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-Applicability to general enterprise data center

Placing SDN devices at edge switches to separate IP core fabric and end-host network can also be applicable in general enterprise data center as a technique to scale out the number of end-hosts without changing the topology of underlay network or address/location consideration. This trend sets forth as premise simpler routing rule at underlay network, while requiring network virtualization at the edge network devices. VL2 separates location address (LA) and application address (AA), which respectively represent Top of Rack(ToR) address (underlay network) and end-host addresses (application servers). It encapsulates AA by LA at ToR level, and those mappings between AAs and LAs are managed by the VL2 directory system. To handle broadcast such as ARP or DHCP, it places a shim layer at every end-host O/S network stack to intercept broadcast traffic and invokes directory service from data center.

-Scalability consideration

Given that Open vSwitch allows 1 million flow entries, it is safe to say that PARES implemented with Open vSwitch as edge switch has more than enough capacity to scale to typical deployments. Let us assume the scenario with 50- ports edge switch and a hypervisor at each port for a total of 50 hypervisors. Assume each hypervisor contains 10 VMs. In the worst case, all 5000 VMs belong to different tenants (although it rarely happens, since MTDC tries to colocate VMs belonging to the same tenants on the same hypervisor.). If we assume 100 VMs per tenant, the total flow entries required is 100K.

The scalability in hardware OpenFlow edge switches can be limited by specification of corresponding hardware OpenFlow devices. Flow entries in typical hardware OpenFlow ranges around 100K entries. Although it is one tenth of the software one, it is enough size for above usage scenario. Moreover, hardware OpenFlow switch guarantees line rate irrespective of the flow table sizes, while large flow entries in software switches potentially incur cache evictions leading to performance degradation. Currently, full implementation of HW OpenFlow switch with TCAM is costly. However, this problem can be overcome as SDN implementations become prevalent.

In order to provide multi-tenancy in data center or to extend Layer 2 semantics upon the Layer 3 network data center, “map and encapsulation” has been widely used in the literature and applications in industry. The advantages of PARES are that there is no need for the modification on end-host O/S, nor requirement of computing resources from end-host hypervisor or servers, since it directly handles ARP and DHCP protocols on edge switches to separate Layer 2 semantic from the end servers to IP core layers. Experimental results show that PARES provides scalable line rate multi-tenancy virtualization at 10 Gbps without sacrificing end-host computing resources.