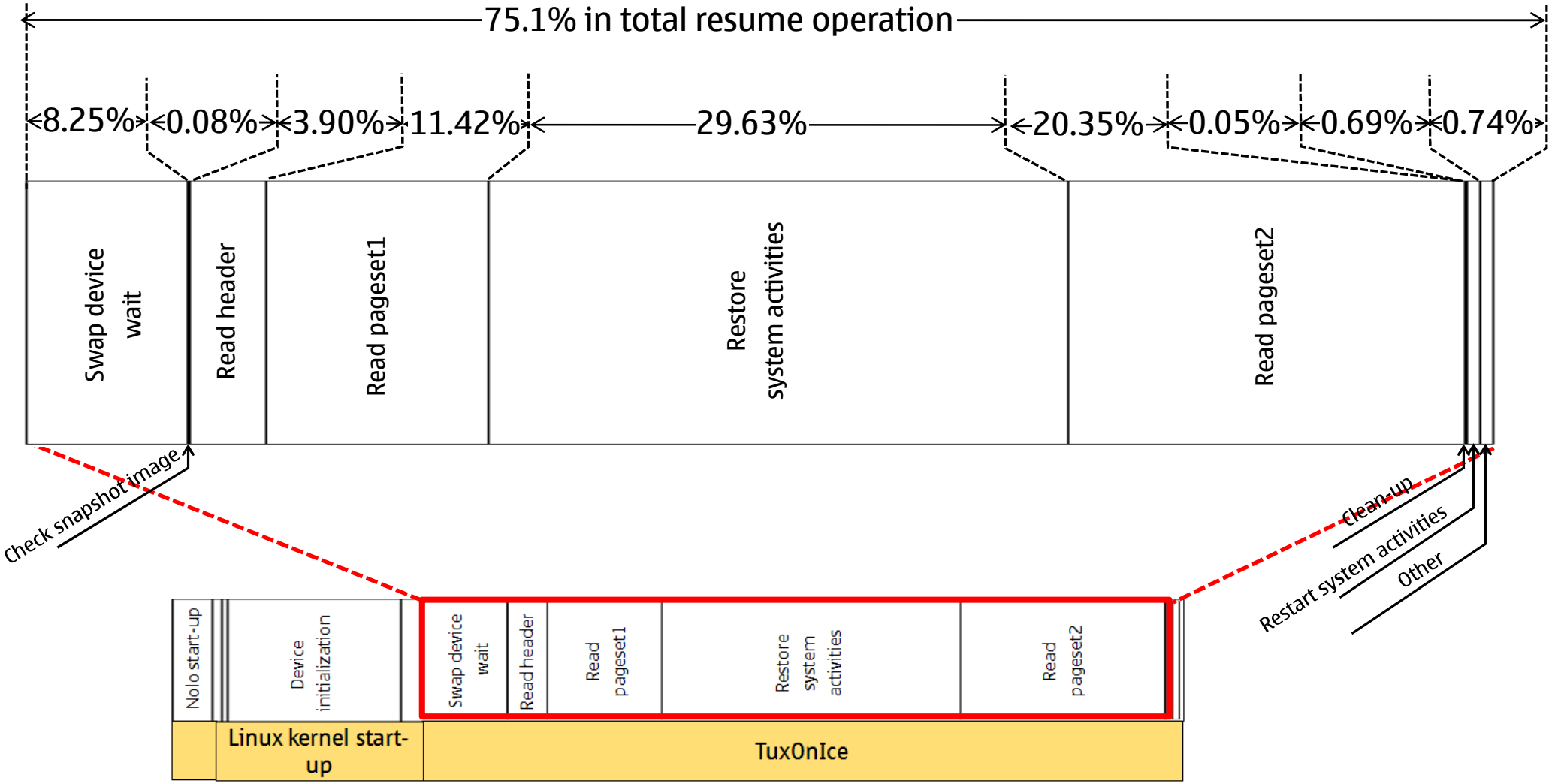
# Summary

- Implement hibernation in a handset device
- Achieved fast resume about 3 seconds
  - cold boot (about 1 minute), TOI (about 10 seconds)
  - Snapshot image size is constant, not proportional to application memory size
- Platform and application independent

# THANK YOU

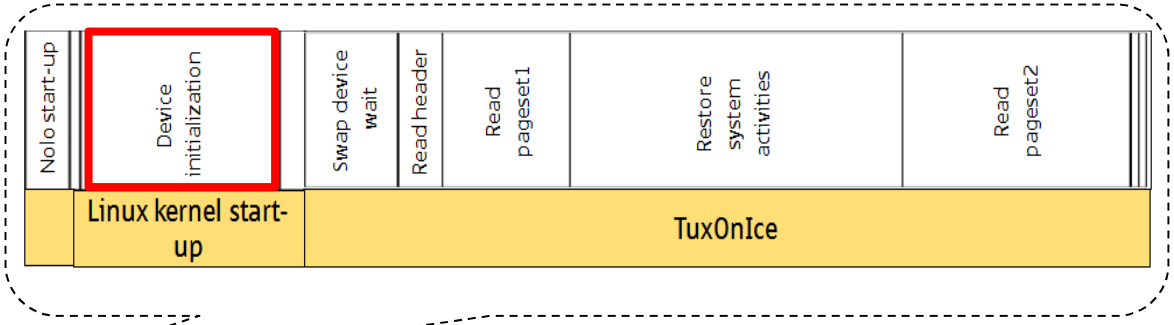
# Appendix

# TuxOnIce Process Breakdown



# Device initialization in kernel start-up

| Device | Time / Total (%) |
|---|---|
| usbcore | 0.11% |
| i2c_omap | 0.27% |
| twl4030 | 0.21% |
| twl4030_usb | 0.17% |
| i2c_omap | 0.87% |
| musb_hdrc | 0.08% |
| net | 0.18% |
| dspbridge | 0.29% |
| **omap dss** | **12.26%** |
| acx565 | 0.11% |
| **serial** | **43.93%** |
| **onenand** | **18.48%** |
| usbcore | 0.45% |
| tsc2005 | 0.85% |
| twl4030_wdt | 2.01% |
| **omap-mcbsp-dai** | **16.37%** |
| input av jack | 0.71% |
| alsa | 0.47% |
| net protocol 17 35 | 0.60% |
| power management | 0.92% |
| vfp | 0.67% |




*Top four dominates*

| Driver | Description | Operation Time (s) |
|---|---|---|
| omap_dss | Display | 12.26% |
| Serial | Serial (UART) | 43.93% |
| onenand | NAND flash | 18.48% |
| omap-mcbsp-dai | MCBSP (serial I/F) | 16.37% |