Research on Testing Technology of Special Data Processor (DPU)

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ABSTRACT: With the rapid development of data centers, customers, data and services will continue to grow, which requires the improvement of the overall system performance synchronization of data centers. Dedicated data processor DPU comes into being. The DPU is positioned as the third main chip in a data center after the CPU and GPU. It can be used to uninstall network and virtualization, security and security protocols, and storage functions, greatly improving the overall performance of a data center. The authenticity, pertinence, comprehensiveness and effectiveness of this special data processor should be considered before testing. Based on these four dimensions, specialized test instrumentation should be used during testing and include multiple test scenarios such as trusted deployment, storage and security protocols, security features and performance, and power consumption measurement.

KEY WORDS: DPU; test; network; safety; storage

With the rapid development of data centers , communication capability and computing capability have become two important development directions that complement each other with data center infrastructure. If the data center only focuses on increasing computing power, and the communication infrastructure cannot keep up with the improvement, then the overall system performance of the data center will still be limited and cannot reach its true potential.

Low power consumption and high efficiency are critical to support scalable, cloud-based services and workloads when computing is performed in a telecommunications network or a very large scale data center environment.At the same time, the continued growth of customers, data and services puts extreme pressure on service providers and data center administrators to improve server performance and productivity while maintaining operating costs.

DPU is positioned as the “third workhorse chip” in data center after CPU and GPU, The chip is able to meet the needs of data centers for efficient networking, processing and migrating data, and functional offloading, and is becoming the tool of choice to achieve these goals through offloading and accelerating to provide maximum performance.Dpu helps virtualization, network storage, graphics processing units to provide any server access to network processing and elastic storage on demand, to enable offloading of various infrastructure operations, to provide software defined and hardware accelerated network, storage, security, and other services.

1 Advantages and applications of DPU

DPU be able to develop one’s skill to full on servers, Dabble in multiple application fields.DPU offloading any function traditionally done by the server frees up the CPU core, Focus on running the application.The following are the applications of Dpu in different areas.

(1) Networking and virtualization

Using network address translation as an example, the DPU implements the NAT capability to map an IP address space to another IP address space.In terms of switching and routing, the DPU can offload switching and routing decisions that are traditionally made by the server and affect server performance.

Enable virtualization infrastructure, Dpus can uninstall the network layer and support other virtualization functions such as SR-IOV and OVS.

(2) Security and security protocols

Such as Internet security protocols, DPU offloading IPSec tunnels is a cost-effective way to protect data in transit while significantly saving host CPU resources.Transport layer security protocol. Deploying TLS protocol is one of the operations that consumes a lot of CPU resources of the server.Using the DPU to uninstall the encryption and decryption of TLS connections reduces the CPU usage of the server.

In terms of security, security has traditionally been done on servers, However, the DPU can flexibly detect and block malware and vulnerabilities to prevent attacks from reaching the server.The DPU can also make decisions based on ACL and flow tables, such as decisions to allow or block certain flows based on patterns and signatures, thus reducing the computing resources that the server needs to make decisions about.

(3) Storage

DPU enables remote direct memory access (RDMA)And RoCE protocol based on Ethernet link layer, And NVME-enabled DPSU can connect hosts to storage devices through a network structure that makes it look like local storage and thus easier for other applications to use.

2 DPU test specifications

During the test, you can analyze DPU indicators in network, security, and storage test scenarios from the following four dimensions.

2.1 Authenticity

The test scenario is an actual application scenario.This requires that test cases not only reflect the most common scenarios, but also

cover a variety of typical long-tail scenarios, and make full use of some of the existing basic testing tools and some mature benchmark procedures to make the best use of everything.

2.2 Pertinence

The test system should be able to highlight the function or performance of specific aspects, to avoid the failure of the test due to other unrelated performance bottlenecks.It is easy to design targeted test benchmark programs and data sets only when the test objectives are specific. Due to the different requirements of different user scenarios, The principle of pertinence is more conducive to users to make reasonable choices. The following three areas should be included in the test indicators are listed.

(1) Network domain

The network domain mainly refers to the functions and performance related to packet processing, For example, if a DPU performs a dual-stack protocol test, ensure that the created service interface is in both IPv4 and IPv6 subnet, that traffic is sent and received correctly, that functions are implemented properly, and that the performance of IPv4 single-stack, IPv6 single-stack, and dual-stack is measured.The acceleration capability of the network after uninstallation is an important basis for various services and computing power on the DPU, and directly affects the upper limit of other services and computing performance.Therefore, the test indicators should at least include function indicators such as support for dual stack, OVS-DPDK uninstallation, ACL, flow statistics, and packet forwarding.IPv4 single-stack, IPv6 single-stack, dual-stack network forwarding, VxLAN forwarding and other performance indicators

(2) Security field

Security scenarios refer to functions that directly support security attributes at different logical levels, If the DPU is performing an SSL uninstall, ensure that it can terminate and restart SSL connections at different passwords and key sizes, as well as performance metrics for public key exchange and bulk encryption.Therefore, the DPU not only accelerates network data packets in the server, but also accelerates the uninstallation of common network security protocols and algorithms.Therefore, the test indicators should include at least functional indicators such as IPSec protocol uninstallation, TLS protocol uninstallation, national secret algorithm uninstallation, IPSec protocol forwarding performance, and TLS protocol forwarding performance.In addition, the DPU is the first key network element for the server to receive packets. Therefore, the DPU must support certain attack defense capabilities. The test indicators must include at least broadcast storm suppression, ping flood, and tcp flood defense capabilities.

(3) Storage domain

Storage scenarios refer to functions and performance related to data storage, If the DPU is uninstalling storage virtualization QoS, ensure that Virtio-blk disks can be mounted correctly and data read and write values of different QoS rates are consistent with expectations. Storage uninstallation on a DPU connects computing power to storage services, and provides computing power, storage elastic scaling, and high-performance parallel I/O read and write capabilities for high-performance computing scenarios in which storage and computing are separated.Therefore, the test specifications include at least RDMA unilateral operation, RDMA bilateral operation, data compression, decompression and uninstallation, basic NVME-oF functions, storage virtualization QoS, and IOPS read/write speed performance specifications.

2.3 Comprehensiveness

From the function perspective of DPU, it should include the test of network, security and storage, In addition, some combination tests such as “network + storage” and “network + security” can be constructed to more fully reflect the application effect of DPU.

2.4 Validity

Quantifiable performance differences, such as CPU usage and memory usage, must be displayed during the test. Perform the same tests before and after the DPU is uninstalled and before and after the application is accelerated to compare whether the overall performance efficiency can be improved.

3 DPU test tools and scenarios

To ensure authenticity and effectiveness, you need to simulate a business background model that is closer to real application scenarios. To solve this problem, professional testing instruments can be used to test. This type of testing instrument integrates complex traffic models of multiple protocols and applications, which can simulate real network behavior and protocol interaction.

At present, there are two types of test instruments, namely virtual test instrument software and hardware test instrument.□1□If the virtual test meter software is used, the software is deployed on the server where the DPU resides and connects to services related to DPU uninstallation□For example, OVS and SR-IOV and so on□, The service model between different tenants, tenant to external, and external to tenant can be simulated and realized on the device under test.The virtualization meter software also emulates a large number of ports, and each port can be independently bound to different OVS, PF, and VF interfaces.□2□When hardware test meters are used, the virtual test meter software can simulate the external to tenant service models in network scenarios and security scenarios with high service throughput required for performance indicator tests.Combining the features supported by the virtual test meter software and the hardware test meter, the following four test scenarios are envisaged.

(1) Test Scenario 1 - Trusted deployment

Test traffic from external application clients entering the server through the DPU.This test can determine that the DPU can be deployed in the server normally, and when the DPU is used as a network adapter part of the functional test.

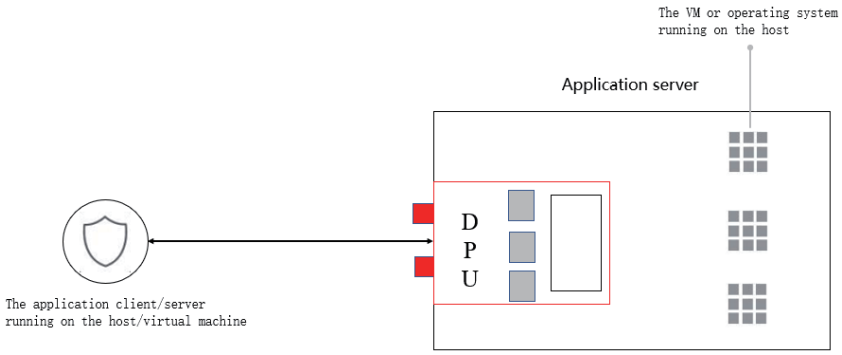

Figure 1 Trusted deployment scenario diagram

(2) Test scenario 2 - Storage and security protocols

The test traffic comes from the test client on one host and goes through the DPU of both hosts to the other host.In this scenario, most storage indicators can be tested. By configuring different types oF storage backends such as NVme-of, Ceph, and iSCSI on the DPU, and mounting different types of disks such as Virtio-blk and NVMe on the DPU, the two servers use the DPU to perform data read/write verification and performance parameters.In this scenario, you can also test functions of security protocols, such as IPSec, TLS, and national secret algorithms.

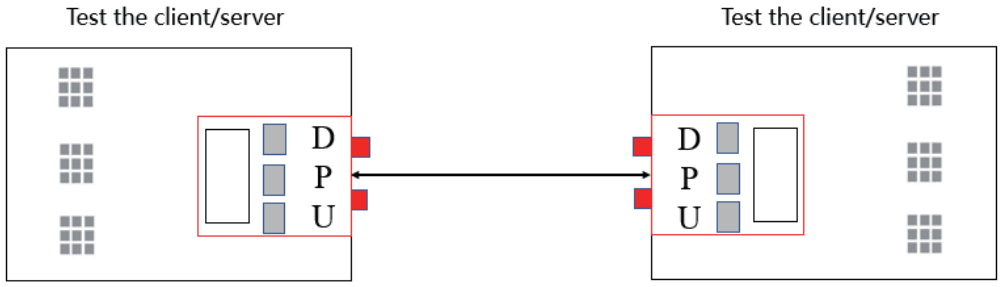

Figure 2 Storage and security protocol scenario diagram

(3) Test scenario 3 - Network, security functions, and performance

The virtualization test meter software is installed on the virtual machine, enabling the virtual machine to interact with the virtual machine, the virtual machine to the external traffic simulator, and the host to the external traffic simulator to verify network and security-related functions and performance.

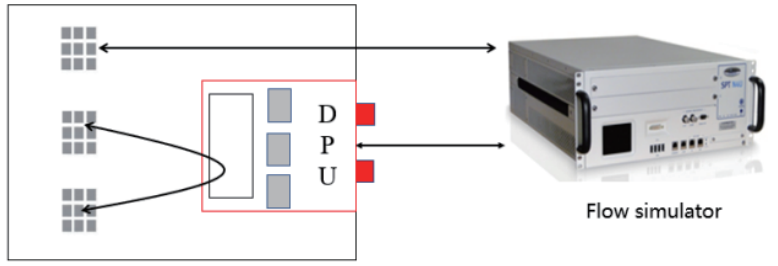

Figure 3 Network, security functions, and performance scenarios

(4) Test Scenario 4: Power consumption measurement

Directly connecting the external power table to the server measures the power consumption of the DPU by measuring the power difference before and after the DPU is installed, The virtual test instrument software installed in the server and external traffic simulator can also be used to observe the light load and full load power consumption.

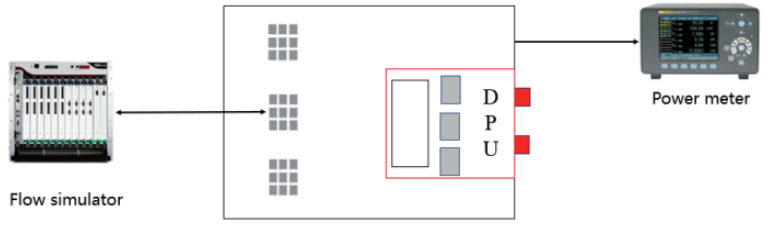

Figure 4 Power consumption measurement scenario

4 Conclusion

DPU is a product with high flexibility for data centers. At present, the development of DPU is still in the early stage. It can realize network, storage and security scenarios, and DPU can provide specialized performance improvement and high efficiency for these scenarios. Therefore, to establish a meaningful DPU test scheme, the key is to think about the definition of its application function. The difficulty of the so-called "test" is not to compare the power consumption, area and other physical parameters, but to test whether it can play a real power in different scenarios to release the CPU, memory and other resources of the device.

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