Agilio® TCO Study

IDLE RESOURCES ARE THE WORST USE OF DATA CENTER SPENDING AND GENERALLY VIEWED AS MONEY GOING DOWN THE DRAIN. THE WAY OPERATORS ARE SOLVING THIS PROBLEM IS BY INTRODUCING SOFTWARE-DEFINED NETWORKING (SDN) INTO THEIR ENVIRONMENT IN ORDER TO INCREASE NETWORK AGILITY.

HOW SERVER-BASED NETWORKING IMPACTS TCO

In a modern data center, servers are accountable for nearly half of the costs associated with operating a data center. Other data center costs include infrastructure, power consumption and hardware networking (cabling, switches, patch panels, etc). As a result, optimizing on dimensions such Gb/s per dollar and/or PPS (packets per second) per dollar are critical. Another way operators are optimizing cost is by maximizing their data center utilization of resources at a given time. Idle resources are the worst use of data center spending and generally viewed as money going down the drain. The way operators are solving this problem is by introducing software-defined networking (SDN) into their environment in order to increase network agility. This is done through simplifying the network design to maximize bandwidth between data center servers, introducing programmability of the fabric through use of centralized control, and lastly pushing more networking tasks to the servers. With this model, operators can gain programmatic control over all of the resources, which provides quick and easy control over how servers are utilized. There is one downside, however, and that is the effect on the server due to the increased reliance on server-based networking.

What enables the programmatic model to work effectively is the use of a virtual switch (vSwitch) on the host. The most commonly used vSwitch implementation is Open vSwitch (OVS). OVS is critical to the success of these implementations. OVS hosts rule and flow entries responsible for directing traffic into and out of tunnels and VMs, translating or modifying packet headers, and enforcing access control and security. The challenge is that running OVS on the server is expensive from a CPU cycle perspective. The number of CPU cores that are dedicated to the vSwitch to execute the workload directly impacts performance of the vSwitch. However, as more CPU cores are allocated to vSwitch operation, lesser numbers of cores are available for virtual machine (VM) and application execution. This limits the effective output of an individual server, having negative effects on PPS/dollar. When applying the PPS/dollar penalty across data centers of medium and large scales, the cost impacts are extremely high.

Data Center Capacity of 500 Billion PPS

This example will compare the CAPEX and 3-Year OPEX for a virtualized data center built with Agilio CX SmartNICs accelerating the OVS datapath, as compared to basic NIC adapters with OVS running in the host CPU kernel. The comparison assumes an Intel-based server with 16 Physical CPU cores (dual socket, 8 core CPU) and a 40GbE network interface. The cost per server is $2,500 and the cost per Top-of-Rack switch is roughly $8,500.

The assumption in the model is that each VM in the data center can process 1Mpps per CPU core assigned to it. VM workloads can greatly vary when it comes to PPS output, however 1Mpps is a reasonable average. To support a data center output of 500 Billion PPS with a VM capacity of 1Mpps, a total of 500K VMs must be deployed with one CPU core assigned to each VM. To support packet I/O to the VMs, OVS must also be present and its CPU consumption must be accounted for in the model.

The breakdown in footprint and costs are as follows:

- Total PPS Rate Output for Data Center: 500 Billion PPS
- Total CPU Cores Needed for VMs: 500K
- Total CPU Cores Needed for OVS: 1.67M
- Total Servers Needed in Data Center: 135,417
- Total number of ToR Switches: 6,771
- CAPEX: $396M
- 3-Year OPEX: $304M

NETRONOME'S FAMILY OF AGILIO SMARTNICS OFFER THE ABILITY TO OFFLOAD AND ACCELERATE OVS WORKLOADS AT A FRACTION OF THE CPU CONSUMPTION THROUGH THE USE OF AGILIO SOFTWARE.

The costs are most impacted by the resource requirement for OVS. Recall that OVS is required for network agility so that operators can achieve optimal utilization across the data center. Unfortunately the agility comes at a high cost penalty.

Netronome's family of Agilio SmartNICs offer the ability to offload and accelerate OVS workloads at a fraction of the CPU consumption through the use of Agilio software. This translates to major savings across data centers of any size. Because the Agilio software integrates with OVS, original control plane interfaces are used and the network-programming model is preserved. The benefit is retaining the network agility achieved using server-based networking, but at higher performance and reduced CPU and server footprint. Consider the same model presented above, but with Agilio SmartNICs and software in use for offload:

METRIC	BASIC NIC WITH HOST OVS	AGILIO SMARTNIC AND SOFTWARE	DELTA (SAVINGS)
Total Mpps in the data center	500 Billion PPS	500 Billion PPS	–
Number of CPU cores needed for applications	500K	500K	–
Number of CPU cores needed for OVS	1.67M	35.7K	1.63M
Total number of servers in data center	135,417	33,482	101,935
Total number of ToR switches in the data center	6,771	1,674	5,097
Total CAPEX	$396M	$98M	$298.2M (~75% savings)
3-year OPEX	$304M	$33M	$270.4M (~75% savings)

Because the amount of CPU resources consumed by OVS are fixed, the cost savings in the comparison grow linearly as the data center capacity increases. This offload and reduction in footprint allow data center business managers to decide if cost reduction and savings are

desired or if revenue expansion is desired through increasing VM density per server. Viewing the model a different way, the Basic NIC with Host OVS suggests that with 135K servers the total data center output is 500 Billion PPS, or 3.7Mpps per server. When using the Agilio SmartNIC and software each server can generate 15Mpps of output, a 4X gain. This output gain suggests using the original server footprint with Basic NICs and Host OVS (135K servers) but with the output achieved through Agilio, the total data center output would increase to 2 Trillion PPS. This would translate to a 4X gain in VM capacity, and therefore equal revenue gain with virtually no impact on data center cost.

For more information on Agilio SmartNICs and software, please visit the product and solution pages at www.netronome.com. The same TCO calculator described in this paper is available on the Netronome website as well, allowing data center operators to calculate the savings they would realize based on their data center size.

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