Achieving High Throughput by Transparent Network Interface Virtualization on Multi-core Systems

Huiyong Zhang, Yuebin Bai, Zhi Li, Niandong Du, Wentao Yang

Beihang University, China
1. Why Transparent Network Interface Virtualization?
2. Motivation
3. Xen network design changes and optimizations
4. Performance results
Network I/O Virtualization

- **Software-based approaches**
  - Paravirtualization I/O model (Xen)
  - Device emulation (Hyper-V, KVM etc.)

- **Hardware-based approaches**
  - Direct I/O (VT-D, IOMMU)
  - Self-virtualization devices (SR-IOV)
Transparent Network Virtualization

- Live migration
- Fault isolation
- Minimize the VM
- …
**Xen Network I/O**

**I/O Channel**
- I/O ring
- Event channel
- Grant table
Experimental Setup

Physical server: Xeon 5405(x2) 4-port 1Gb/s NIC
Virtual Server: 1VCPU 512MB memory
Dom0: 4VCPU 2GB memory
Xen I/O Performance

Only achieve 2.3Gb/s throughput
Dom0 CPU utilization

```
debian:/home/zhanghuiyong# xm vcpu-list
Name          ID  VCPU CPU State Time(s) CPU Affinity
Domain-0      0   0   1 -b-    820.7 any cpu
Domain-0      0   1   2  r--      21.9 any cpu
Domain-0      0   2   3 -b-      17.5 any cpu
Domain-0      0   3   0 -b-      25.6 any cpu
```

**Reason**
- All interrupts are delivered to VCPU0
- Only one-pair tasklets in the netback
Xen network design changes

- Balanced event dispatcher
- Multi-tasklet netback
Balanced Event Dispatcher

- When network traffic is low
  - deliver all events notification to VCPU0
    (better cache behavior)

- When network traffic is high
  - deliver all events notification to all VCPUs
    (to achieve high throughput)
Multi-tasklet Netback

● Define N pairs tasklet, where N=Dom0 VCPU #

● Each tasklet has its own tx_queue and rx_queue

● Assign each virtual network interface to a tasklet, According to the event dispatcher
Can achieve 3.7G/s, improved by 68%
Performance

CPU resources are utilized more effectively
Improve the TCP ping-pong Latency
Optimization

- Event Notification Control in Netback
- LRO in Netfront
Achieving High Throughput by Transparent Network Interface Virtualization on Multi-core Systems