USING CONTAINERS FOR GPU APPLICATIONS

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Enable GPUs in the container ecosystem:

• Monitoring
• Orchestration
• Images
• Runtime
• OS
CHALLENGES
A Typical Cluster

Ubuntu 14.04
Drivers 367
4x Maxwell

CentOS 7
Drivers 361
4x Kepler

Ubuntu 16.04
Drivers 375
8x Pascal

CUDA 7.5
CUDA 7.0
cuDNN 4

CUDA 7.5
cuDNN 6

Patches

CUDA 8.0
CONTAINERS

To the rescue

Portable and reproducible builds
Ease of deployment
Isolation of resources
Run across heterogeneous CUDA toolkit environments (sharing the host driver)
Bare Metal Performance
Facilitate collaboration
VIRTUAL MACHINES VS CONTAINERS

Not so similar
NVIDIA-DOCKER

github.com/NVIDIA/nvidia-docker
DOCKERHUB IMAGES

Multiple flavors
CONTAINERS ON NVIDIA DGX-1
NVIDIA’s Deep Learning System
NVIDIA-DOCKER 1.0
Internals

```
$ NV_GPU=0 nvidia-docker run -ti nvidia/cuda
```
LIMITS OF NVIDIA-DOCKER 1.0
Limited scope

Only for Docker CLI
Docker plugins are difficult to manage
Not extensible (OpenGL, Vulkan, InfiniBand, KVM, etc.)
Challenging to support new architectures (Power, ARM)
Difficult to integrate into the container ecosystem
DOCKER COMPONENTS

[Diagram showing Docker components and moby tools]

Upstream *projects*

Downstream *products*
WHAT’S A CONTAINER
Kernel building blocks

Init system  Netlink
Namespaces  Capabilities
Cgroups  Seccomp
BPF  UnionFS
LSM  KVM
Netfilter  …
LIBNVIDIA-CONTAINER

github.com/NVIDIA/libnvidia-container

Integrates with the container internals
Agnostic of the container runtime
Drop-in GPU support for runtime developers
Better stability, follows driver releases
Brings features seamlessly (Graphics, Display, Exclusive mode, VM, etc.)
NVIDIA-DOCKER 2.0
Internals

docker

http(s)(+unix)

dockerd

grpc+unix

docker-containerd + shim

nvidia-runc

container process

nvidia-oci-runtime

libnvidia-container
cuda+nvml

nvidia driver

$ docker run -ti -e NVIDIA_VISIBLE_DEVICES=0 --runtime=nvidia nvidia/cuda
DEMO!
CONTAINER FUTURE

Enable GPUs everywhere

nvidia-docker 2.0 release
Multi-arch support (Power, ARM)
Support other container runtimes (LXC/LXD, Rkt)
Additional Docker images
Additional features (OpenGL, Vulkan, InfiniBand, KVM, etc.)
Support for GPU monitoring (cAdvisor)
QUESTIONS?