Composable Infrastructure for On-Prem Kubernetes-Based Systems S9572

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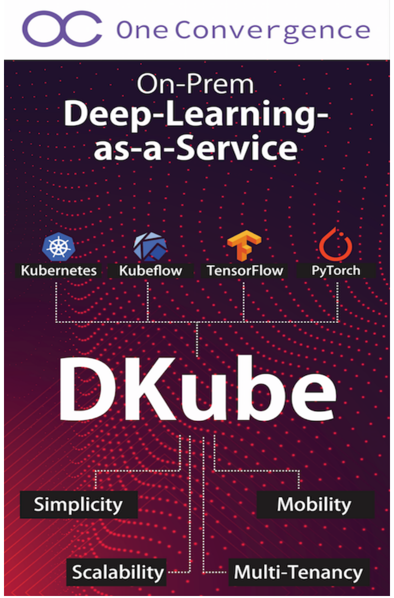
Agenda

- Introduction
- State of the art
- Problem description
- Proposal
- Scale-Out performance

Introduction

- One Convergence Products
  - http://www.oneconvergence.com

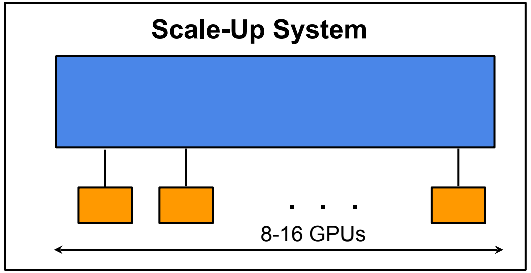
- Topic
  - GPU Composition for Kubernetes workloads

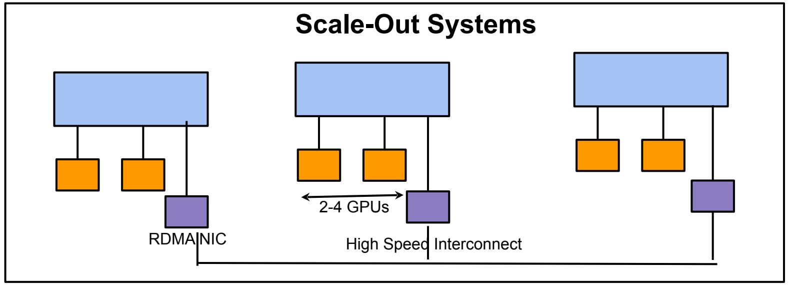


DFabric

Scale-Out Architecture

- Why Scale-out?
  - Scale-up vs Scale-out
    - Affordable GPU servers
    - Incrementally add new GPU hardware
    - Resiliency - No single point of failure
    - Higher network speeds via RDMA NICs
  - Challenges
    - Cluster management
    - Workload orchestration
    - Resource management
    - Achieving best performance
  - On-Prem
    - Cloud providers address this
    - On-Prem needs to be solved





Platform of Choice

- Kubernetes
  - Cluster management
  - Container orchestration
  - Standard interfaces for Network and Storage
    - CNI & CSI
  - Node-specific resource management
    - Device plugins for GPUs, RDMA, etc

GPU Allocation

- POD Spec

```
resources:
  limits:
    nvidia.com/gpu: 2 # requesting 2 GPUs
```

- Different types of GPUs
  - Label each node with the type of GPU

    ```
    kubectl label nodes <node-with-k80> accelerator=nvidia-tesla-k80
    kubectl label nodes <node-with-p100> accelerator=nvidia-tesla-p100
    ```

  - Specify using node selectors in the POD spec

    ```
    nodeSelector:
            accelerator: nvidia-tesla-p100 # or nvidia-tesla-k80 etc.
    ```

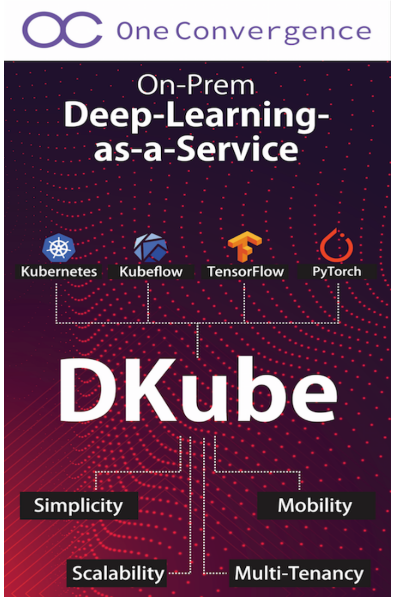
Challenges

- User needs to be aware of
  - GPU vendor, Type of GPU and GPU nodes
- Resource segmentation
  - Experimental vs Production jobs
- Better utilization of GPUs
  - Schedule by mutual agreement
- Multi-user
  - Isolation of workloads
- Cluster changes
  - Scale-out/scale-down
  - GPU health
- Topology
  - RDMA, NVLink®, etc
- Complex with increasing number of users/nodes

Extending Kubernetes

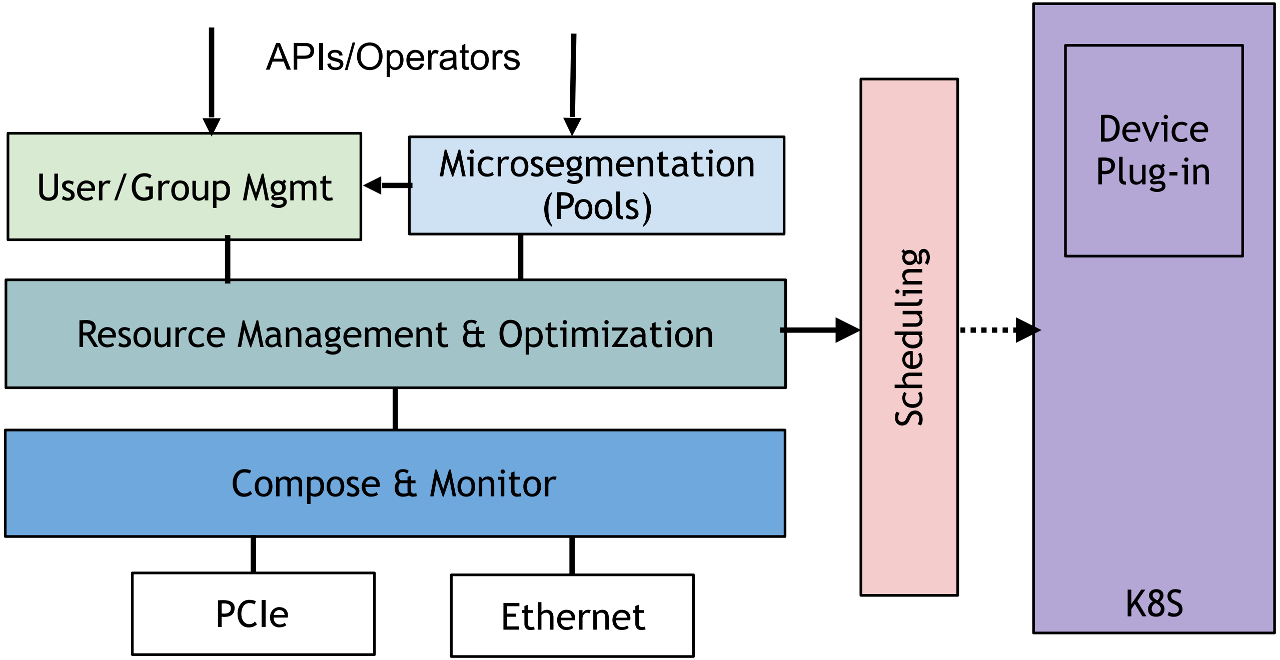
- Custom Resources
  - Dynamically extend Kubernetes API
  - CRDs - Custom Resource Definitions
    - Handled by API server
    - Uses Kubernetes storage
    - Custom Controller provides Declarative API
  - Aggregated APIs
    - Separate service, Complex
    - Custom storage
- Operators
  - Combines Custom Resources & Custom Controllers
  - Domain knowledge
  - Examples
    - Etcd, Prometheus operators
    - Tf operator in Kubeflow

DFabric



DFabric

DFabric Architecture

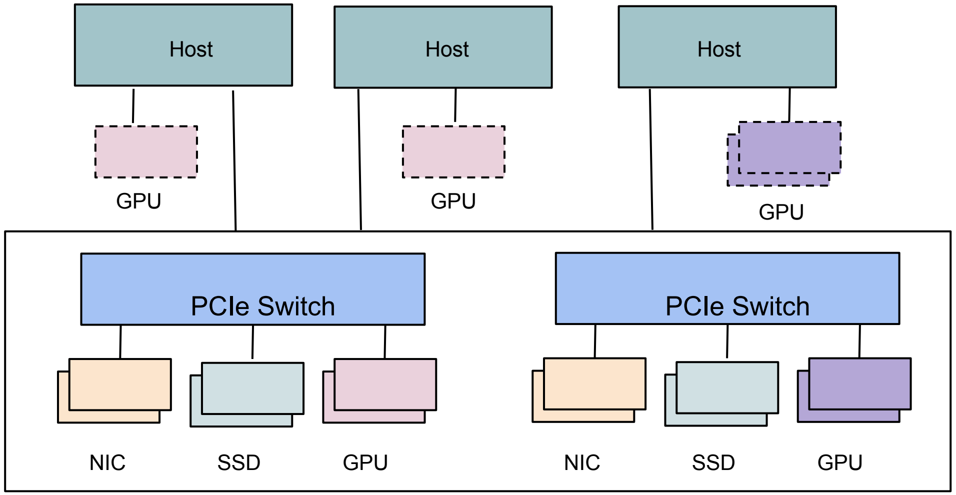


Pool & Group Benefits

- Abstracts resources
  - User doesn't need to be aware of GPU hardware
  - Groups determine GPU association
- Better utilization of GPUs
  - Better distribution of workload
- Isolation of workloads
  - Separate Namespace per user
- Topology awareness
  - Schedules RDMA/GD wherever applicable
- Monitors changes to cluster
  - Scale-out/Scale-down
  - GPU health

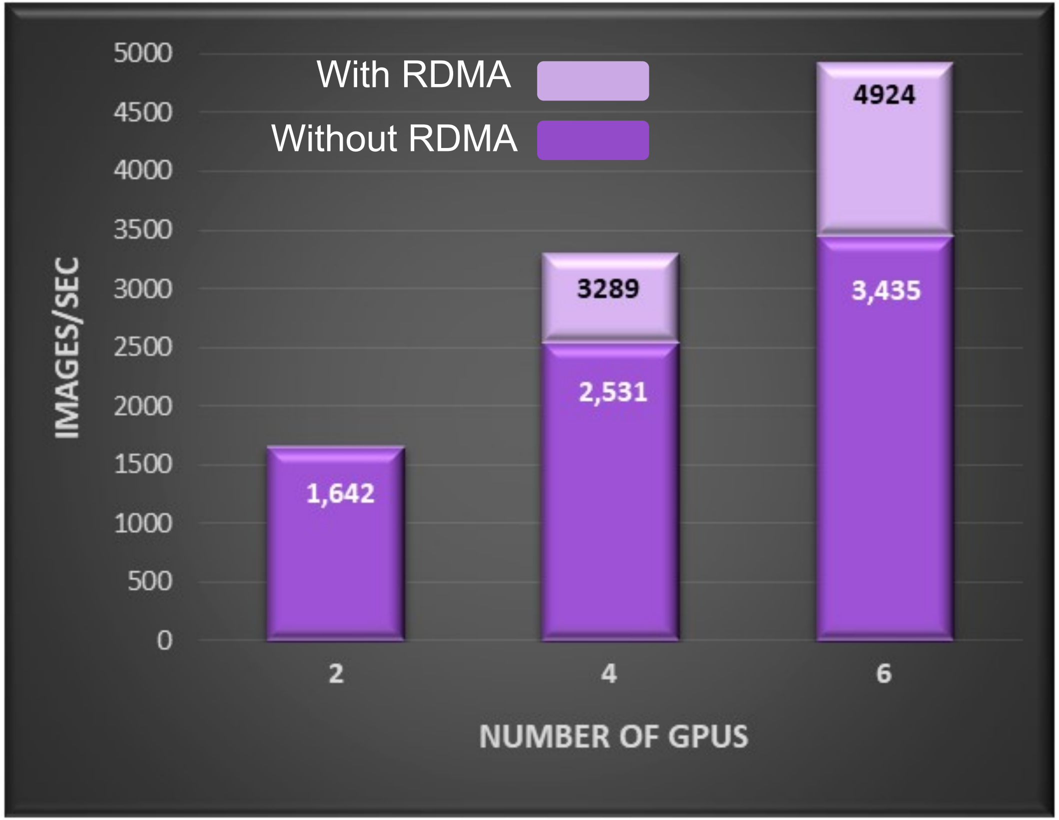
Disaggregated PCIe JBOG

- Introduction
- Static composition
  - Fixed at node composition time
- Dynamic composition
  - Dynamically attaches to POD
  - GPUs move across nodes
  - Device plugin requirements



PCIe Fabric

Scale-Out Performance



3 Node Cluster

Each node contains:

- ○ Lenovo™ Thinksystem™ SD530
- ○ Intel® Xeon® Gold 6148 @2.4 GHz
  - ▪ 384 GB RAM
  - ▪ 20 Cores
- ○ 2 NVIDIA® V100 GPUs / 16GB
- ○ Mellanox® 100Gbps ConnectX®-5
  - ▪ RDMA NIC
- ○ CUDA 9.0
- ○ Cudnn 7.4.1.5-1
- ○ TensorFlow 1.12
- ○ Mellanox OFED 4.5-1.0.1.0
- ○ NCCL openmpi-3.0.0
- ○ Horovod: 0.15.2
- ○ DKube/DFabric™ 1.0.3

Summary

- Scale out architecture
  - http://www.oneconvergence.com/blogs/
- Platform requirements
  - DFabric
  - http://www.oneconvergence.com/dfab

Thank You

Questions?