CLOUD COMPUTING APPLICATIONS

Virtualization: MicroVMs and Unikernels

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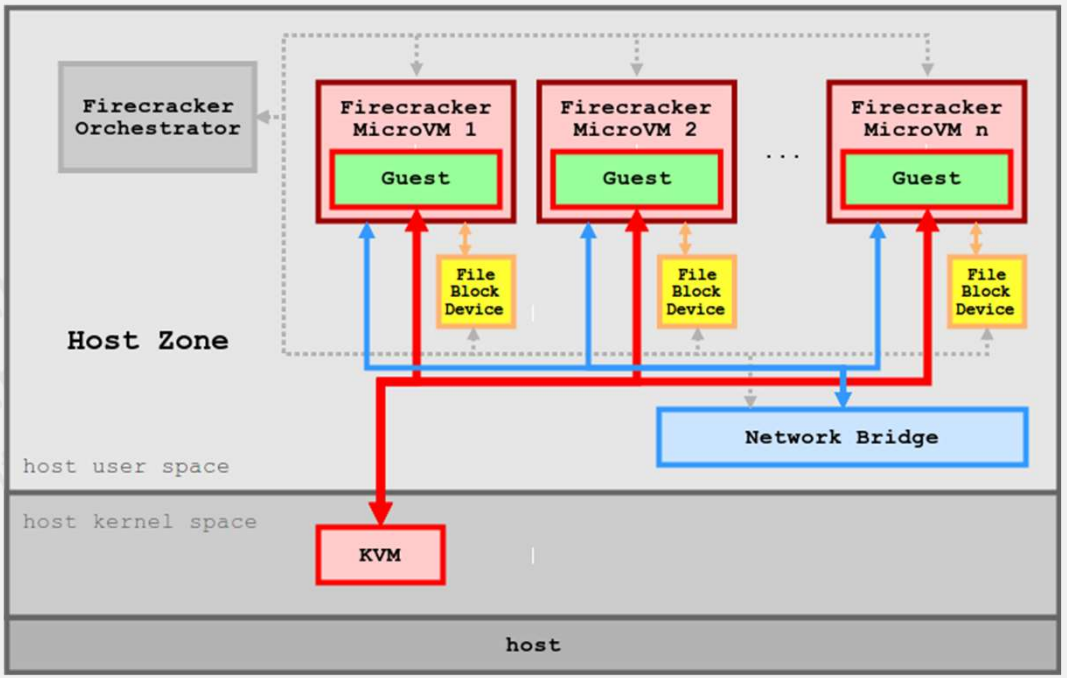
MicroVMs

- A typical virtual machine usually has many virtual I/O devices to make it usable
  - Think about an EC2 instance
    - Virtual storage
    - Virtual Network
    - Virtual Display
    - USB, Audio, …
  - The guest operating system supports device drivers, kernel modules, etc. for all
  - Typical load time in tens of seconds, if not minutes
- MicroVMs designed for cloud native
  - Serverless Computing use cases
  - Serverless containers
    - Fargate
  - Function as a Service
    - Lambda

FireCracker

- Open Source Project by Amazon
- Based on top of the Linux KVM
  - Similar to QEMU (VMM driver)
- Idea: as light weight as possible
  - VMM
  - Guest OS
- No support for graphics drivers
- The only virtual devices:
  - Paravirtualized virtio net
  - Paravirtualized virtio block
  - a one-button keyboard
    - To reset the VM
  - Interrupt controller
  - Timer
  - Clock

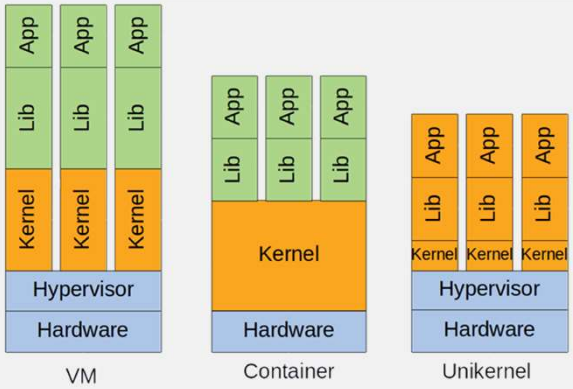


FireCracker

- VMM starts in 8 ms
- VM Start time less than 125 ms
  - Firecracker InstanceStart API call to the start of the Linux guest user-space /sbin/init process
  - Lightweight Linux guest, e.g. Alpine Linux
- Memory overhead less than 5 MiB
- OSv on FireCracker
  - Specialized OS
  - Boot time in less than 5 ms

Unikernel

- Unikernels are a relatively new concept
- Software is directly integrated with the kernel it is running on
- Compiling source code, along with only the required system calls and drivers, into one executable program using a single address space
- Unikernels can only run a single process, thus forking does not exist
- The build process results in a complete (virtual) machine image of minimal size that only contains and executes what it absolutely needs
- Example: OSv → Can run on FireCracker in 5 ms (compare to 125 ms for Linux), 18 MiB memory overhead, can run any Linux Executable



Operating System-Level Virtualization

- Virtualizing a physical server at the operating system level, enabling multiple isolated and secure virtualized servers to run on a single physical server
- Examples:
  - Linux-Vserver
  - Solaris Containers
  - FreeBSD Jails
  - Chroot
  - CGroups