15th ANNUAL WORKSHOP 2019

NCCL AND LIBFABRIC: HIGH-PERFORMANCE NETWORKING FOR MACHINE LEARNING

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INTRODUCTION

- **AWS recently announced our Elastic Fabric Adapter for HPC/ML workloads**
- **Discussion of EFA and Libfabric tomorrow morning, but for now:**
  - 100 Gbps ethernet network
  - OS bypass with UD and custom reliable datagram protocols
  - Libfabric primary programming interface
- **Support for both HPC-like and GPU instance types**
- **How can customers best utilize our GPU instances for large scale training workloads?**

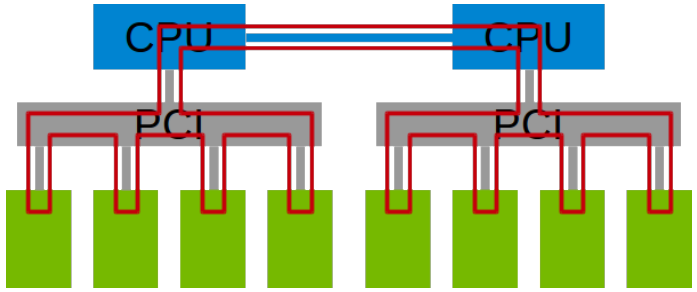
SO NCCL?

- **NVIDIA's NCCL (NVIDIA Collective Communication Library) is becoming the middleware of choice for machine learning applications**

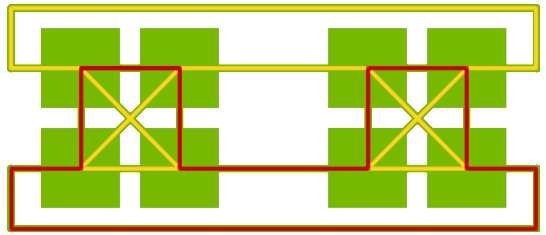
- **NCCL 2 focused on multi-node, multi-GPU training**
  - TCP and OFED VERBS support included from NVIDIA
  - Support for external plug-ins

- **AWS has built a Libfabric plug-in for NCCL2**

NCCL PRIMER

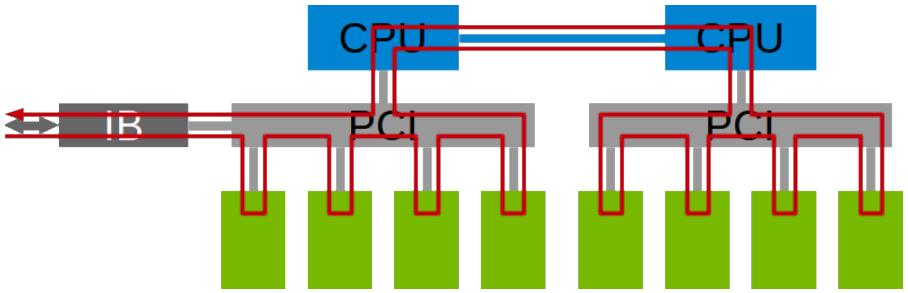


PCIe: 1 ring



DGX: 4 rings

NCCL PRIMER



Extend to multi-node

NCCL PLUG-IN INTERFACE

- **Initialization / Cleanup**
  - Plug-in provides local host topology information
  - NCCL core handles GPU/NIC mapping
  - Functions for determining capabilities (such as ability to send to/from GPU buffers directly
- **Listen/Connect/Accept interface for connections**
  - Can be multiple connections between any two processes
  - NCCL has a “ring” construct; each ring will have a set of connections
- **Explicit memory register / deregister APIs**
- **Non-blocking send/receive with Test**
  - Ordered message channel
  - Messages are potentially large

LIBFABRIC NCCL PLUG-IN

- **Requires fi_nic support to provide PCI address / endpoint association**
- **Uses FI_EP_RDM endpoints with FI_ORDER_SAS and FI_TAGGED**
  - Need multiple ordered channels between any two processes (multiple “rings” in NCCL terms)
  - Wanted to reduce pressure on hardware resources and avoid polling multiple completion queues
  - Scalable endpoints another possibility, but not as widely supported
- **NCCL, like MPI, doesn’t have a backpressure concept, so implement a queue for messages that can’t be queued in provider**
  - Some things never change ☺
- **~1500 lines of code, most of which is setup or queueing**
- **Available on GitHub:**
  - https://github.com/aws/aws-ofi-nccl/
  - Apache 2.0 License

FUTURE WORK

- **GPUDirect support**
  - Can we keep most of the interface changes in the memory registration logic?
  - Obviously ignoring the kernel part of the GPUDirect discussion
- **Performance tuning**
  - AWS is still tuning the end to end stack for EFA, hard to tightly measure with so much in flight
  - Seeing big advantages for our infrastructure, but comparing TCP to OS Bypass, so…
- **Bug fixes**
  - Many “unknown unkonwns.”

CALL FOR PARTICIPATION

- Want to build community Libfabric plug-in for NCCL
- Need provider testing. We've tested with EFA and TCP providers, but there are many more
- Performance tuning
- GPUDirect development: let's get a model everyone can use

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THANK YOU

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