Hardware Resource Control in L4 micro-kernels

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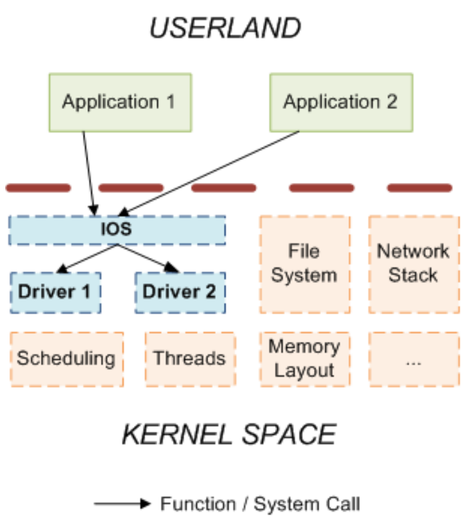
Motivation

In most operating systems, userland processes have unrestricted access to hardware drivers, by system calls in monolithic kernels or IPCs in µ-kernels such as L4. This unrestricted access can often allow **malicious software to force a denial of service on the driver** or strongly impact its quality of service.

To mitigate this safety issue without impacting much drivers code, **our approach is to extend L4 IPCs by adding a control layer to IPCs aimed at drivers.**
This would allow admission control to the driver, as well as **accounting and managing the driver's occupation by user processes**.

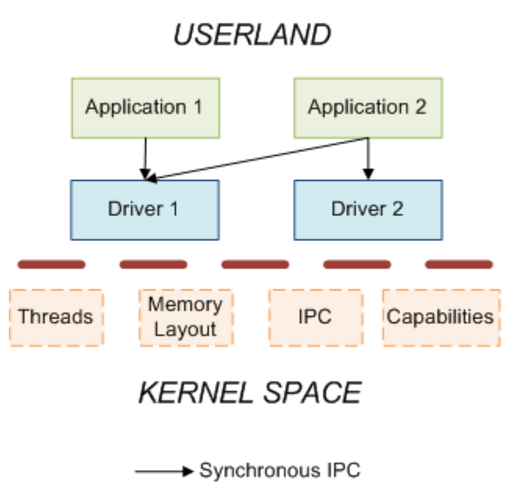
Context: Operating System Kernels

Monolithic Kernels



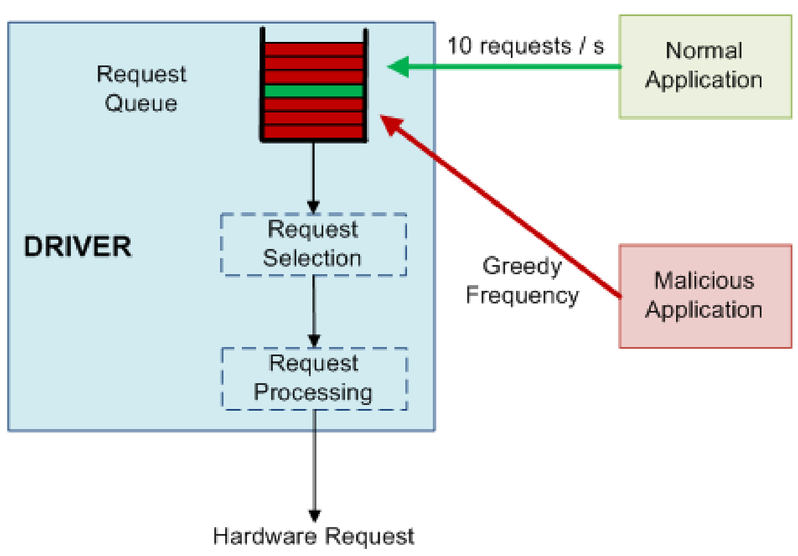
- All privileged code in kernel
- Communication via method calls
- Unified drivers interface (IOS)

L4 µ-kernel

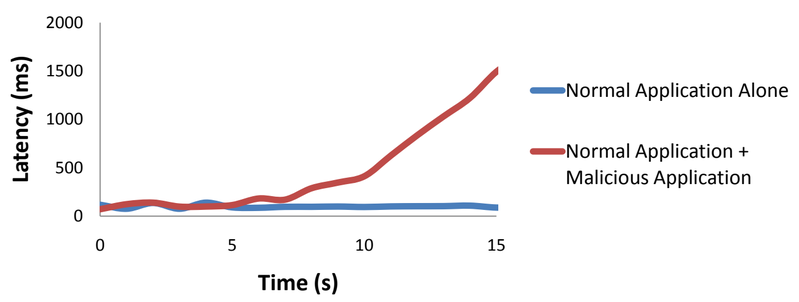


- Minimal kernel
- Communication via synchronous IPCs
- Userland privileges managed by capabilities

An Example of Resource Monopolization



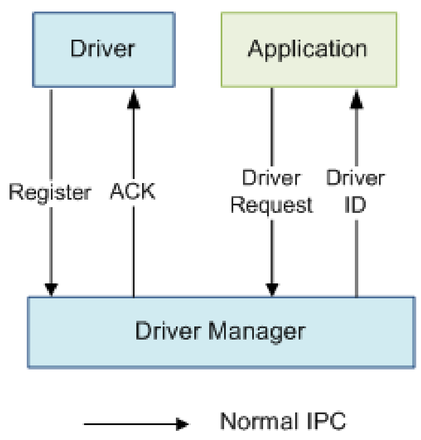
Delay between application deadlines and actual processing



➔ The quality of service provided by the driver to the normal application is severely impacted

Proposition: Extend L4 IPCs

Admission Control

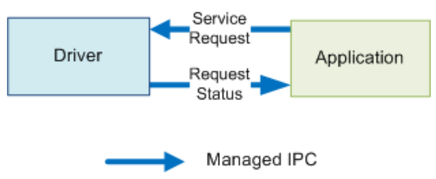


Manage to-drivers IPCs rights

Control to-devices memory access rights

Maintain drivers list

IPC Extension for Resource Control



Account and control driver occupation time

Expected Benefits

- **Safety:** Prevent malicious threads from monopolizing drivers

- **QoS Management:** Accounting and admission control would allow resource reservation and real-time guarantees

Open Questions

- How about resource control in higher layers?

- Which uniform resource reservation model?

- Robustness of managed IPCs to malicious users?