Design of Vhost-pci
- designing a new virtio device for inter-VM communication

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Agenda

Part 1: Usage and Motivation
Part 2: Design Details
Part 3: Current Status
Part 1: Usage and Motivation
Transformation of Network Appliances

Network Appliances to Virtual Network Functions (VNF): transformation relies on high performance inter-VM communication schemes
Virtual Network Function Forwarding Graph

http://www.etsi.org/deliver/etsi_gs/nfv/001_099/002/01.01.01_60/gs_nfv002v010101p.pdf
VNF Forwarding with Vhost-pci

--- Logical Link

Data Flow 1

Data Flow 2
Existing Inter-VM Network Packet Transmission

- Long Code Path: packets are transmitted from one VM to another via an intermediary
- Packets, streamed out of VMs, are bumper-to-bumper in the central vSwitch
Vhost-pci for Inter-VM Network Packet Transmission

Advantages:

- Short Code Path: packets are transmitted from one VM directly to another VM
- Better scalability
Micro-benchmarking Results

VSPERF / Chain of 2 to 5 VM
- RFC2544 via ext. packet generator DPDK Pktgen
- OVS DPDK on two cores (default)
- VM setup: one pinned vCPU, 2GB RAM (hugepages)
- pCPU: Intel(R) Xeon(R) E5-2698 v3 @ 2.30GHz

Normalized throughput

vhost-user

vhost-pci
Part 2: Design Details
Vhost-pci Design

No change needed to in-guest drivers for virtio devices
**Vhost-pci Server**

- To use the vhost-pci based inter-VM communication mechanism, a VM’s QEMU needs to create a vhost-pci server
- Creates a vhost-pci-server by adding the following QEMU booting commands:
  - `-chardev socket,id=vhost-pci-server-xyz,server,wait=off,connections=32,path=/opt/vhost-pci-server-xyz`
  - `-vhost-pci-server` `socket,chardev=vhost-pci-server-xyz`
Vhost-pci Client

- To use a vhost-pci device on another VM as a backend, the originating virtio device supplies a vhost-pci client which connects to the remote vhost-pci server.

- Create a virtio device with a vhost-pci client using the following commands:
  - `-chardev socket,id=vp-client1,path=/opt/vhost-pci-server-xyz`
  - `-device virtio-net-pci,mac=52:54:00:00:00:01,vhost-pci-client=vp-client1`

- The client communicates to the server using the vhost-pci protocol to set up the inter-VM communication channel.
Vhost-PCI Protocol

<table>
<thead>
<tr>
<th>Protocol Msg</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHOST_PCI_GET_UUID</td>
<td>Identifies a frontend VM</td>
</tr>
<tr>
<td>VHOST_PCI_GET_MEMORY_INFO</td>
<td>Used to map the entire frontend VM’s memory</td>
</tr>
<tr>
<td>VHOST_PCI_GET_DEVICE_INFO</td>
<td>Frontend device info (device type, vring addr etc)</td>
</tr>
<tr>
<td>VHOST_PCI_GET_FEATURE_BITS</td>
<td>Feature bits of the frontend device to be negotiated with the vhost-pci device and driver</td>
</tr>
</tbody>
</table>
Vhost-pci Device Management

Device Creation

1. Vhost-pci Device Instance

2. Map

3. Register to a BAR, Size = 2N

4. Hot-plug into the VM

Memory Info Msg

... memory_size 0
...

... memory_size 1
...

... memory_size 2
...

... memory_size
...
Vhost-pci Driver

struct vhost_pci_info:
- struct vhost_pci_dev[MAX_NUM];

struct vhost_pci_dev:
- u32 device_type;
- u64 device_id;
- void *dev;

Pointer to the device specific structure
e.g. dev = net_device
vhost-pci-net shares vrings created by the originating virtio-net device

TX ring from originating device becomes RX ring at mirrored device, and vice versa

Copying packets in and out of originating device rings is the responsibility of vhost-pci-net
Part 3: Current Status
Current Status

- Initial PoC completed, summary of results presented
- Design RFC v2 has been sent out to KVM/QEMU mailing list ([https://lists.gnu.org/archive/html/qemu-devel/2016-06/msg05359.html](https://lists.gnu.org/archive/html/qemu-devel/2016-06/msg05359.html))
- Patches implementing RFC v2 design are work in progress
End of Presentation

Thank you!