RDMA on MANA

Microsoft Azure Network Adapter

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Agenda

- RDMA Background
- MANA Overview
- DPDK over MANA
- RDMA over MANA
- Current State
RDMA Motivation

Modern datacenter applications demand high throughput and low latency.

Standard TCP/IP stacks cannot meet these requirements

*Remote Direct Memory Access (RDMA) saves network stack overhead*
RDMA Benefits

Improved tail latency for storage IO

- Eliminate Network latency
  - Remove TCP overhead, data copies, HTTP formatting
- Switches and NICs form a lossless Fabric
  - Hop-by-Hop backpressure-based flow control
  - Eliminates retransmission due to congestion drops
- DCQCN prevents queue buildup in the switches
  - ECN + E2E congestion control implemented in the NIC

CPU savings

- No CPU involvement in the READ and WRITE ops
  - Reduces CPU load on storage nodes
RDMA: Remote Direct Memory Access

RDMA bypasses host OS stack → frees host CPU, lowers latency
Introducing MANA
Microsoft Azure Network Adapter (MANA)

- **Microsoft Azure Network Adapter (MANA)** leverages both the latest and future hardware acceleration features in Azure and provide competitive performance.

- MANA provides performance, availability, extensibility, and servicing features critical to the ever-evolving cloud landscape.

- MANA is designed with RDMA performance and quality in mind - enabling customers to achieve low latency and high throughput required for their workloads.

- MANA is implemented in FPGA RTL - furthers Microsoft's investments into FPGA technology

- P.S. MANA is now available for customer to test-drive as part of the Azure Boost Preview
MANA Components

Virtual Machine
- Mana driver

Host/Hypervisor

MANA Management SW

MANA NiC (FPGA)

PCle

TOR
Linux MANA RDMA Driver

- Modeled as an auxiliary device to Linux MANA Ethernet driver
  - Hardware is exposed as a PCI device
  - Support multiple network devices over one PCI function
  - Each network device can optionally expose an RDMA port

- RoCE v2 RDMA only support

- Support two types of queue pairs
  - RAW – used to expose native device queue to user-mode
    - Used by DPDK
  - RC – reliable connection
    - Support CM verbs
    - RC queue pair
DPDK over MANA
Linux MANA RDMA Device Model

PCI Virtual Function

PCI device

Ethernet device

 Auxiliary device

RDMA device

IB ports

IB port 0

IB port n-1

Network devices

net_device 1

net_device n

Linux kernel

Port 1

Port n

MANA Hardware

Microsoft implementation

Kernel
Why using RDMA / IB verbs for DPDK?
• We can support DPDK in the VM using only one VF
  • If using VFIO, all NICs are assigned to either DPDK or kernel but not both
  • RDMA allows the kernel and DPDK use the same VF
• No need for v-IOMMU
  • Memory safety is guaranteed by RDMA memory registration
Memory Registration

- Virtual Address (VA)
  - Guest Registers virtual memory
  - Translated to gPA by Mana HW

Mana HW

Guest Physical Address (gPA)

Host IOMMU

- Hypervisor Maps guest physical address
- IOMMU translates to hPA

Host Physical Address (hPA)

- Virtual IOMMU for the guest is not required.
- viommu very expensive to implement in the Hypervisor
- Inter process memory safety is guaranteed by the memory registration.
- It’s essential for the container workload.
RDMA over MANA
RoCEv2 Packet Format

The IP/UDP header are used to:

1. Route the packet to the correct node
2. Indicate this is an RDMA packet using UDP protocol number 4791
3. Indicate RDMA packet length (BTH don’t have packet length field)

https://upload.wikimedia.org/wikipedia/commons/c/c5/RoCE_Header_format.png
Microsoft ibverbs implementation

RDMA app

Fast Path

User Space

Char Device

Hardware

Kernel applications

Kernel Space

IB Uverbs

IB Core

Mana HW

libmana

LibibVerbs

Mana HW

Hardware

User Space

Kernel Applications

RDMA app
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