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Speeding up Kernel Testing and Debugging with virtme-ng

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Problem

- Testing kernels can be painful and slow
- Lots of re-deployments and reboots involved
- Wait time
- Unpredictable results
- Lack of a fast **edit/compile/test** cycle

Proposed solution

- Create a virtual copy of your entire system on-the-fly
- Run your kernel inside this ephemeral system
- No re-deployments involved
- Extremely fast reboots

State of the art: virtme

- Written by Andrew Lutomirski
- Tool that allows to virtualize your running system
- Boot qemu/kvm instance with a custom kernel
- Export host rootfs to the guest (9p fs) in read-only mode
- Writes allowed in a tmpfs $HOME

virtme: limitations

- Limited testing capabilities

- Performance
  - Poor filesystem performance with 9p-fs
    - *(9p improvements with v5.15)*
  - Boot time not ideal

- Maintenance
  - Project not maintained anymore :(

virtme-ng

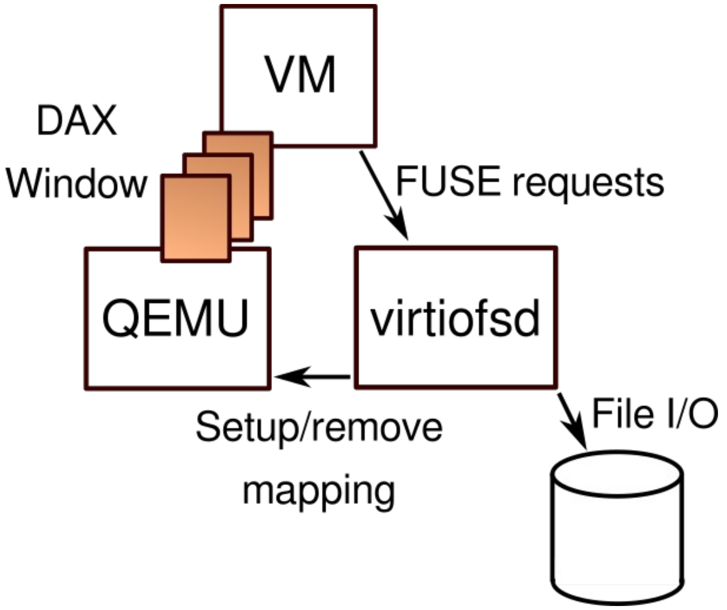
- virtiofs + overlayfs
  - Improve filesystem performance
  - CoW live snapshot of the entire host filesystem

- qemu/kvm microVM
  - Lightweight virtual platform

- virtme-ng-init
  - Custom init script written in Rust

virtiofs

- Shared file system that lets virtual machines access a directory tree on the host using FUSE / vhost-user



https://virtio-fs.gitlab.io/design.html

Replace 9p-fs with virtiofs

- `$ time git diff`
  - `Before: 284.5s`
  - `After:     1.7s`

- `Boot time`
  - `Before: 6.2s`
  - `After:  5.2s`

Overlayfs to handle writes (CoW)

- Use overlayfs to handle writes
  - upperdir/workdir → tmpfs

- Automatically create overlays for the standard system paths at boot (/usr, /etc, /var, ...)

- EPERM issue with implicit overlayfs O_NOATIME (now fixed in virtiofsd upstream)

Qemu ‘microvm’ architecture

- microvm
  - virtual platform (inspired by *firecraker)*
  - Minimalist machine type (without PCI nor ACPI)
  - Optimized for boot time and memory footprint

- `Boot time`
  - `Before: 5.2s`
  - `After:  3.8s`

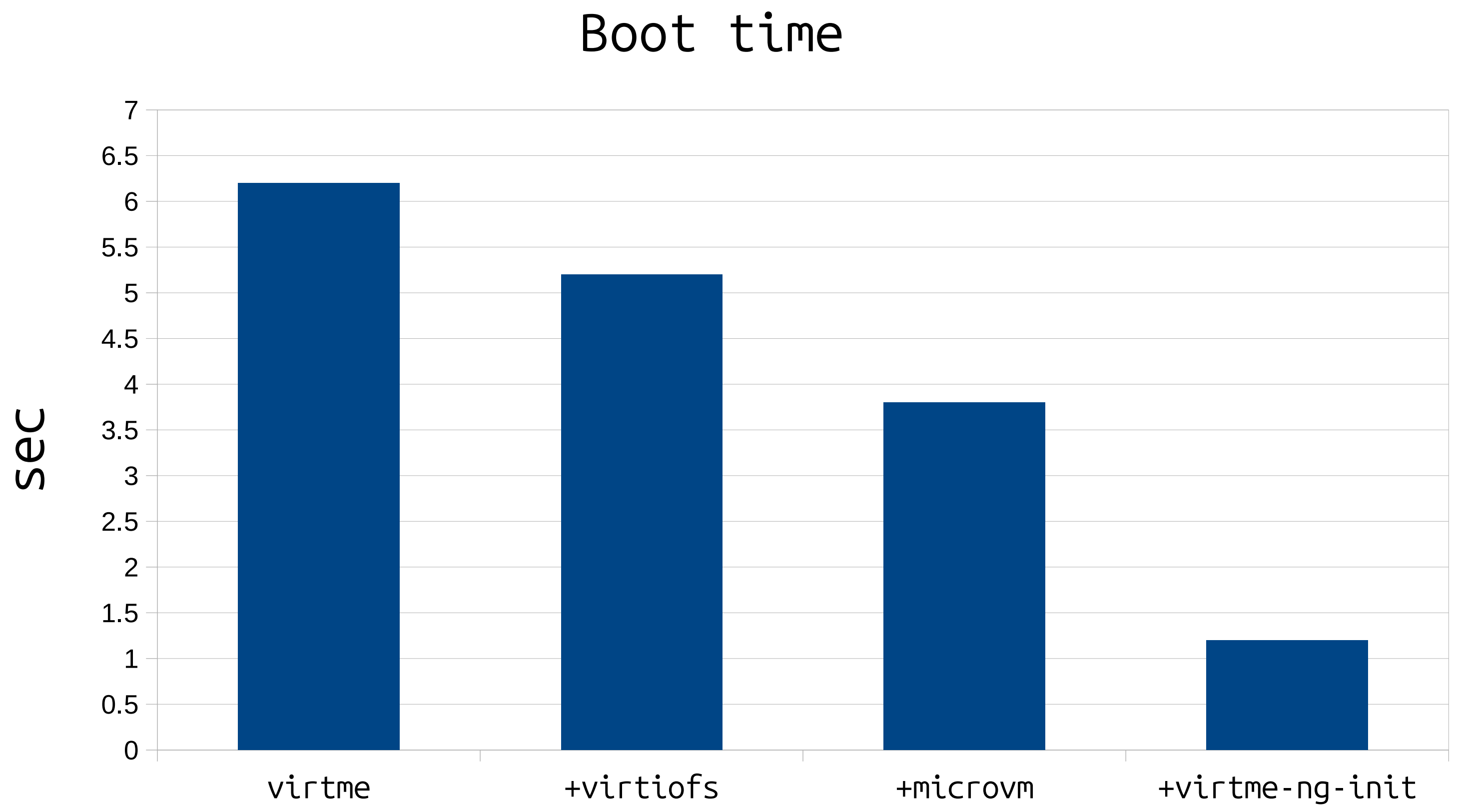
Kudos to Fejes Ferenc (@spyff0)

virtme-ng-init

- virtme-ng-init
  - Custom init script implemented in Rust
  - Replace original virtme’s init script written in bash

- `Boot time`
  - `Before: 3.8s`
  - `After:  1.2s`

Result: boot time



Demo

- https://youtu.be/3sDkVuXVw9A

Conclusion

- virtme-ng can provide a fast **edit/compile/test** workflow for kernel development
- Testing a kernel in 1.2s-1.3s is nice
- Easy to use by everyone (e.g., students, junior devs)
- Reduce power consumption required to do kernel testing

What’s next?

- Increase user base / collect feedbacks and potentially become a standard tool for kernel dev
- systemd support
- Better support across distro
- Better snaps/flatpack support

References

- virtme-ng
  https://github.com/arighi/virtme-ng
- Eco-friendly Linux kernel development: minimizing energy consumption during CI/CD
  https://lwn.net/Articles/935773/
- virtiofs
  https://virtio-fs.gitlab.io/
- Qemu microVM
  https://www.qemu.org/docs/master/system/i386/microvm.html

Questions?

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