Genode as Desktop OS

Norman Feske
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Outline

1. Why another operating system?
2. Architectural principles
3. Framework for building operating systems
4. Desktop scenarios
5. Present and future

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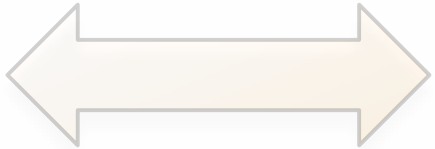
Universal Truths

Assurance  Scalability

Accountability  Utilization

Security  Ease of use

Problem: Complexity

Today's commodity OSes — Exceedingly complex trusted computing base (TCB)

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TCB of an application on Linux:

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- Daemons
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→ **User credentials are exposed to millions of lines of code**

Problem: Complexity (II)

Implications:

- High likelihood for bugs (need for frequent security updates)

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- Huge attack surface for directed attacks
- Zero-day exploits

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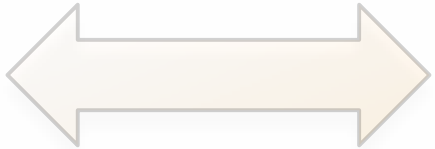
Security  Ease of use

Problem: Resource management

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- Lack of accounting

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  → Largely indeterministic behavior

  → Need for complex heuristics, schedulers

```
Jul 24 12:58:30 neo kernel: [72454.482259] cupsd invoked oom-killer: gfp_mask=0x201da, order=0, oom_adj=0, oom_score_adj=0
Jul 24 12:58:30 neo kernel: [72454.482264] cupsd cpuset=/ mems_allowed=0
Jul 24 12:58:30 neo kernel: [72454.482268] Pid: 1416, comm: cupsd Tainted: G        WC  3.0.0-22-generic #36-Ubuntu
Jul 24 12:58:30 neo kernel: [72454.482270] Call Trace:
Jul 24 12:58:30 neo kernel: [72454.482279]  [<ffffffff810b5c8d>] ? cpuset_print_task_mems_allowed+0x9d/0xb0
Jul 24 12:58:30 neo kernel: [72454.482286]  [<ffffffff8110df91>] dump_header+0x91/0xe0
Jul 24 12:58:30 neo kernel: [72454.482289]  [<ffffffff8110e2f5>] oom_kill_process+0x85/0xb0
Jul 24 12:58:30 neo kernel: [72454.482293]  [<ffffffff8110e69a>] out_of_memory+0xfa/0x250
Jul 24 12:58:30 neo kernel: [72454.482298]  [<ffffffff81113f3f>] __alloc_pages_nodemask+0x80f/0x820
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Jul 24 12:58:30 neo kernel: [72454.482311]  [<ffffffff8114a0a3>] alloc_pages_current+0xa3/0x110
Jul 24 12:58:30 neo kernel: [72454.482314]  [<ffffffff8110ab4f>] __page_cache_alloc+0x8f/0xa0
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Jul 24 12:58:30 neo kernel: [72454.482361]  [<ffffffff8117bb6a>] ? poll_select_set_timeout+0x7a/0x90
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Jul 24 12:58:30 neo kernel: [72454.493363] Out of memory: Kill process 22727 (oom) score 691 or sacrifice child
Jul 24 12:58:30 neo kernel: [72454.493367] Killed process 22727 (oom) total-vm:2702616kB, anon-rss:2701332kB, file-rss:172kB
```

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Accountability  Utilization

Security  Ease of use

Key technologies

- Microkernels
- Componentization, kernelization
- Capability-based security
- Virtualization

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...but how to compose those?

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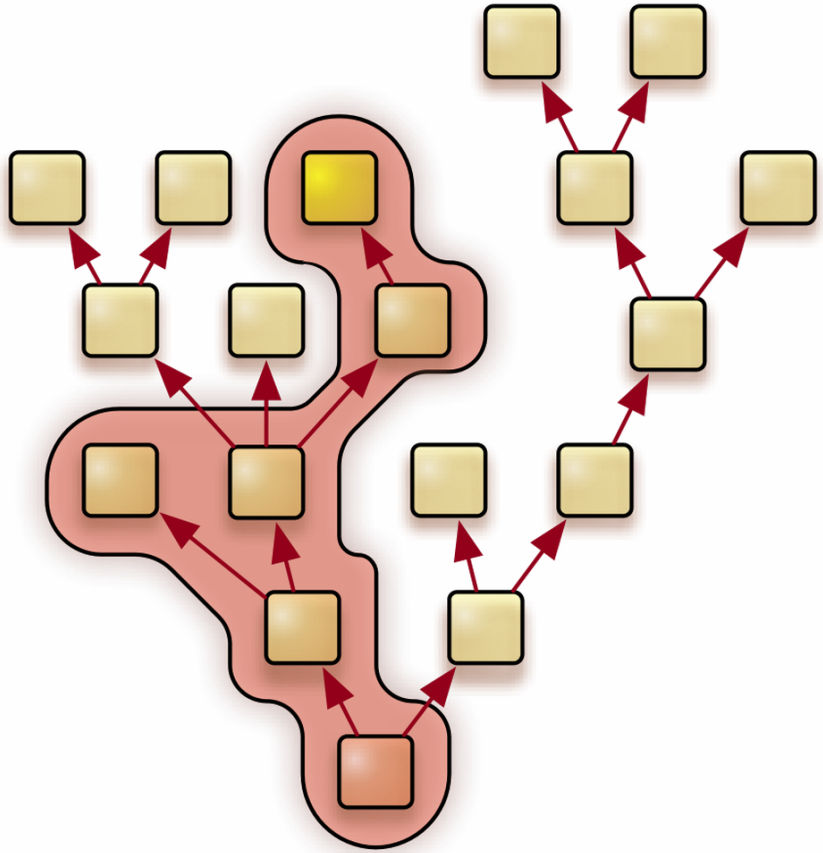
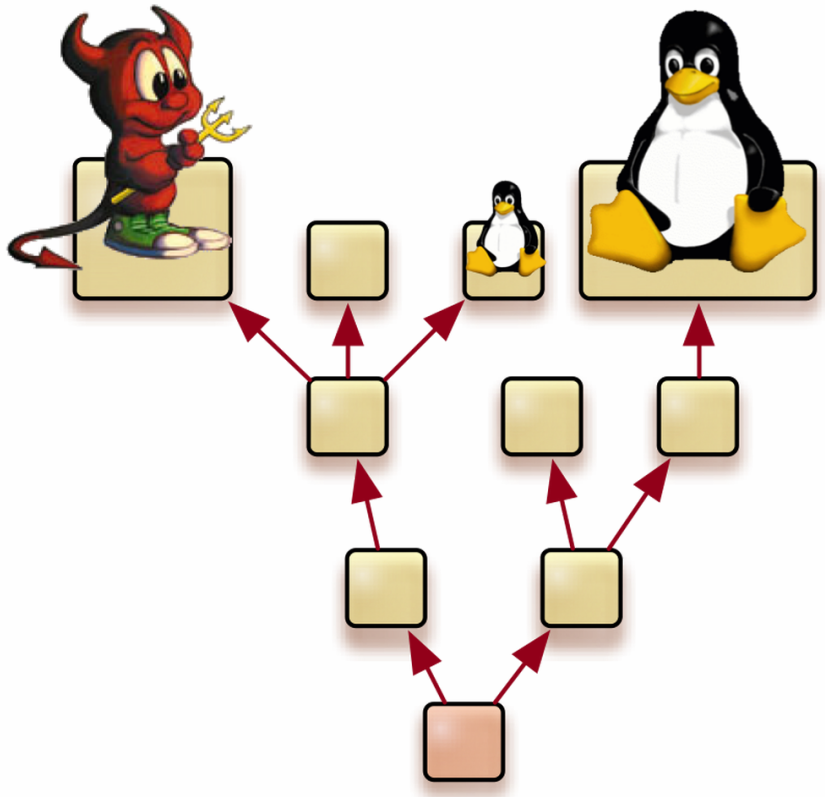
Idea



→ Application-specific TCB

Combined with virtualization



Object capabilities

Delegation of authority between components

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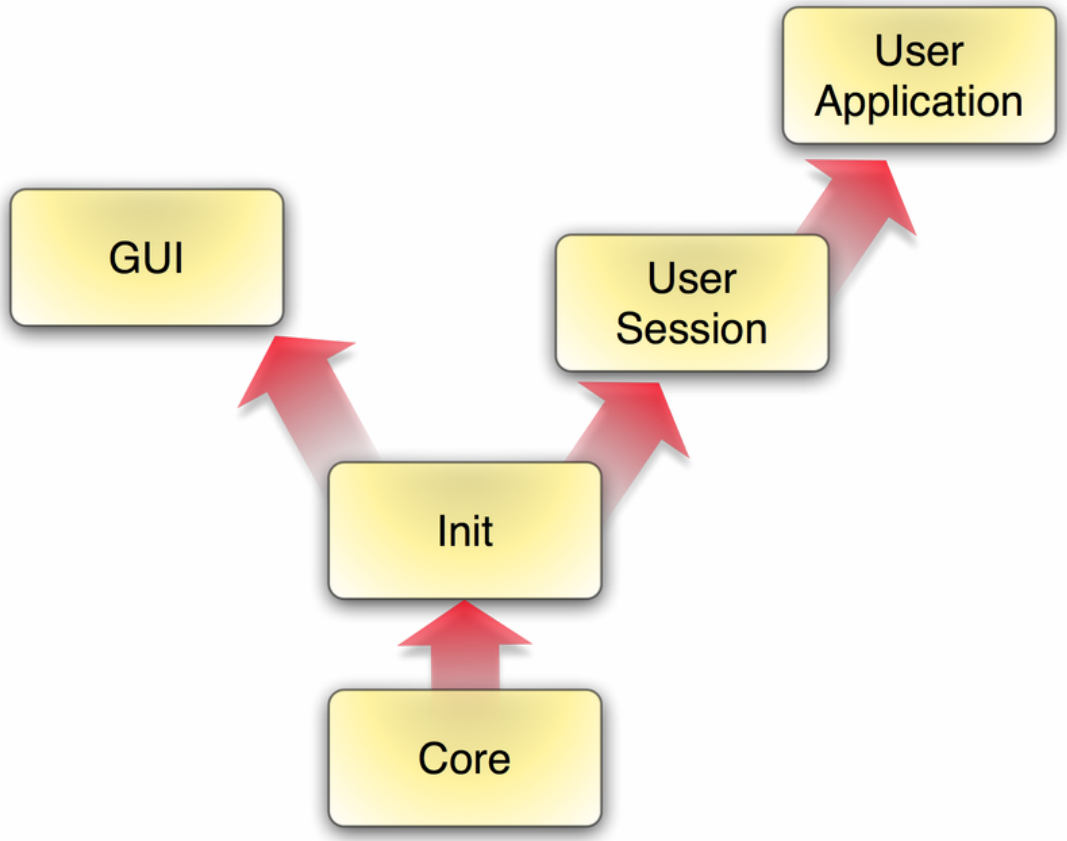
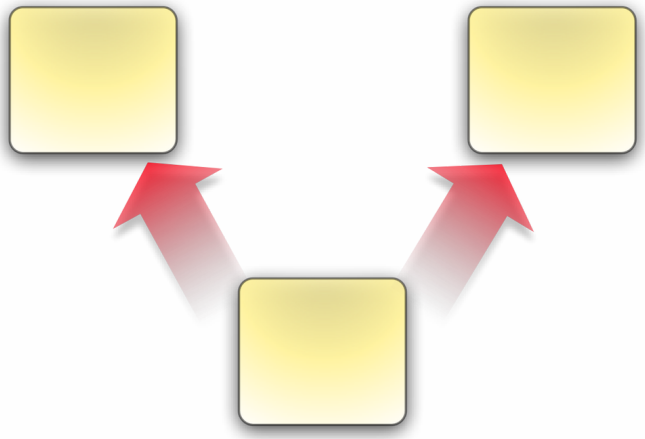
- Each component lives in a virtual environment
- A component that possesses a *capability* can
  - Use it *(invoke)*
  - Delegate it to acquainted components

Recursive system structure



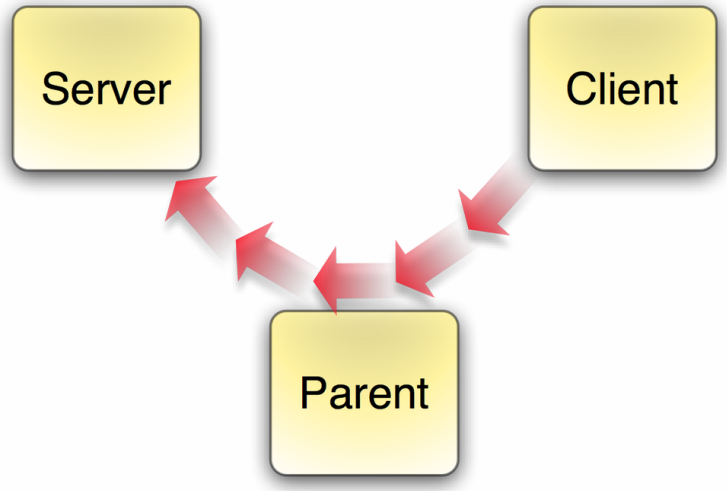
Resource management

Explicit assignment of physical resources to components



Resource management (II)

Resources can be attached to sessions



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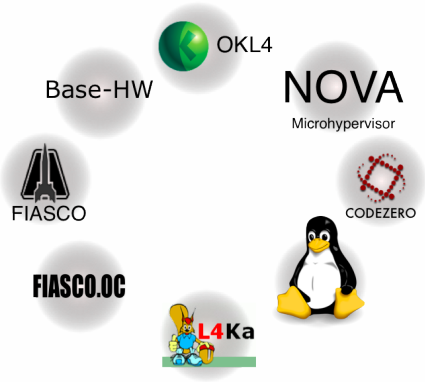
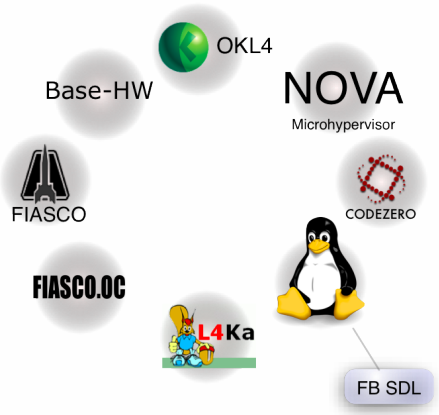
Components


OKL4
Base-HW
NOVA
Microhypervisor
FIASCO
CODEZERO
FIASCO.OC
L4Ka

Components

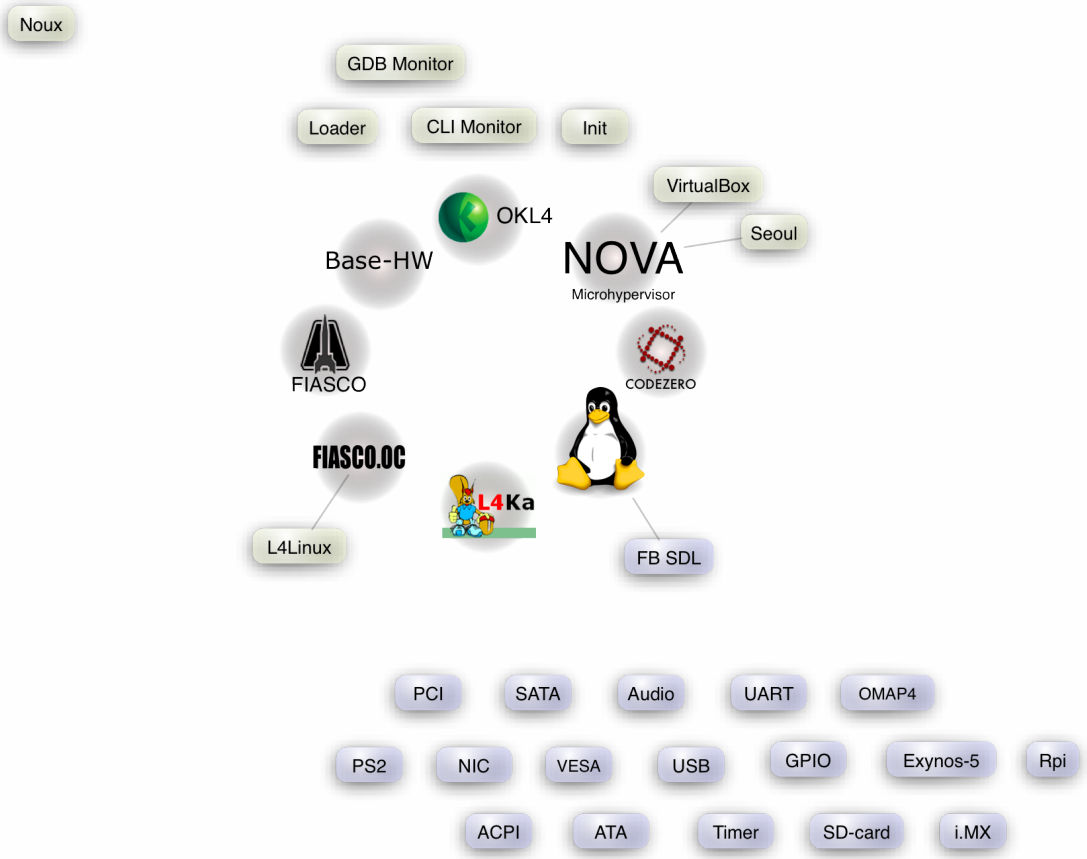


PCI SATA Audio UART OMAP4

PS2 NIC VESA USB GPIO Exynos-5 Rpi

ACPI ATA Timer SD-card i.MX

Components


Noux
GDB Monitor
Loader
CLI Monitor
Init
VirtualBox
Seoul
OKL4
Base-HW
NOVA
Microhypervisor
FIASCO
CODEZERO
FIASCO.OC
L4Ka
L4Linux
FB SDL
PCI
SATA
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UART
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GPIO
Exynos-5
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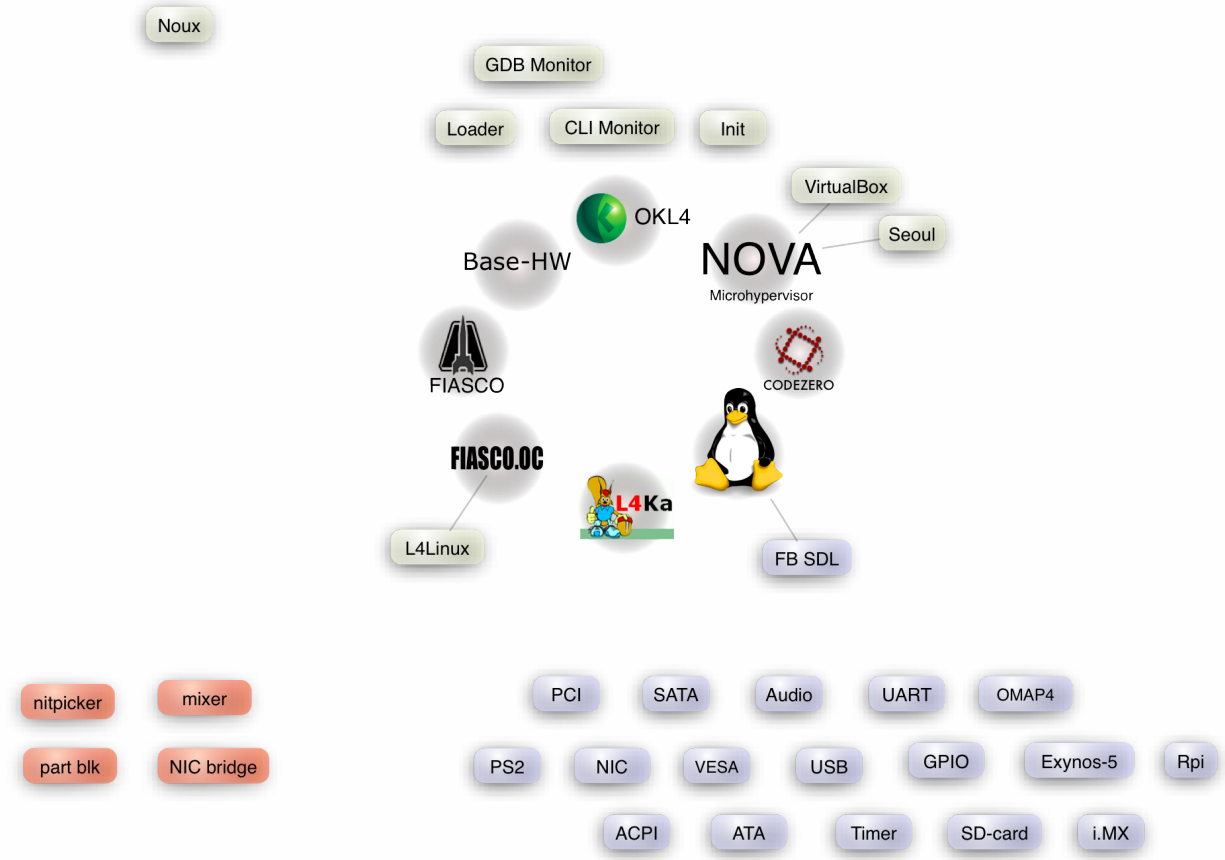
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nitpicker
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part blk
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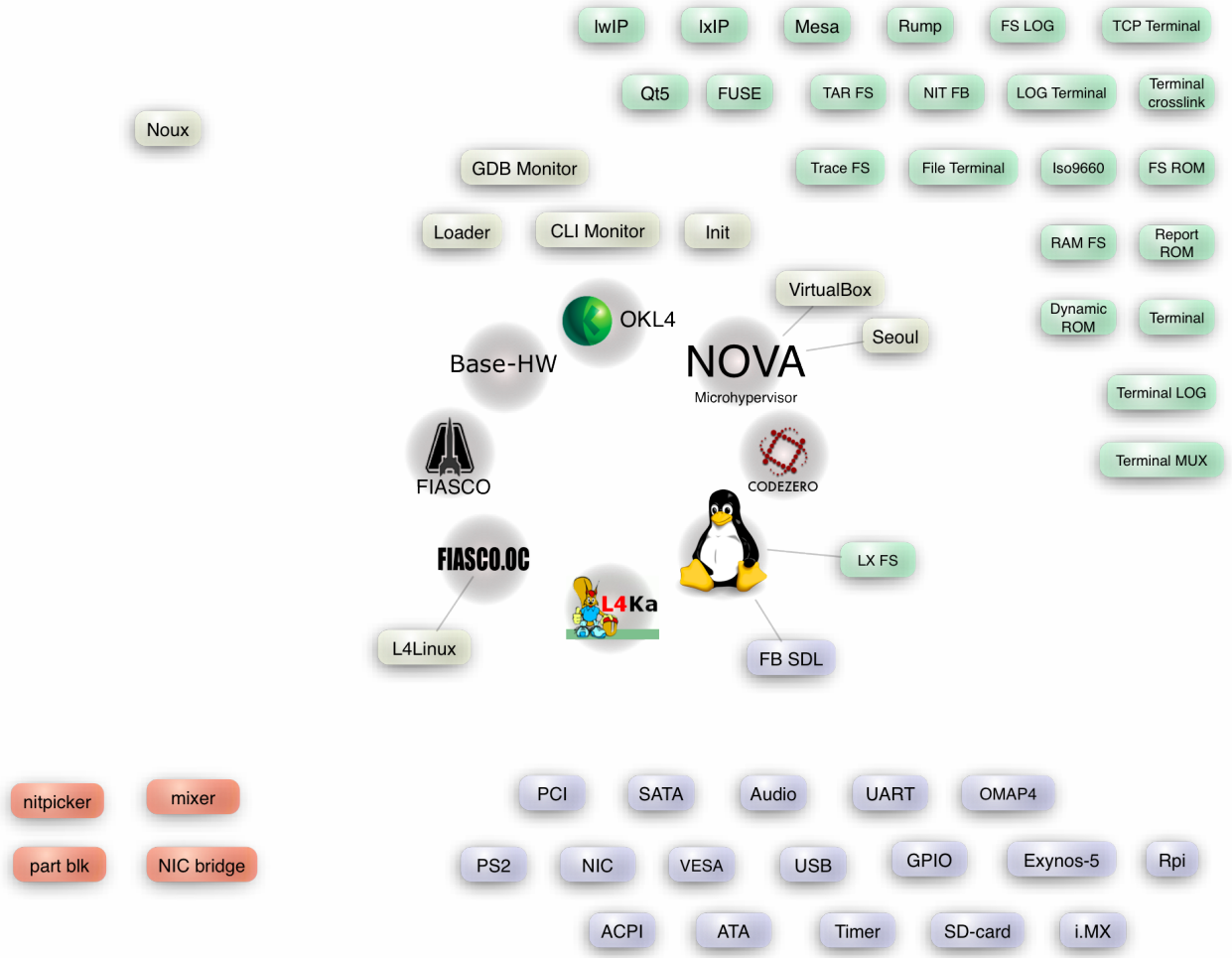
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lxIP
Mesa
Rump
FS LOG
TCP Terminal
Qt5
FUSE
TAR FS
NIT FB
LOG Terminal
Terminal crosslink
Noux
GDB Monitor
Trace FS
File Terminal
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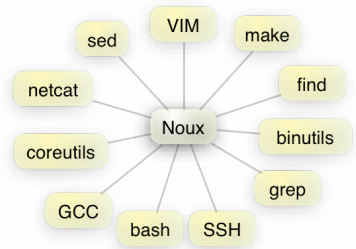
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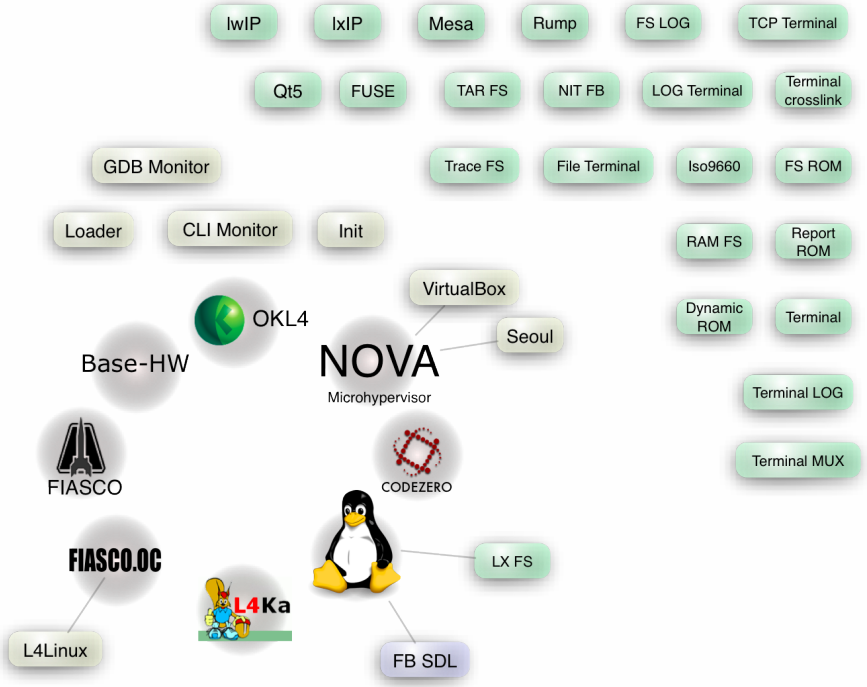
netcat
find
Noux
binutils
coreutils
grep
GCC
bash
SSH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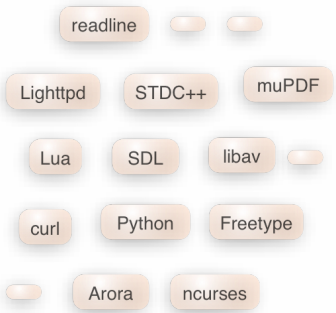
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Lighttpd
STDC++
muPDF
Lua
SDL
libav
curl
Python
Freetype
Arora
ncurses


nitpicker
mixer
part blk
NIC bridge


PCI
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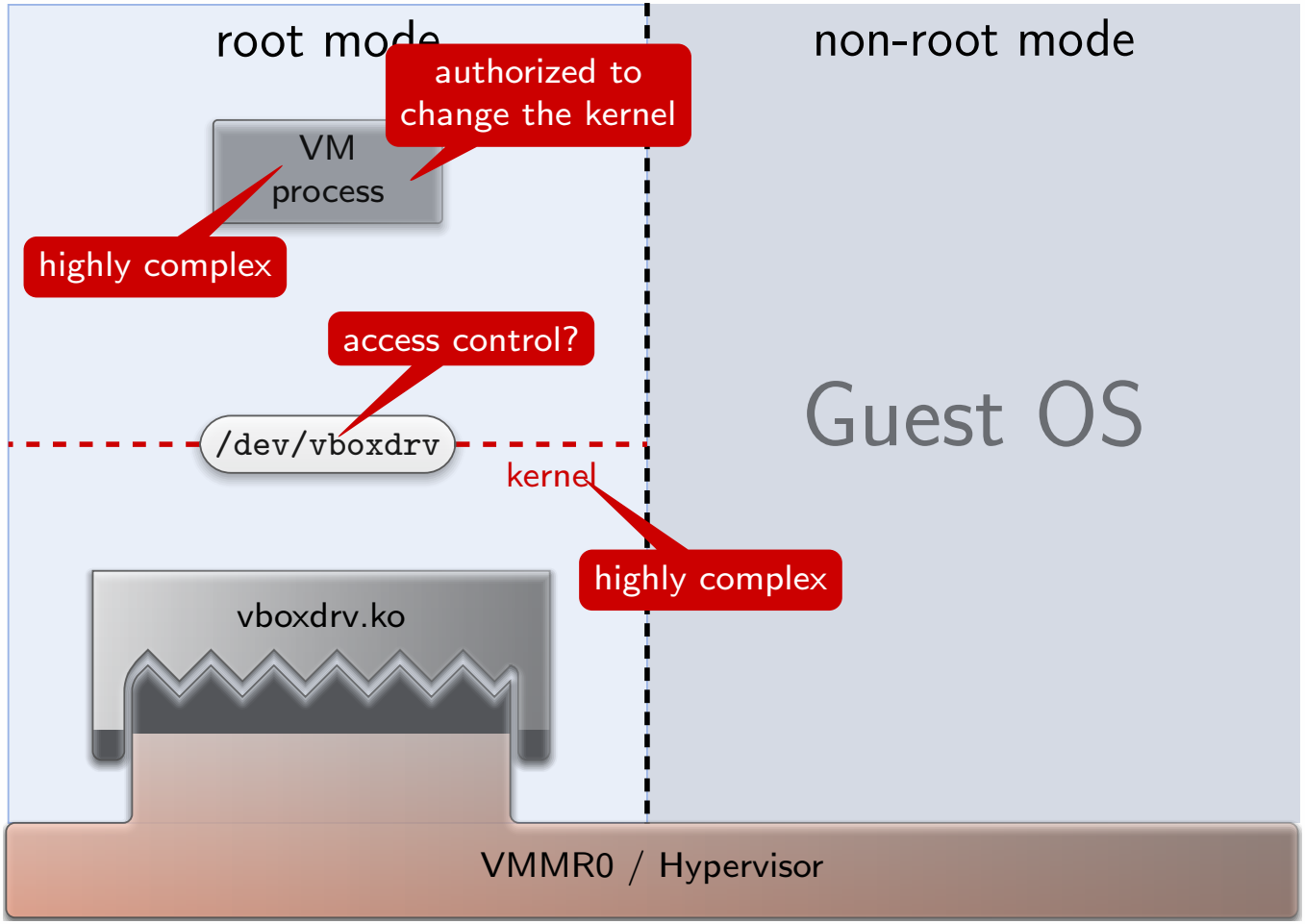
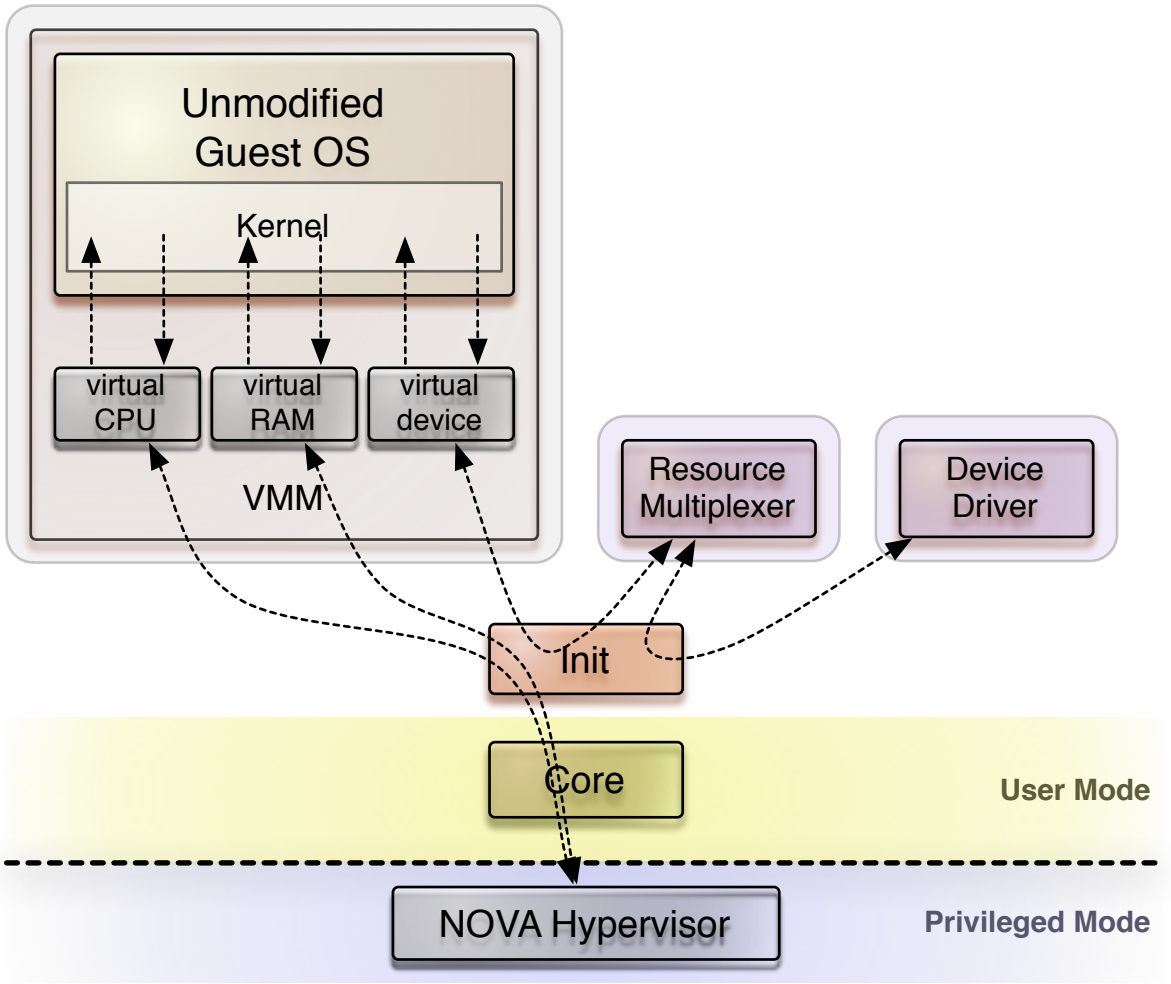
Faithful virtualization (traditional)



VirtualBox as Genode subsystem



OS-level virtualization

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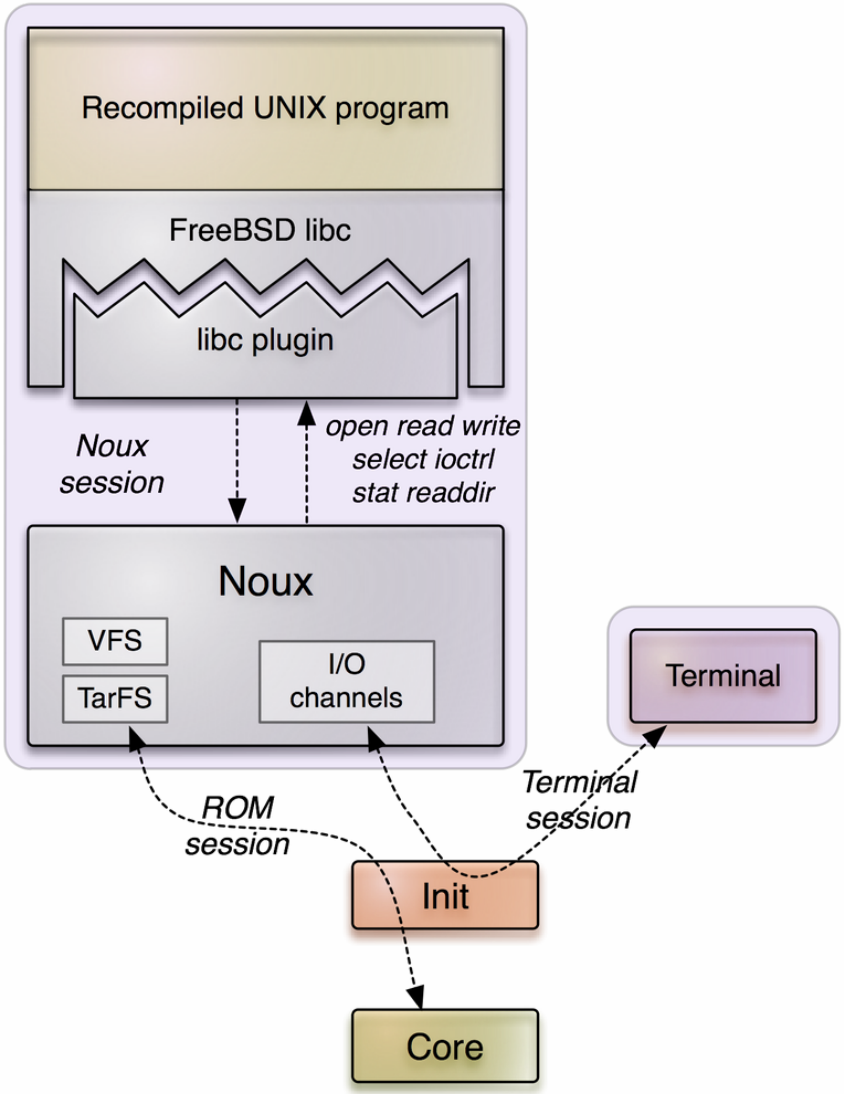
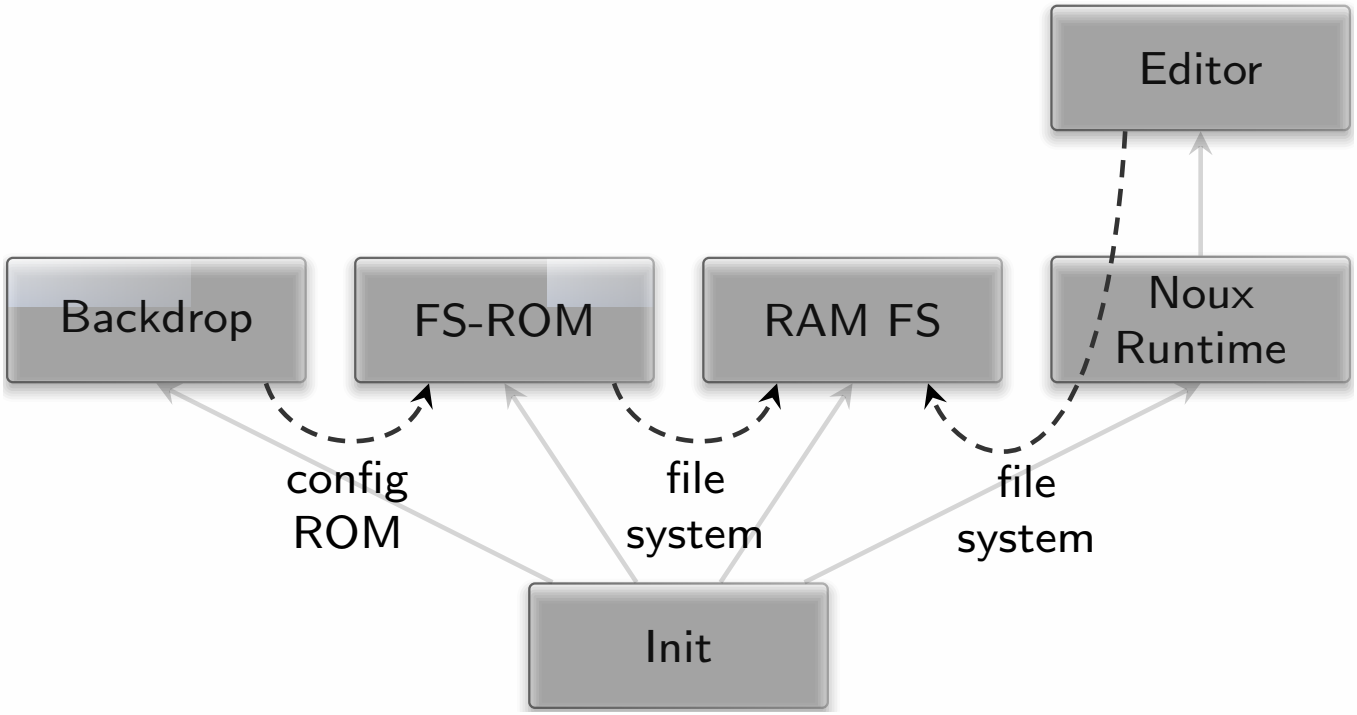


OS-level virtualization (example)



Multi-component applications

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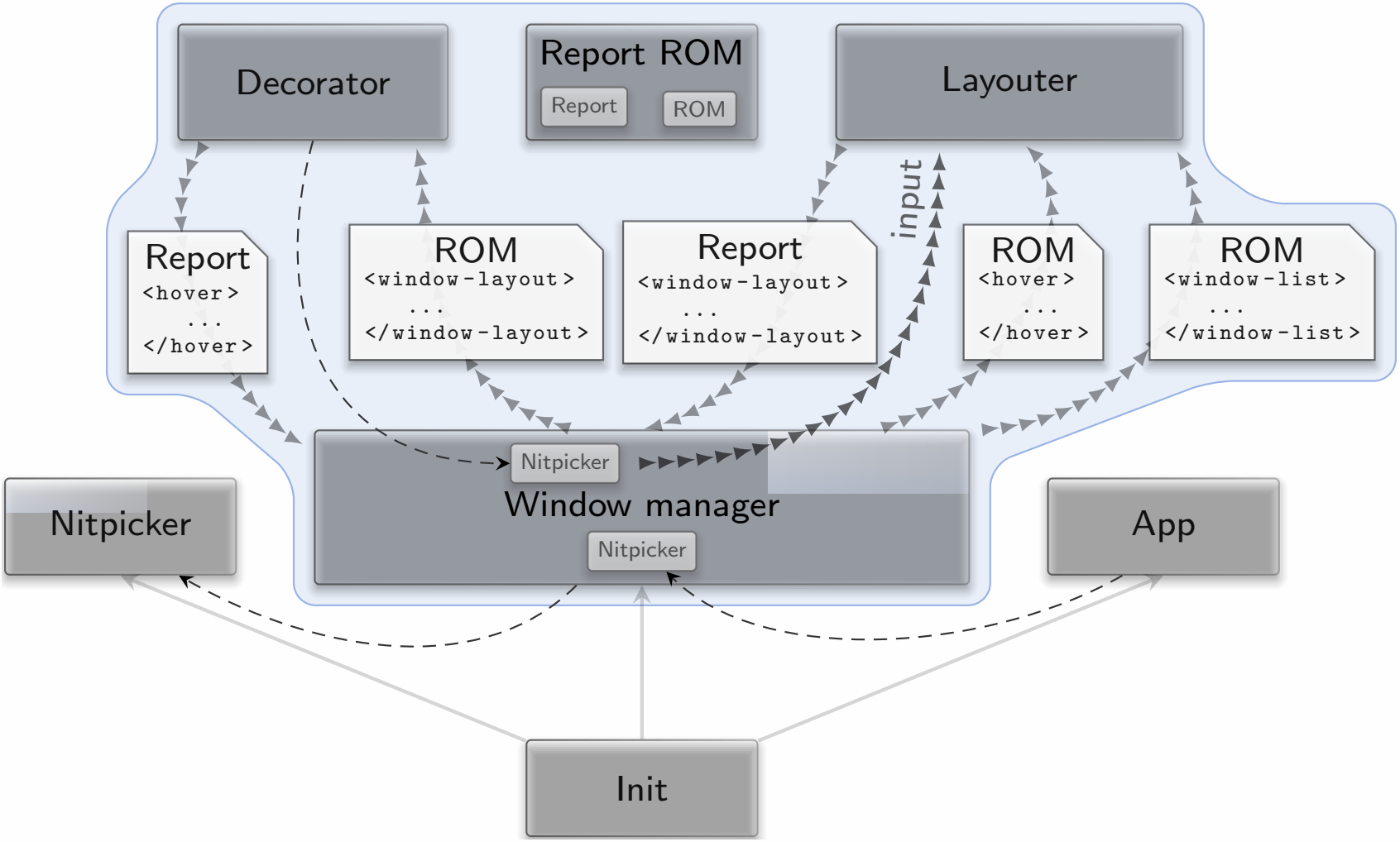
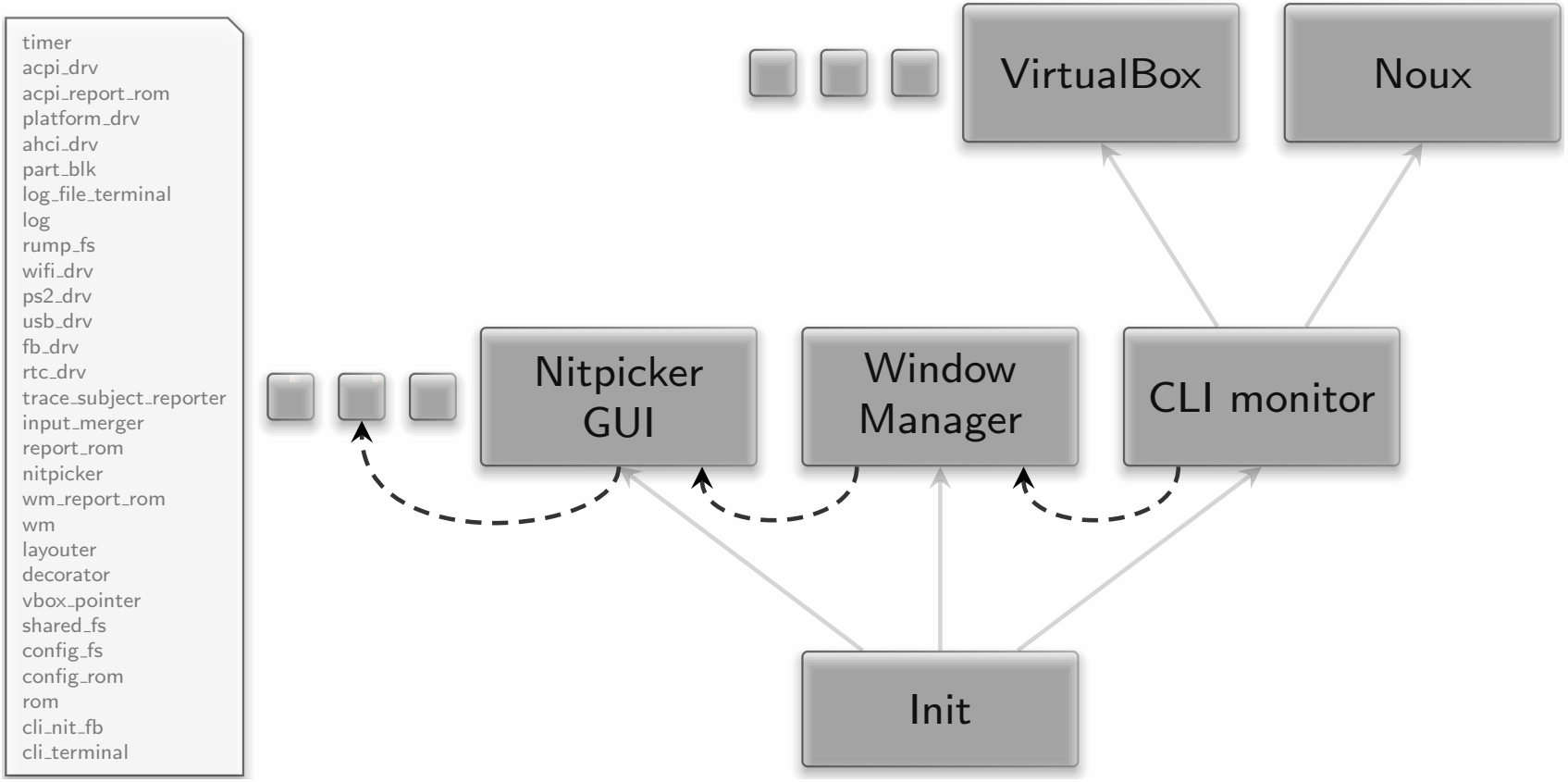
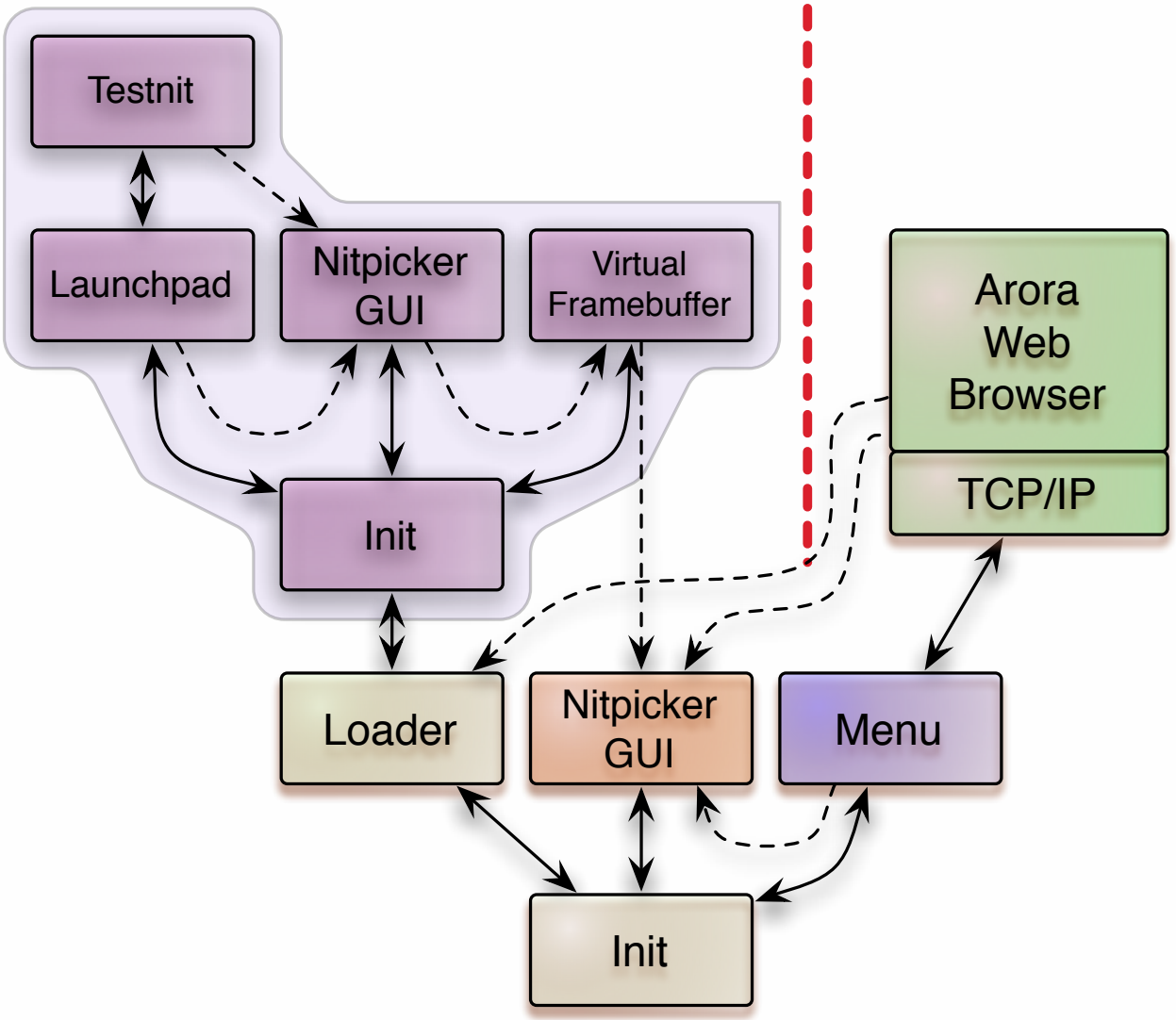


“Turmvilla” scenario



Rich applications



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Disclaimer

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- No package management
- Limited hardware support
- Not yet palatable for uninitiated end users

Ambitions

- Eating our own dog food (tool chain, email, IRC...)

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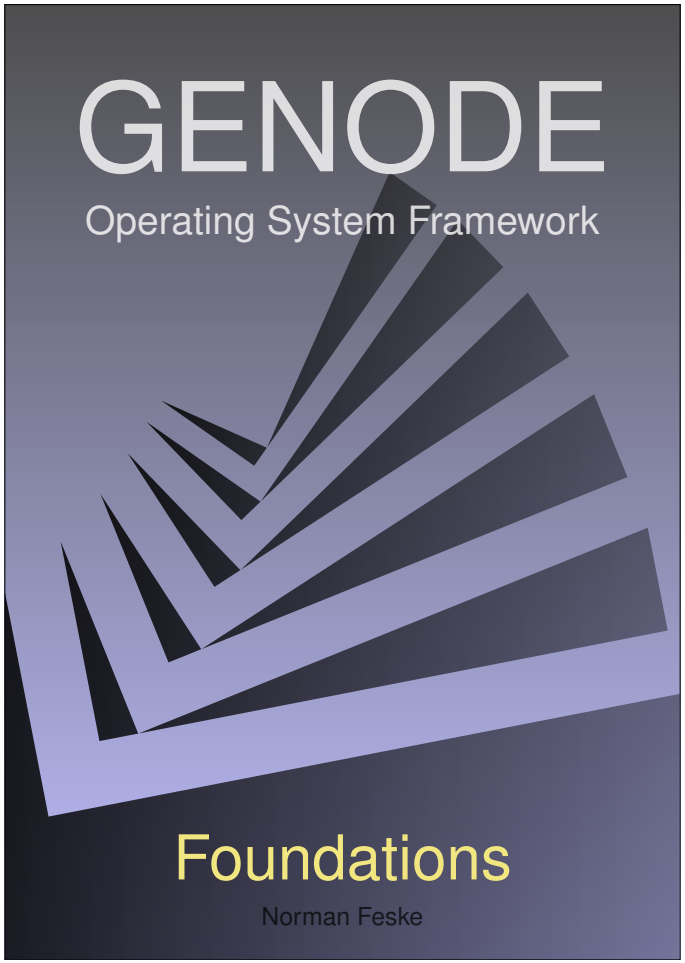
The Book “Genode Foundations”



http://genode.org/documentation/genode-foundations-15-05.pdf

Thank you

Genode OS Framework

http://genode.org

Genode Labs GmbH

http://www.genode-labs.com

Source code at GitHub

http://github.com/genodelabs/genode