Boot-Time Optimization for the Real World

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Motivations for this Talk

ELC-E 2019

- “We Need to Talk About Systemd: Boot Time Optimization for the New init daemon”
  - Basic introduction to boot time optimization
- “Timing Boot Time Reduction Techniques”
  - Many good techniques, impressive results
  - Unacceptable compromises for any of my projects
- That’s it?

Motivations for Boot-Time Optimization

- Hard requirements
  - Required interactions with the outside world within a certain deadline after power-on.
- Soft requirements
  - User experience

Choose Your Optimization Targets

Examples:

- First CAN message on the bus
- First content on the display
- Limited user interaction possible
- Full user interaction possible

Priorities of Conflicting Requirements

- Debugging devices in the field
- Robustness
- Security
- Development & testing
- Maintenance

systemd only

Techniques

- ~~Disable~~
  - Handled in previous presentations
- Delay
  - Do thing after the optimization target is reached
- Improve
  - Optimize initialization code
- Cheat
  - Find new ways to satisfy the requirements

Serial Console

- Kernel output on a serial console is very slow
- Userspace is better but still unnecessary overhead

→ `loglevel=5`

  - Only show warnings or worse (should be none)

→ `systemd.log_level=warning`
`systemd.show_status=auto`

  - Only show output after an error occurs

udev Coldplug

- Enumerate existing hardware while booting
- Ensures that devices are available before accessed
- Takes a long time

→ Avoid dependencies in the hot path

udev Coldplug - Data Partitions

Use automounts

- No direct dependency on the device of the partition
- udev coldplug happens while the application is starting
- The application waits for the filesystem on the first access

udev Coldplug - Data Partitions

Trick systemd to skip device dependencies

- The device must exist when userspace starts
- Manual fsck handling required
- What=UUID=...
  - Only works as explicit mount unit, not via fstab
- What=/symlink/outside/dev
  - Works as explicit mount unit and via fstab

udev Coldplug - Data Partitions - Example

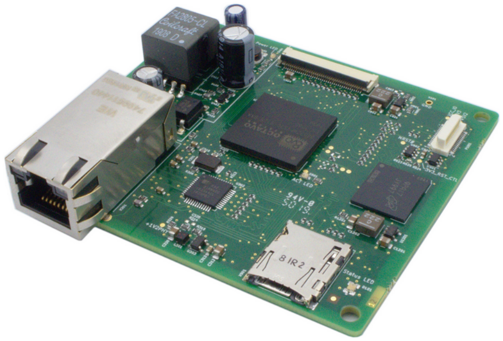
Simple Qt QML Application

1. Create QGuiApplication & QQuickView
2. Read dummy file from the data partition
3. Load QML
4. Show Window
5. sd_notify()

udev Coldplug - Data Partitions - Example

- Hardware: STM32MP1 (Dual Cortex-A7 800MHz), eMMC

- Start: ~8.0s
- Automount: ~7.4s
- Fake device: ~6.7s
- Automount + Fake device: ~6.7s



udev Coldplug – Multiple Stages

- Avoiding coldplug dependencies is not always possible

→ Two coldplug stages:

-
  ```
  udevadm trigger --type=devices \
      --subsystem-match=drm …
  ```

-
  ```
  udevadm trigger --type=devices \
      --subsystem-nomatch=drm …
  ```

Early Splash Screen

- Run as pid 1
- Show splash screen
- Release DRM master (drmDropMaster())
- Fork
  - Exec systemd in pid 1
  - Just wait to be killed in the child

Early Application

- fork() + exec() systemd
- Cannot take advantage of the systemd features
  - Resource control, watchdog / monitoring, security
- Possible solutions:
  - Import into service
    - Write pid to /sys/fs/cgroup/system.slice/myapp.service/cgroup.procs
    - Pass the sd_notify fd for watchdog handling
    - Still no security features
  - Restart application is a service
    - State must be transferred

Debug Features vs. Boot-Time

- Kernel tracing infrastructure
- Kernel startup until rootfs is mounted:
  - Tracing enabled: ~1.4s
  - Tracing disabled: ~0.5s

- Most of the time is spent in trace_eval_init()
  - Maybe this could be done later / on demand?

Patch opportunity

Security - Challenges and Opportunities

- Security enforces software architecture design
  - multiple processes for privilege separation
  - defined resource requirements for access permissions
- Reuse software architecture for boot-time optimization
  - Not everything needs to start immediately
  - Process ordering and startup priorities
  - Avoid dependencies in the hot path
  - ...

Designing Hardware to Boot Fast

- Fast mass storage
- No USB in the hot path
- Avoid FPGA setup in the bootloader

Questions?

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