

Boot Time: benefits & drawbacks of Linux sleep and hibernate

Tom Dohmen
Logic Technology BV


**DESIGN AUTOMATION
& EMBEDDED SYSTEMS**

FPGA - SECURITY - INTERNET OF THINGS - ELECTRONIC DESIGN & PRODUCTION - EMBEDDED - DESIGN FOR EXCELLENCE - EMBEDDED DESIGN CHALLENGES

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- Founded in 1993 – 25 years of Logic Solutions!
- Located in Panningen (The Netherlands)
- Strong position in Europe
- Product Manager and European Sales Partner for 



Boards & Solutions

- Computer On Module
- Boundary Scan Tools
- Test & Burn-in Adapters
- Functional Testers



Development Tools

- Software Suites
- Debuggers
- Performance Analyzers
- JTAG-Tools



Software Quality

- Software Certification
- Coding Rules Enforcement
- Unit Testing
- Code Coverage



Software Components

- Flash Media Drivers
- Reliable File Systems
- UEFI BIOS
- Customization Services

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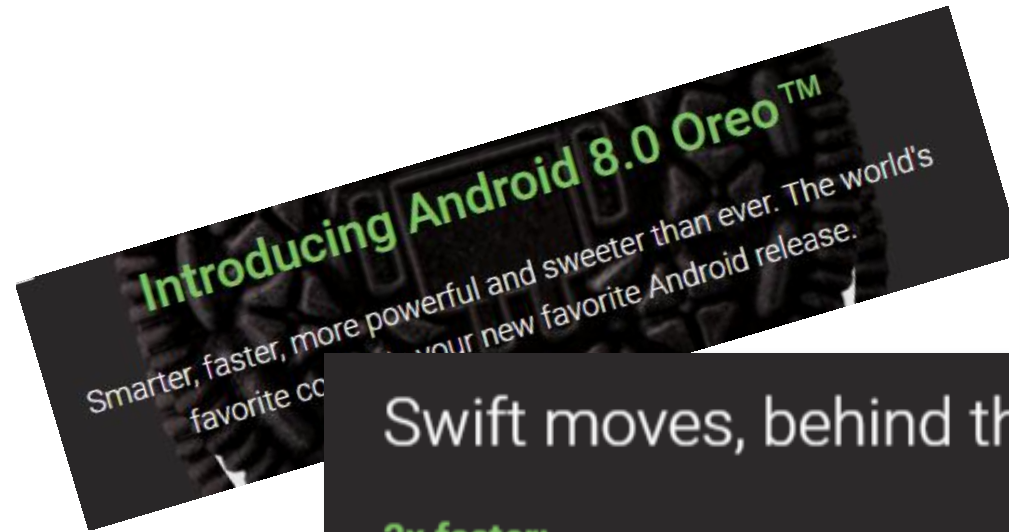


Introduction

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- Instant-on experience desired
- Linux longer boot than RTOS
 - Android longer than stock Linux
- Google targets faster boot time with Oreo
- Application on top



Swift moves, behind the scenes

2x faster:

Get started on your favorite tasks more quickly with 2x the boot speed when powering up*

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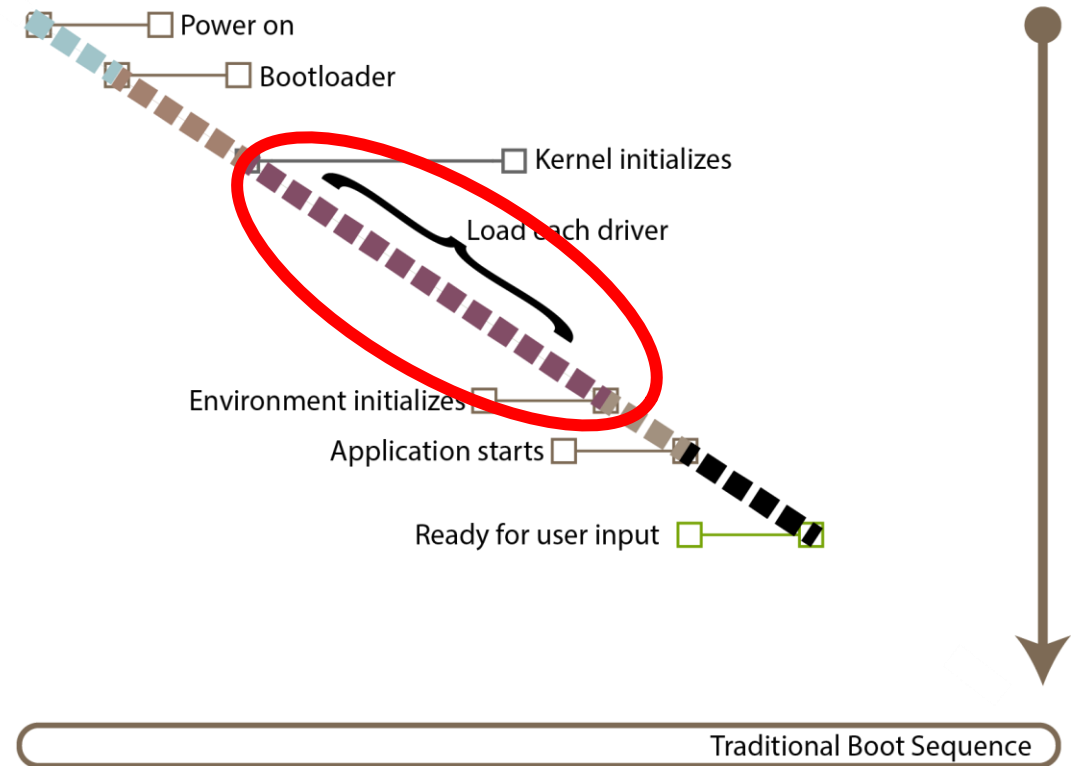
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Description of the boot process

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- Device must go through a series of stages
- People focusing on reducing startup time
 - Hardware and kernel get most attention

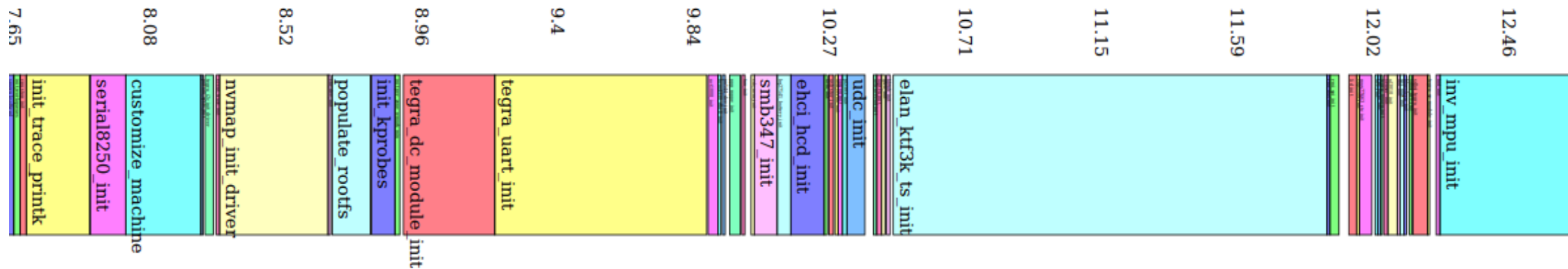


Techniques to identify problems

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- Hardware and kernel through `bootgraph.pl`
- NAND startup particularly pernicious
- Cost of maintaining kernel changes



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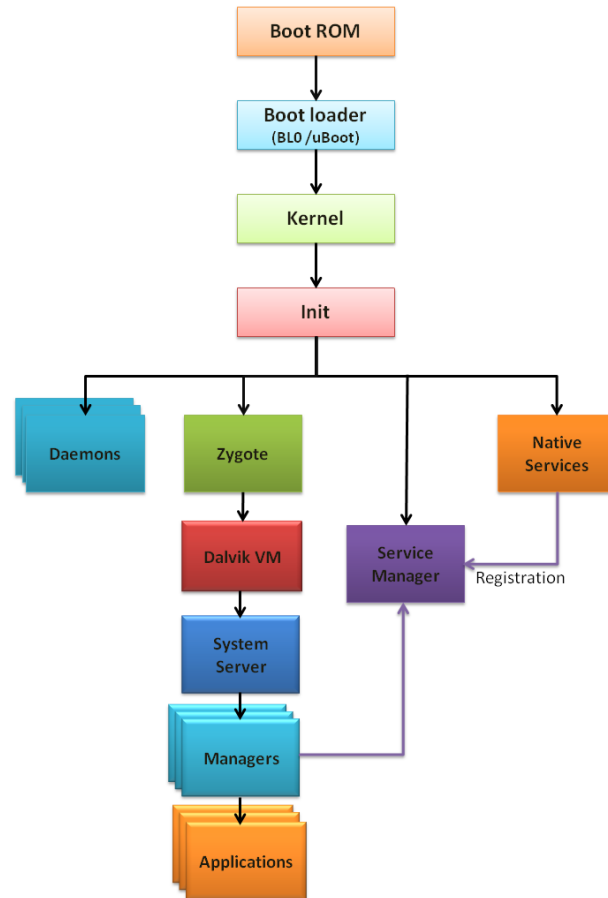
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Application adds to the problem

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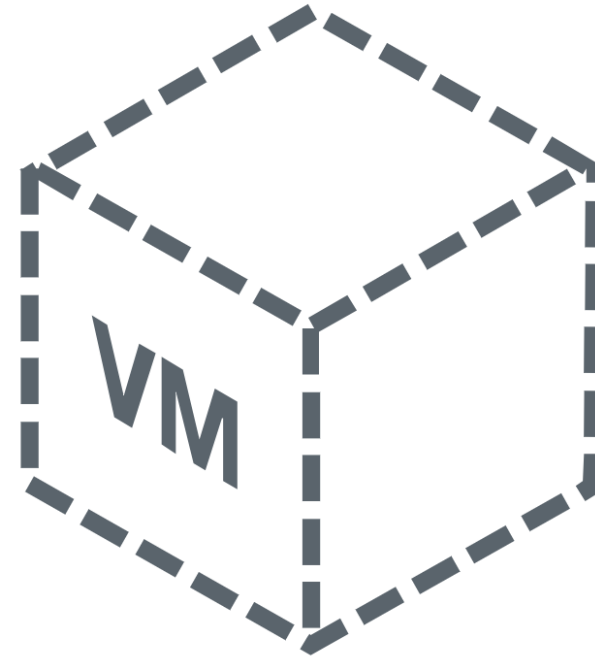


- Application must start up;
- Before that, the environment;
 - Database common in Android.
- Graphics libraries and external communications.

Virtual Machines - and snapshots

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- Suspended application – called snapshot
- Virtual machine - simulated processor and hardware
- Embedded designs don't have total control



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Startup draws power

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○ Power drain at start time:

- Screen on (status update)
- Reading from the media
- Environment and application

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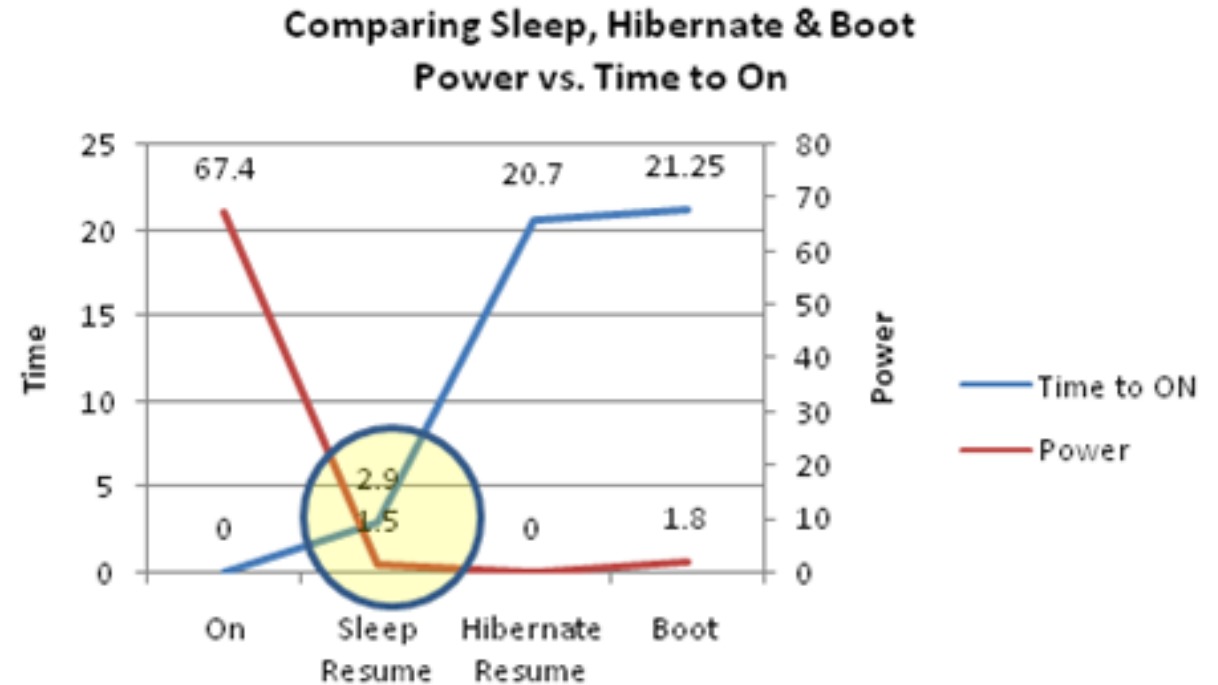
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Sleep mode uses less, but not zero, power

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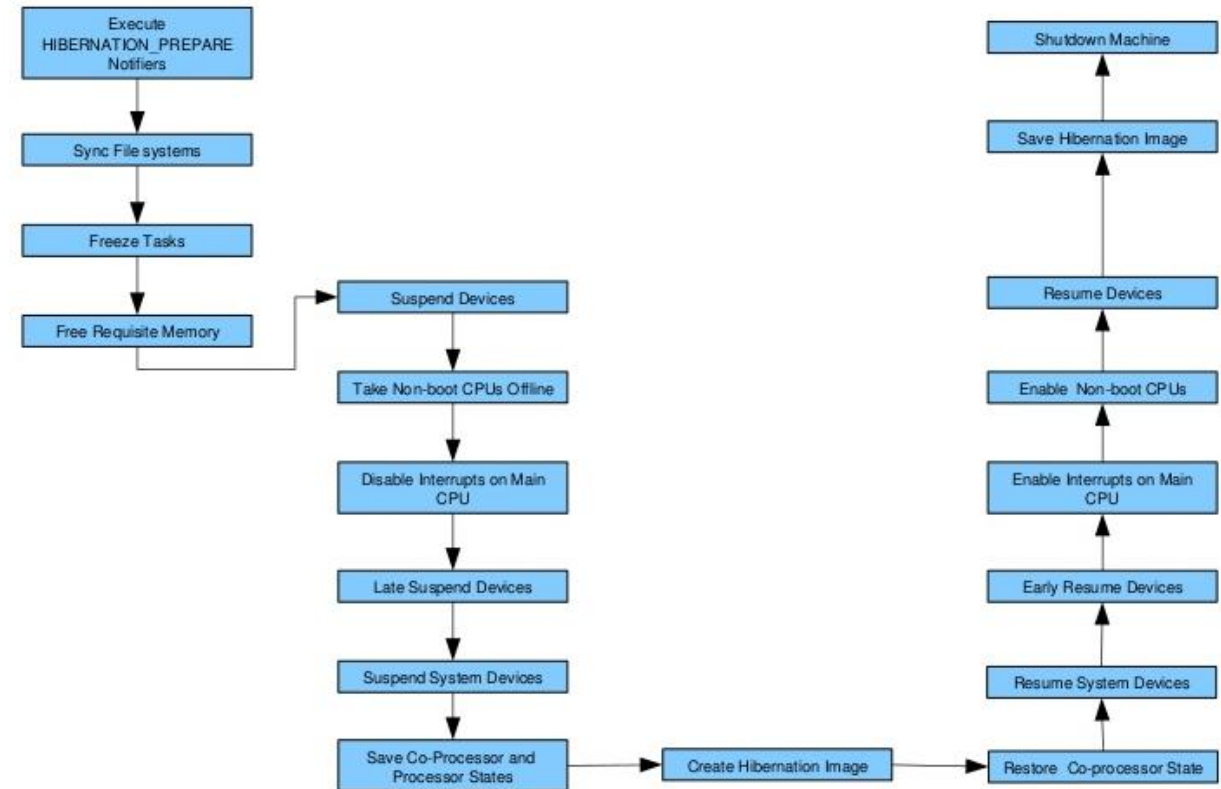
- Processor suspended
- Requires constant power (DRAM refresh)
- Some indication (heartbeat)
- Power lost = data lost



Hibernation

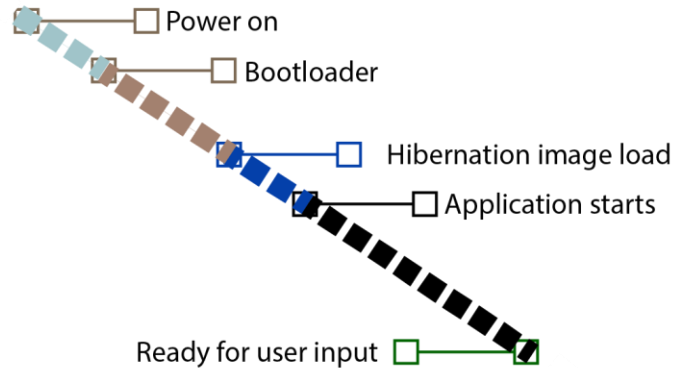
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- Commits all of DRAM to media
- Suspend operation needs to be power safe
- Suspend and resume can take time
- Application and drivers must support hibernation
- Power can be completely off



Restoring from hibernation

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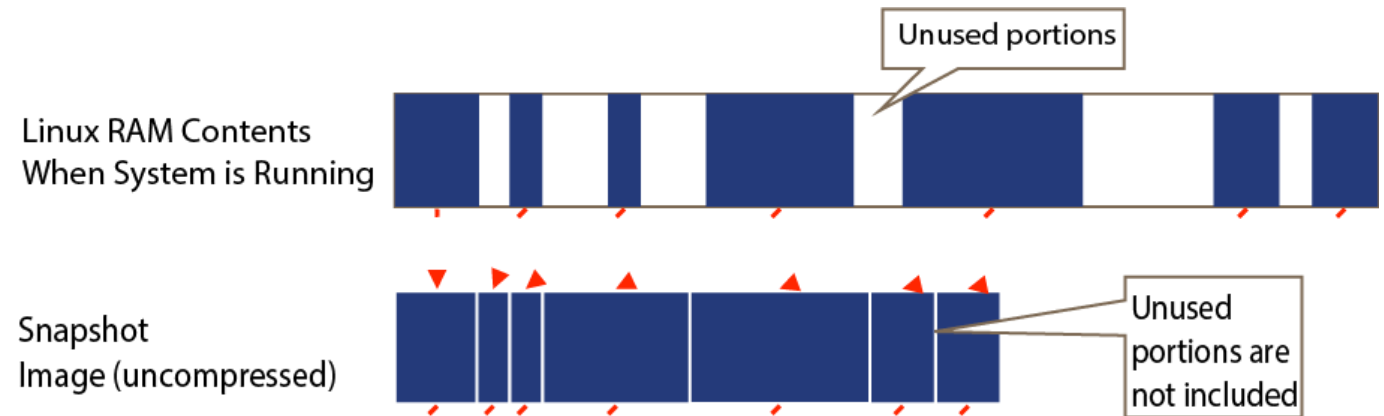


- Quicker than a full cold boot
- Require support in BSP and drivers
- Amount of data a disadvantage
- Additional time for commit and restore

Improving hibernation

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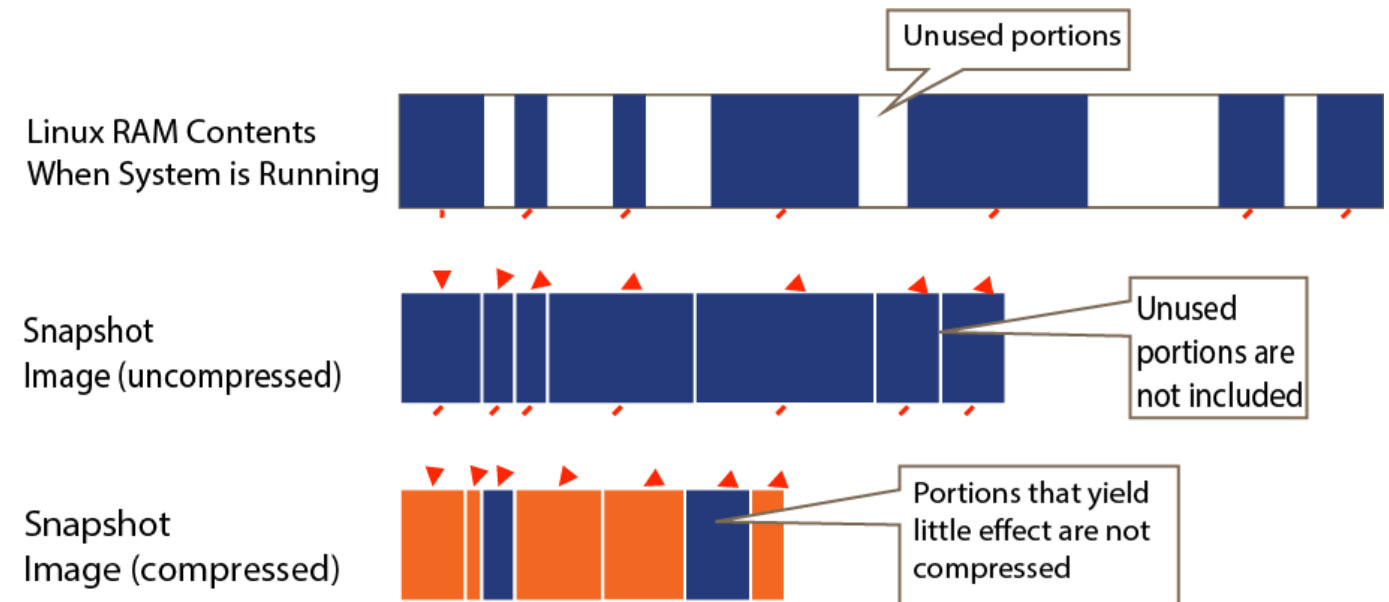
- Skip unused portions of DRAM
- Restore will allocate and blank
- Reduces I/O requirements
- Requires knowledge of drivers and kernel



Further improvements

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- Programs highly compressible
- Further reduces I/O requirements



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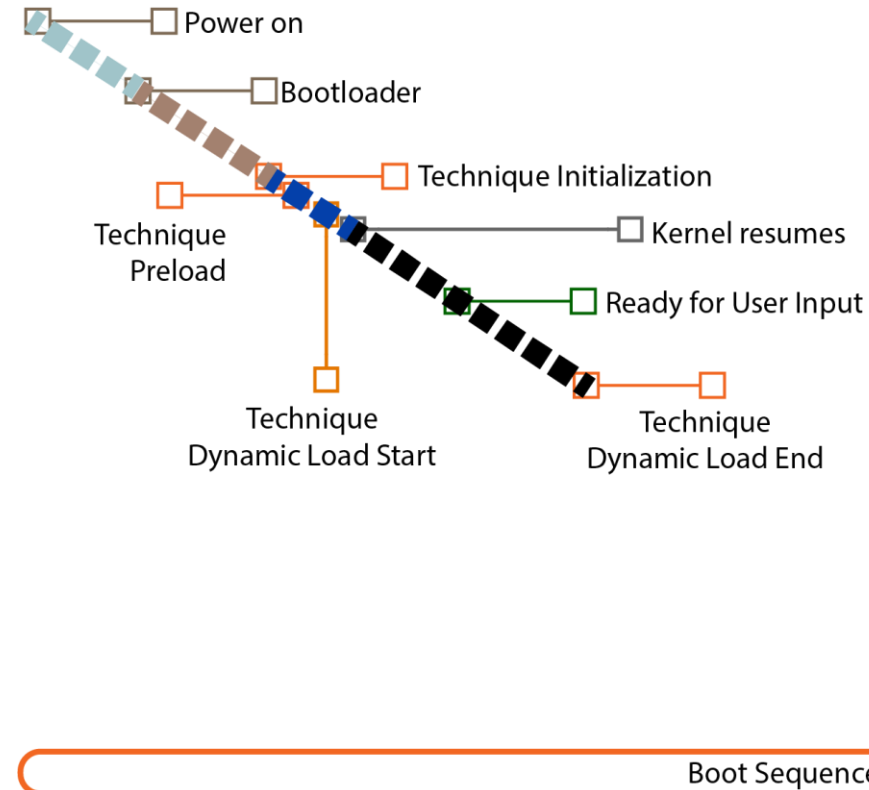
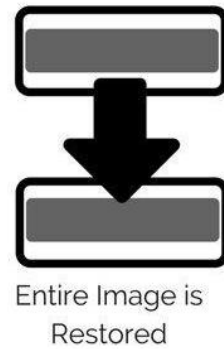
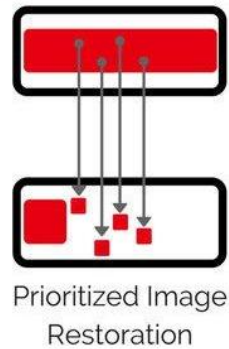
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Restoring from advanced hibernation

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- Prioritize load process
- Ready for input achieved earlier
- Fastest result from a complete powered off state



Remove time to suspend application

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- Same restoration each time
- Use a factory image
- Can be enhanced to read some configuration
- Ideal for an appliance

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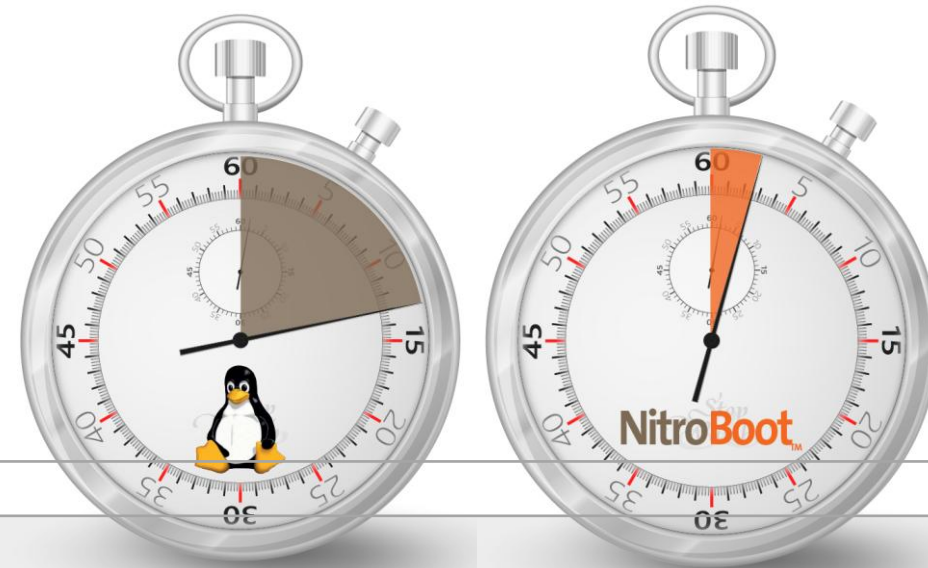
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Fastest time to application-ready for embedded Linux systems

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System Configuration

NXP iMX6DL SabreSDP; OS: Linux 4.1.15 with Wayland Desktop

Initialized devices: IOMUX/GPIO, UART, I2C, eMMC (SD Card), USB HOST, Ethernet, LCD (TouchPanel), HDMI, Audio

Snapshot image size: 144 MB (compressed); 221.5 MB (uncompressed)

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Conclusion

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- Moving to Linux/Android from RTOS or bare metal negatively impacts first impressions
- Hibernation offers nearly instant-on with minimal power impact
- Techniques to speed up hibernation available to further shorten time to application ready!

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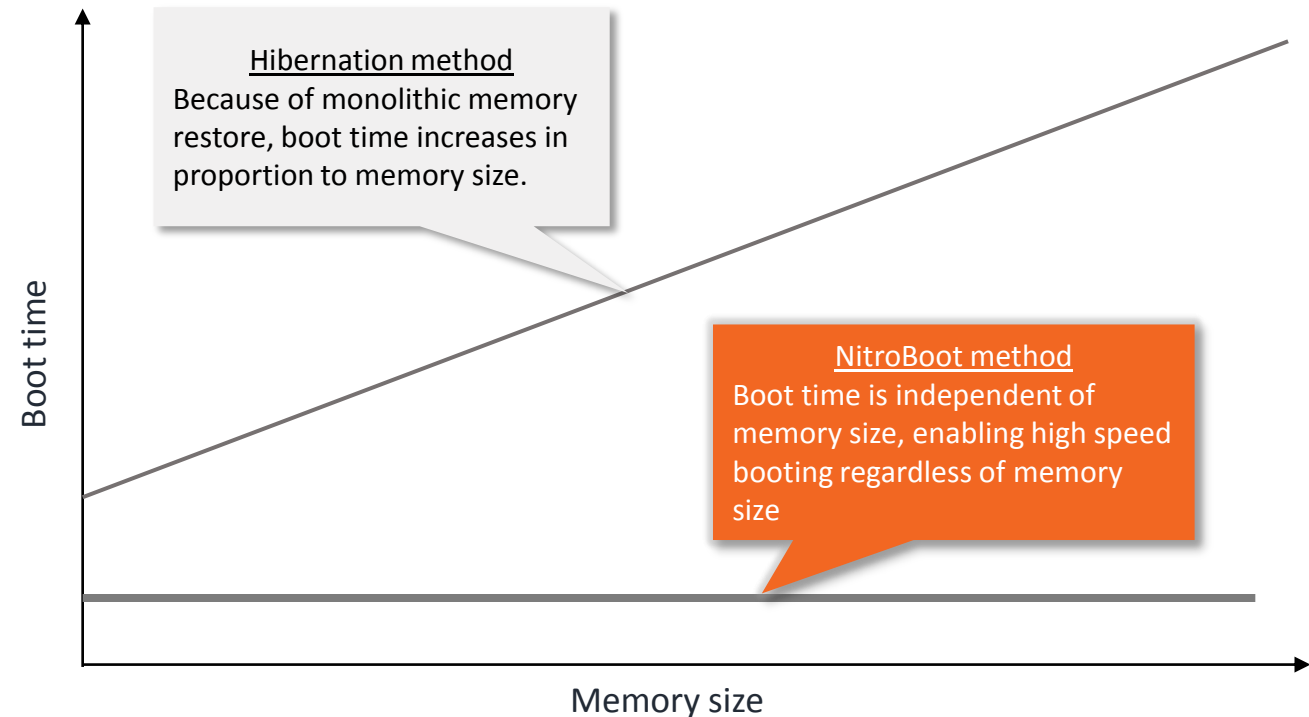


Boot time solution from Datalight called NitroBoot

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- Faster time-to-first-response
- Easier to maintain than custom tuning
- Consistently fast at any size



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Questions?

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