Test Date: December 3st 2018
Author: Intel DPDK Validation Team
# Revision History

<table>
<thead>
<tr>
<th>Date</th>
<th>Revision</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>December 3rd, 2018</td>
<td>1.0</td>
<td>Initial document for release</td>
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Audience and Purpose

The primary audience for this test report are architects and engineers implementing the Data Plane Development Kit (DPDK). This report provides information on packet processing performance testing for the specified DPDK release on Intel® architecture. The initial report may be viewed as the baseline for future releases and provides system configuration and test cases based on DPDK examples.

The purpose of reporting these tests is not to imply a single “correct” approach, but rather to provide a baseline of well-tested configurations and procedures with reproducible results. This will help guide architects and engineers who are evaluating and implementing DPDK solutions on Intel® architecture and can assist in achieving optimal system performance.

Test setup:

The device under test (DUT) consists of a system with an Intel® architecture motherboard populated with the following;

- A single or dual processor and PCH chip, except for System on Chip (SoC) cases
- DRAM memory size and frequency (normally single DIMM per channel)
- Specific Intel Network Interface Cards (NICs)
- BIOS settings noting those that updated from the basic settings
- DPDK build configuration settings, and commands used for tests

Connected to the DUT is an IXIA*, a hardware test and simulation platform to generate packet traffic to the DUT ports and determine the throughput at the tester side. The IXIA is used to implement RFC2544 on the DUT.

Benchmarking a DPDK system requires knowledge of networking technologies including knowledge of network protocols and hands-on experience with relevant open-source software, such as Linux*, and the DPDK. Engineers also need benchmarking and debugging skills, as well as a good understanding of the device-under-test (DUT) across compute and networking domains.

DPDK Testpmd Test Case: Documentation may be found at http://www.dpdk.org/doc/guides/testpmd_app_ug/index.html.

The testpmd application can be used to test the DPDK in a packet forwarding mode and also to access NIC hardware features. Note in the Testpmd example if the –i argument is used, the first core is used for the command language interface (CLI).


Procedure: Send a specific number of frames at a specific rate through the DUT and then count the frames that are transmitted by the DUT. If the count of offered frames is not equal to the count of

* Other names and brands may be claimed as the property of others.
received frames, the rate of the offered stream is reduced and the test is rerun. The throughput is the fastest rate at which the count of test frames transmitted by the DUT is equal to the number of test frames sent to it by the test equipment.

**DPDK Phy-VM-Phy(PVP) RFC2544 test case:**
This test setup is shown in Figure 1. The traffic is generated by Ixia running RFC2544(IxNetwork* 8.12 with 0 packet loss, and the duration for each round is 60 seconds). The flow is one fixed flow. In this test setup, one port(40G) of Intel® Ethernet Converged Network Adapter XL710-QDA2 is used to inject traffic to Vhost/virtio. The case is to measure vhost/virtio system forwarding throughput, and the theoretical system forwarding throughput is 40 Gbps. Both Vhost and Virtio is DPDK polling mode driver. The flow is as below: IXIA→NIC port0→Vhost-user0→Virtio→Vhost-user0→NIC port0→IXIA.

![Figure 1. DPDK PVP test setup](image-url)
DPDK Vhost VM to VM iperf test case:
This test setup is as shown in Figure 2. Iperf is the TCP/UDP/SCTP network bandwidth measurement tool. Iperf performance test is widely used in the industry. In this case, Vhost is using DPDK polling mode driver, Virtio is using Linux kernel driver. The test case is to measure DPDK vhost PMD’s capability for supporting the maximum TCP bandwidth with virtio-net device.
The flow is as below: virtio-net1 \(\rightarrow\) vhost-user0 \(\rightarrow\) vhost-user1 \(\rightarrow\) virtio-net2.

Figure 2. DPDK VM2VM iperf test setup
Intel® Xeon® Processor Platinum 8180 (38.5M Cache, 2.50 GHz)

### Hardware & Software Ingredients

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
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</table>
| Server Platform           | Intel® Server Board S2600GZ  
Intel® Server Board S2600GZ Family                                       |
| CPU                       | Intel(R) Xeon(R) Platinum 8180 (38.5M L3 Cache, 2.50 GHz)  
Number of cores 56, Number of threads 112.                                |
| Memory                    | Total 96GB over 8 channels, DDR4 @2666 Mhz                                   |
| PCIe                      | 1 x PCIe Gen3 x8                                                             |
| NICs                      | Intel® Ethernet Converged Network Adapter XL710-QDA2 (2x40G)                |
| BIOS                      | SE5C620.86B.01.00.0013                                                       |
| Microcode version         | 0x2000043                                                                   |
| Host Operating System     | Ubuntu 18.04 LTS                                                            |
| Host Linux kernel version | 4.15.0-20-generic                                                           |
| Host GCC version          | gcc (Ubuntu 7.3.0-16ubuntu3) 7.3.0                                          |
| Host DPDK version         | 18.11                                                                       |
| Guest Operating System    | Ubuntu 16.04 LTS                                                            |
| Guest GCC version         | gcc (Ubuntu 5.4.0-6ubuntu1~16.04.4) 5.4.0 20160609                           |
| Guest DPDK version        | 18.11                                                                       |
| Guest Linux kernel version| 4.4.0-62-generic                                                            |

### Boot and BIOS settings

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Host Boot Settings</td>
<td>hugepagesz=1G hugepages=20 default_hugepagesz=1Gisolcpus=1-40 intel_iommu-on nohz_full=1-40 rcu_noobs=1-40 iommu-pt</td>
</tr>
<tr>
<td>VM Boot Settings</td>
<td>hugepagesz=2M hugepages=512 isolcpus=1-2 nohz_full=1-2 rcu_noobs=1-2</td>
</tr>
</tbody>
</table>
| BIOS                      | CPU Power and Performance Policy <Performance>  
CPU C-state Disabled  
CPU P-state Disabled  
Enhanced Intel® Speedstep® Tech Disabled  
Turbo Boost Disabled    |
| Host Real Time Settings   | echo -l > /proc/sys/kernel/sched_rt_period_us   
echo -l > /proc/sys/kernel/sched_rt_runtime_us   
echo 10 > /proc/sys/vm/stat_interval   
echo 0 > /proc/sys/kernel/watchdog_thresh |
VM Real Time Settings

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>echo 0 &gt; /proc/sys/kernel/watchdog</td>
<td></td>
</tr>
<tr>
<td>echo 0 &gt; /proc/sys/kernel/nmi_watchdog</td>
<td></td>
</tr>
<tr>
<td>echo -1 &gt; /proc/sys/kernel/sched_rt_period_us</td>
<td></td>
</tr>
<tr>
<td>echo -1 &gt; /proc/sys/kernel/sched_rt_runtime_us</td>
<td></td>
</tr>
</tbody>
</table>

Test Case 1 – DPDK PVP RFC2544 zero packet loss test

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIC</td>
<td>Intel® Ethernet Converged Network Adapter XL710-QDA2 (2x40G)</td>
</tr>
<tr>
<td>Driver</td>
<td>i40e DPDK PMD</td>
</tr>
</tbody>
</table>

Test Configuration

- Test tool: IxNetwork 8.40.1400.5 EA
- Qemu Version: 2.11.1, Qemu above 2.8 can support change Vring size using qemu command.
- Vring size: 1024, the max Vring size Qemu support
- Hugepage size: 1G
- Virtio Mergeable: On
- Forward Mode: testpmd mac forward
- Vhost: 1 queue 1 logic core
- Virtio: 1 queue 1 logic core
- Totally 2 logic cores from 2 physical cores are used.

Flow Configuration

- 1 Flow with fixed source and destination IP.

Test Step

1. Bind one 40G NIC port to igb_uio
2. Launch Vhost:
   ```
   ./x86_64-native-linuxapp-gcc/app/testpmd -l 10-11 -n 4 --socket-mem 1024 --vdev 'eth_vhost0,iface=vhost-net,queues=1' -- -i --txd=1024 --rxd=1024 --nb-cores=1
testpmd>set fwd mac
testpmd>start
   ```
3. Launch VM:
   ```
   chrt -f 95 taskset -c 12,13,14 qemu-system-x86_64 -name us-vhost-vml -cpu host -enable-kvm -m 2048 -object memory-backend-file,id=mem,size=2048M,mem-path=/mnt/huge,share=on -numa node,memdev=mem -mem-prealloc -smp cores=2,sockets=1 -drive file=/home/osimg/ubuntu16.img -chardev socket,id=char0,path=./vhost-net -monitor unix:/tmp/vm2_monitor.sock,server,nocleanup -net nic,vlan=2,macaddr=00:00:00:08:e8:aa,addr=1f -net user,vlan=2,hostfwd=tcp:127.0.0.1:6002-:22 -netdev type=vhost-user,id=mynet1,chardev=char0,vhostforce -device virtio-net-pci,mac=52:54:00:00:00:01,netdev=mynet1,mrg_rxbuf=on,rx_queue_size=1024,tx_queue_size=1024 -vnc :10 -daemonize
   ```
4. Bind vdev to igb_uio and Launch Virtio in VM:

```bash
./x86_64-native-linuxapp-gcc/app/testpmd -c 0x3 -n 4 -- -i --txd=1024
--rxd=1024
testpmd>set fwd mac
testpmd>start
```

Test Result:

<table>
<thead>
<tr>
<th>Packet Size (Bytes)</th>
<th>Throughput (Mpps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>64</td>
<td>7.56</td>
</tr>
<tr>
<td>128</td>
<td>6.31</td>
</tr>
<tr>
<td>256</td>
<td>5.04</td>
</tr>
<tr>
<td>512</td>
<td>3.79</td>
</tr>
<tr>
<td>1024</td>
<td>2.78</td>
</tr>
<tr>
<td>1280</td>
<td>2.50</td>
</tr>
<tr>
<td>1518</td>
<td>2.25</td>
</tr>
</tbody>
</table>

![Graph](image.png)

Figure3. DPDK PVP RFC2544 performance with 1core for vhost-user and 1core for virtio
Test Case 2 – DPDK VM2VM iperf performance test

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Case</td>
<td>virtio-net performance test for VM2VM</td>
</tr>
<tr>
<td>Nic</td>
<td>Intel® Ethernet Converged Network Adapter X710-DA4 (4x10G)</td>
</tr>
<tr>
<td>Driver</td>
<td>i40e DPDK PMD</td>
</tr>
</tbody>
</table>
| Test configuration | Qemu Version : 2.11.1 
Hugepage size : 1G 
dequeue-zero-copy: Enabled 
Iperf version: 2.0.5 |
| Core settings | 1 core for vhost-user, and assign each VM 1 core |
| Test step | 1. Bind one 10G NIC port to igb_uio 
2. Launch Vhost with: 
`./examples/vhost/build/vhost-switch -c 0x1c00 -n 4 --socket-mem 2048,2048 --p 0x1 --mergeable 1 --vm2vm 1 --tso 1 --tx-csum 1 --dequeue-zero-copy --socket-file ./host-net --socket-file ./host-net1` 
3. Launch VM1 and run iperf server: 
`taskset -c 13 \` 
`qemu-system-x86_64 -name us-vhost-vml \` 
`-cpu host -enable-kvm -m 4096 -object memory-backend-file,id=mem,size=4096M,mem-path=/mnt/huge,share=on -numa node,memdev=mem -mem-prealloc \` 
`-smp cores=1,sockets=1 -drive file=/home/osimg/ubuntu16.1.img \` 
`-monitor unix:/tmp/vm2_monitor.sock,server,nowait -net nic,vlan=2,macaddr=00:00:00:08:e8:aa,addr=1f -net user,vlan=2,hostfwd=tcp:127.0.0.1:6004:-22 \` 
`-chardev socket,id=char0,path=./vhost-net -netdev type=vhost-user,id=mynet1,chardev=char0,vhostforce \` 
`-device virtio-net-pci,mac=52:54:00:00:00:01,netdev=mynet1,mrg_rxbuf=on,csum=on,gso=on,guest_csum=on,host_tso4=on,guest_tso4=on,guest_ecn=on \` 
`-vnc :10 -daemonize` 
In VM1: 
`ifconfig ens3 1.1.1.2` 
`arp -s 1.1.1.8 52:54:00:00:00:01` 
`iperf -s -i 1` 
4. Launch VM2 and run iperf client: 
`taskset -c 15 \` 
`qemu-system-x86_64 -name us-vhost-vml \` 
`-cpu host -enable-kvm -m 4096 -object memory-backend-file,id=mem,size=4096M,mem-path=/mnt/huge,share=on -numa node,memdev=mem -mem-prealloc \` 
`-smp cores=1,sockets=1 -drive file=/home/osimg/ubuntu16.2.img \` 
`-monitor unix:/tmp/vm2_monitor.sock,server,nowait -net nic,vlan=2,macaddr=00:00:00:08:e8:aa,addr=1f -net user,vlan=2,hostfwd=tcp:127.0.0.1:6005:-22 \` 
`-chardev socket,id=char1,path=./host-net1 -netdev type=vhost-user,id=mynet2,chardev=char1,vhostforce \` 
`-device virtio-net-pci,mac=52:54:00:00:00:02,netdev=mynet2,mrg_rxbuf=on,csum=on,gso=on,guest_csum=on,host_tso4=on,guest_tso4=on,guest_ecn=on \` 
`-vnc :11 -daemonize` 
In VM2: 
`ifconfig ens3 1.1.1.8` 
`arp -s 1.1.1.2 52:54:00:00:00:01` 
`iperf -c 1.1.1.2 -i 1 -t 60`
Test Result:

| Throughput with vhost dequeue zero-copy | 43.5 Gb/s |

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