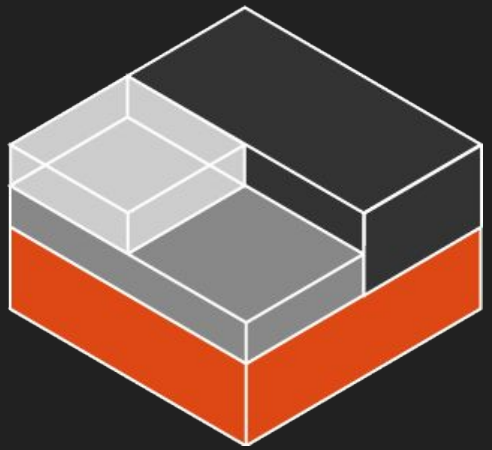
Using Containers for GPU Workloads

NVIDIA GPU Technology Conference
San José, California



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Who we are

LXC

- Venerable container manager
- Umbrella project
  - Make containers better
  - Contributions to
    - Kernel
    - Other projects (shadow, glibc, …)
  - Create, foster new software projects
    - Lxcfs
    - lxd
    - pylxd
    - cgmanager
    - libresource

Containers: A userspace fiction

Early uses of ‘containers’ (before containers):

- Jails
- VPS
- Plan 9
- MLS (/tmp polyinstantiation)
- Checkpoint/restart
- Borg

Newer uses of containers features:

- NOVA network (openstack)
- Sandstorm (sandbox)
- Chrome (sandbox)
- FTP daemons
- Actual containers (lxc, lxd, docker, …)

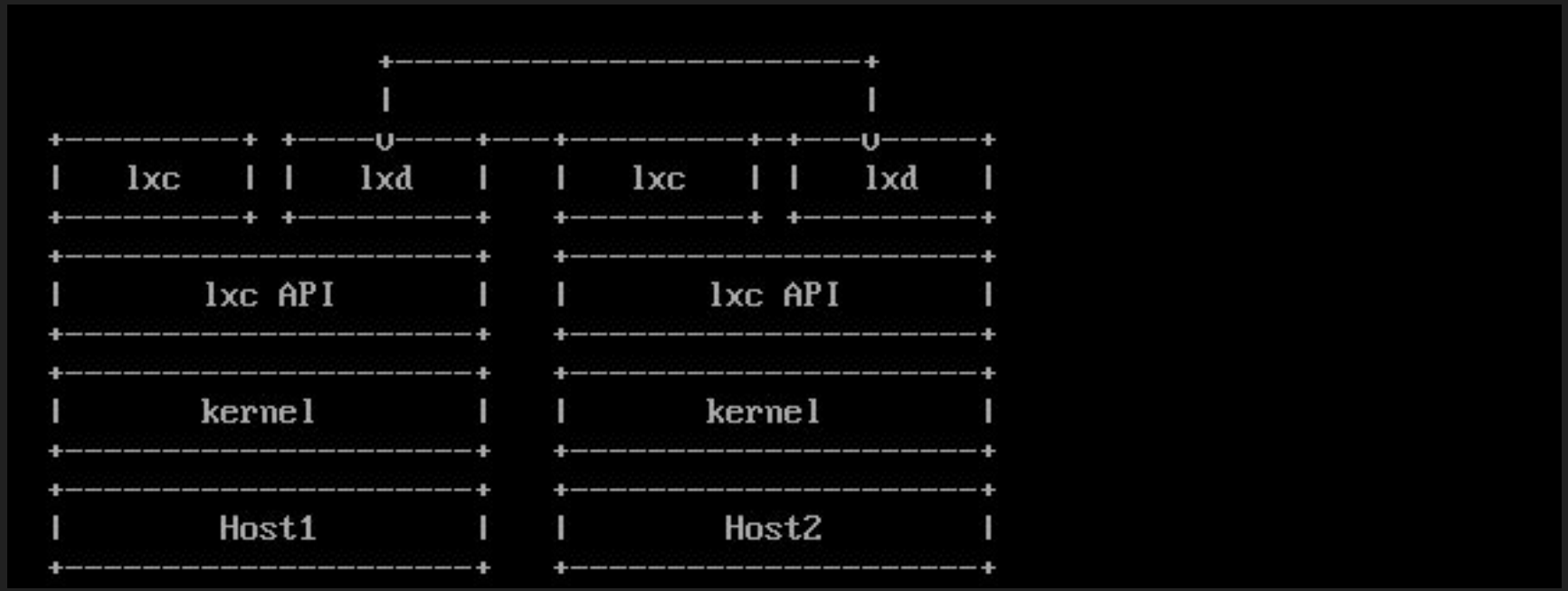
Building blocks

- Namespaces
  - Mounts
  - PID
  - UTS
  - IPC
  - Cgroup
  - Network
  - User
  - (time, ima, LSM, …)
- Capabilities bounding set
- LSM
- Cgroups
- Seccomp
- Devpts

Advantages:

- No emulated hardware
- No guest kernel
- Flexible sharing with host
- Easy introspection/debugging from host

LXC and LXD



LXC vs LXD

LXC

- No long-running daemon
- Completely unprivileged use
- Local use only
- (lxcpath, container)

LXD

- Privileged long-running daemon
- Image based
- Remote based
  - Macbook client:

```
lxc remote add host2 host2.example.org

lxc launch ubuntu:xenial host2:i1

lxc exec host2:i1 touch /tag

lxc publish host2:i1 host3: --alias img2
```

User namespace

Requirements:

- Uid separation (c1.1000 != c2.1000)
- Container root privileged over container
- Container root not privileged over host
- Able to nest

Details:

- Userids are *mapped*
- Capabilities targeted to user ns
- Namespaces, resources owned by a ns
- Hardware belongs to initial user ns
- Uid 1000 can always map uid 1000
- Root can *delegate* other uids to 1000
- (demonstrate)

Using Devices In Containers

- Very fast networking
  Infiniband, SR-IOV
- Interacting with devices
  cell phones, scientific equipment
- Dedicated block storage
  physical disks or partitions
- Computation
  GPUs

Using Devices In Containers

- Device access is handled by the host kernel
  The hardware doesn't need any special capabilities.
- Device nodes are identified and passed to the container
  The workload doesn't need to be container-aware.
- Devices can be shared very efficiently
  The same device can be passed to multiple containers, allowing for simultaneous access if the kernel driver supports this.
- Devices can be attached and detached on the fly
  They are just files or kernel constructs so can be moved around, added and removed as needed without requiring a reboot of the host or container.

Demo Time