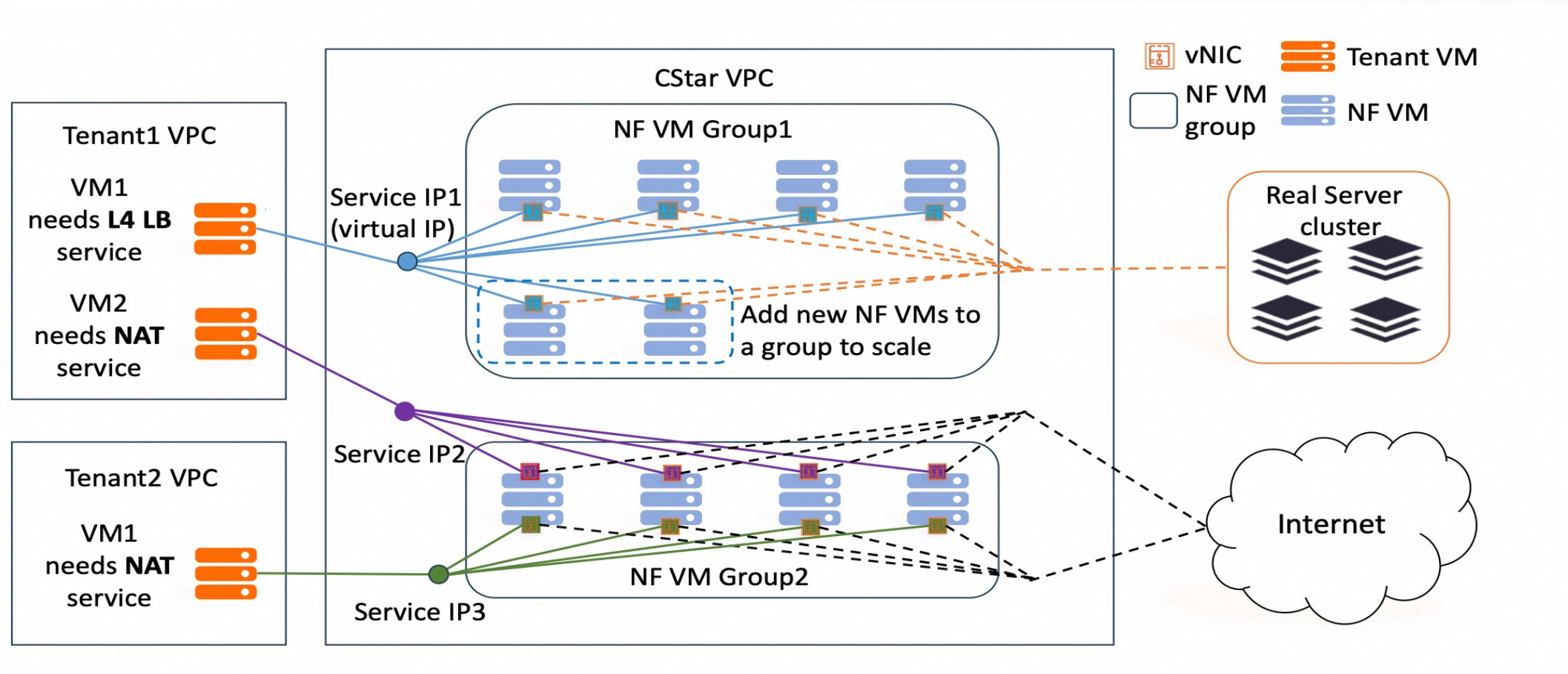


Augmenting Public Cloud Infrastructure for Heterogeneous Network Function Virtualization

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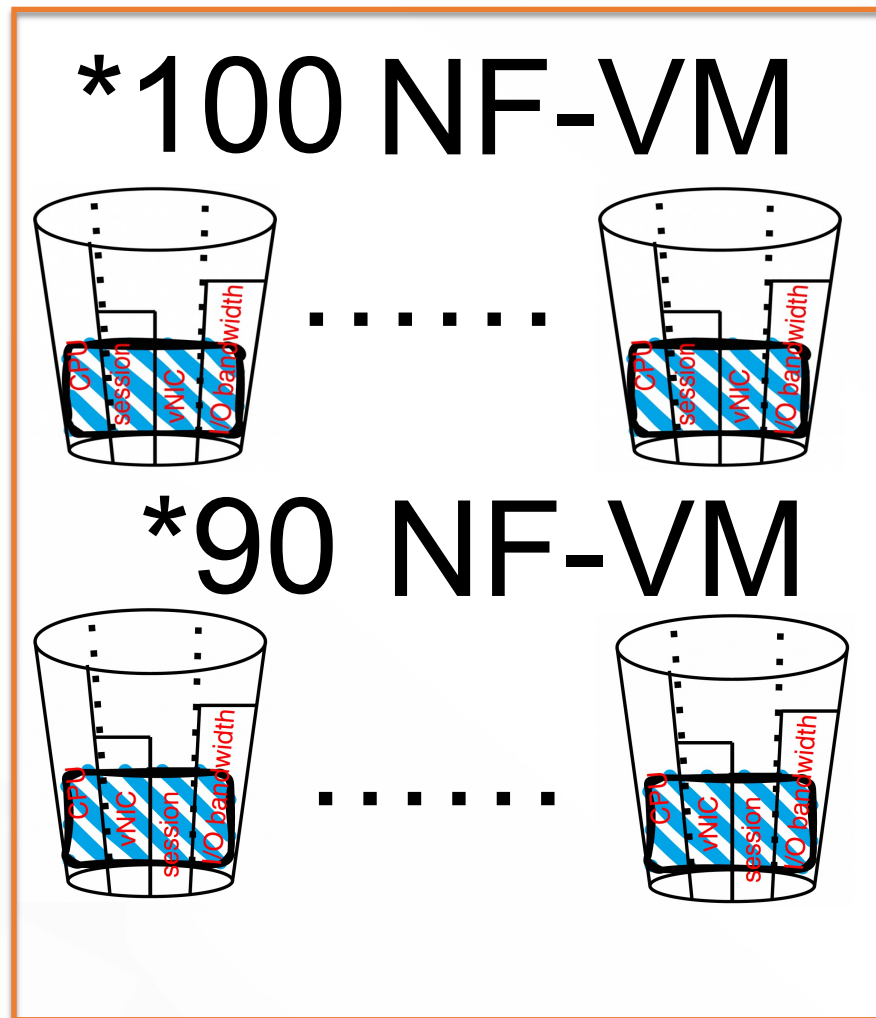
BACKGROUND: VM-based NFV Architecture



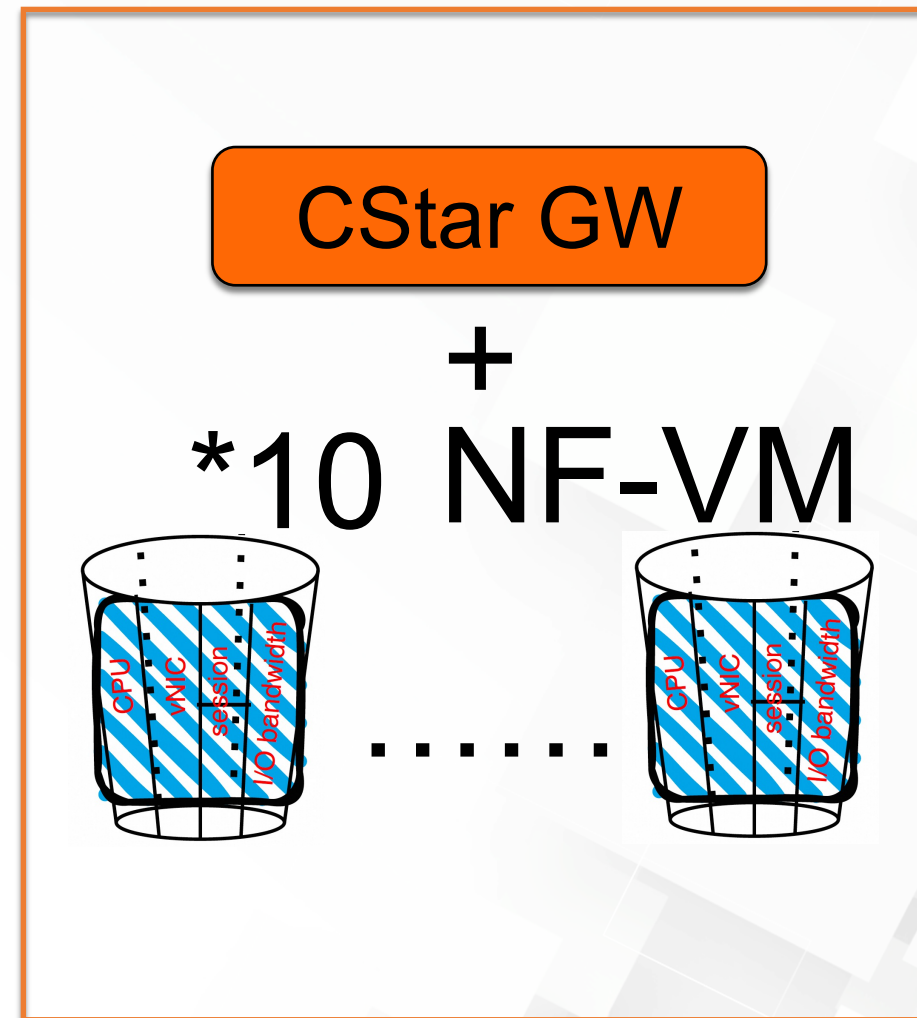
- Implementing network functions (e.g., LB, NAT) using **standard VMs**
- Allocate a **service IP** to the tenant to access the NF-VM
- Use **multiple** NF-VMs to form **a group** to handle traffic for a single tenant

The barrel effect in VM-based NFV

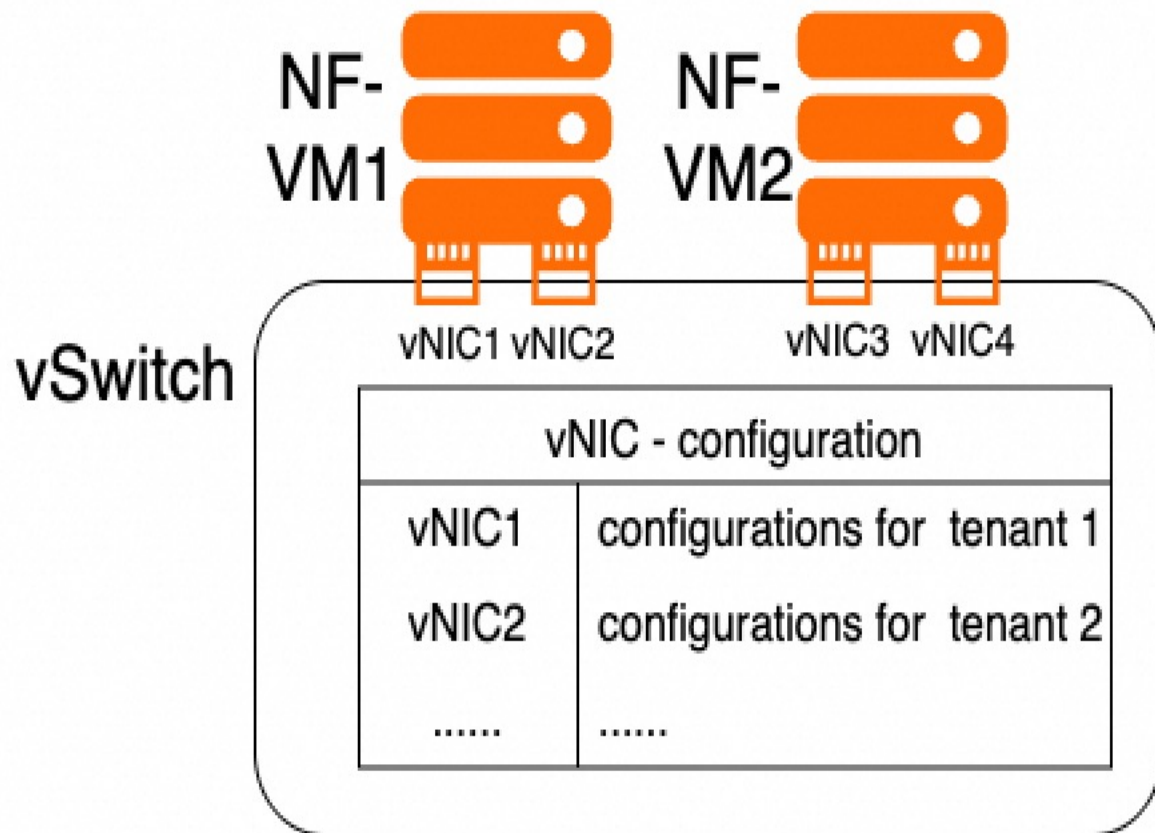
Resource limitations require us to
allocate more VMs.



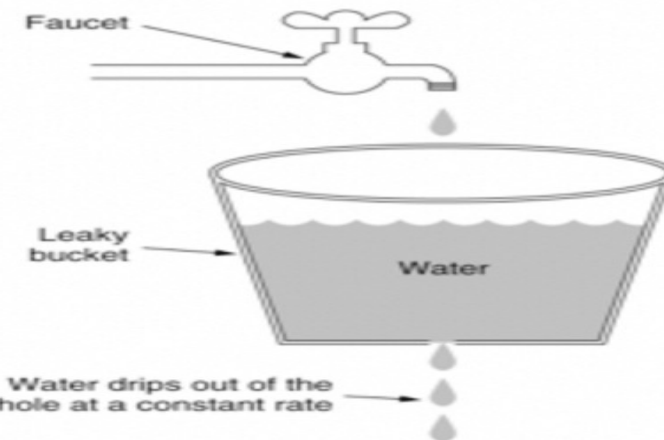
Use **CStar GW** to compensate for the
resource shortcoming and **reduce overhead.**



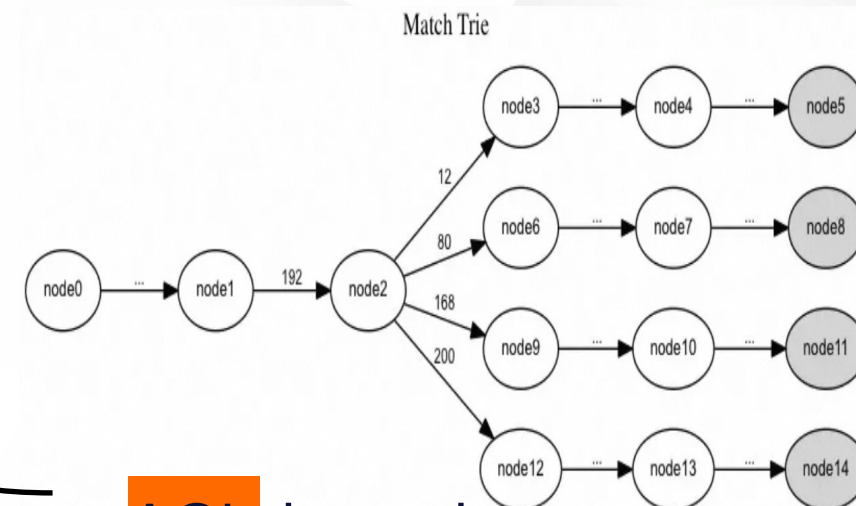
BACKGROUND: vNIC



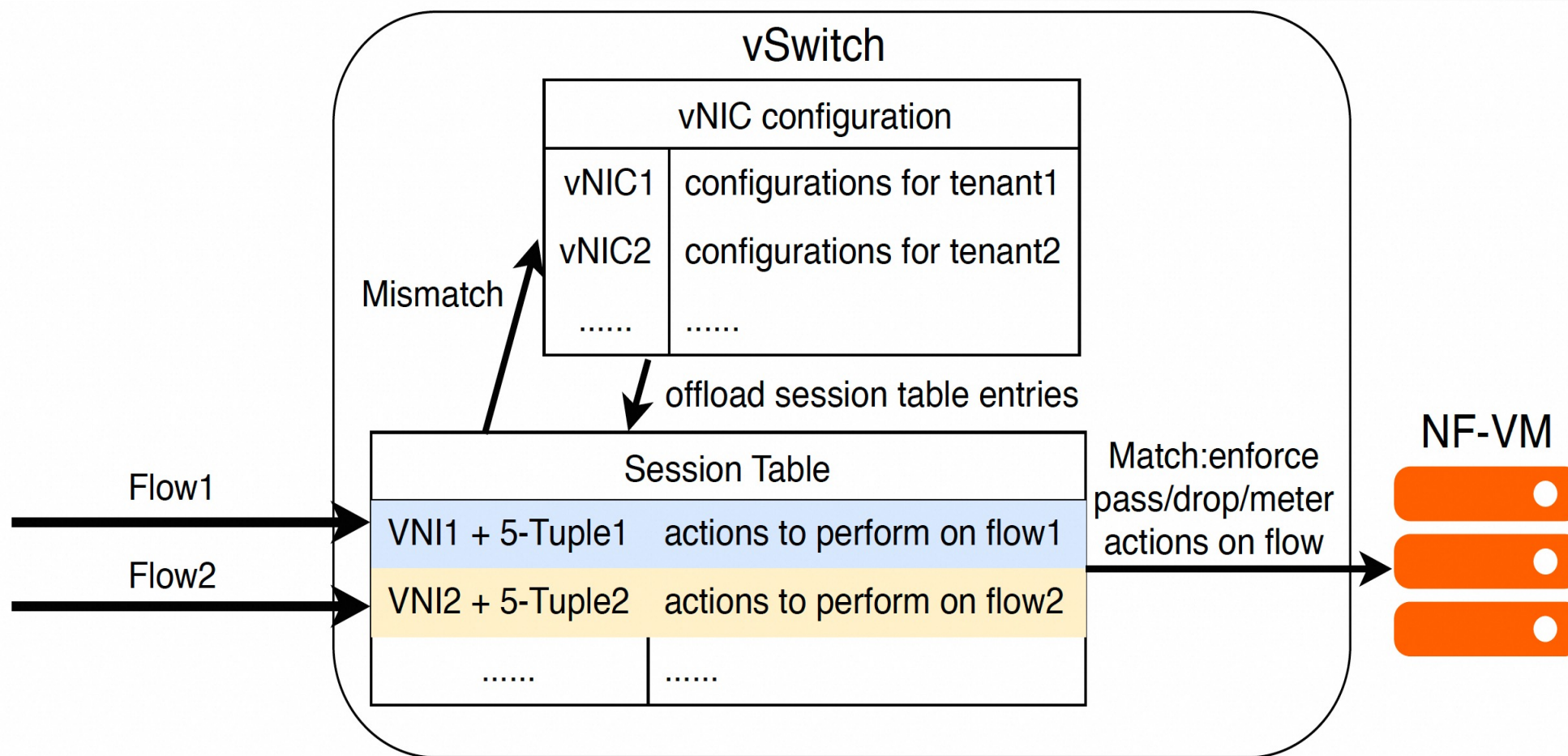
Tenant1's
vNIC
configurations



Rate limiting based on
the leaky bucket

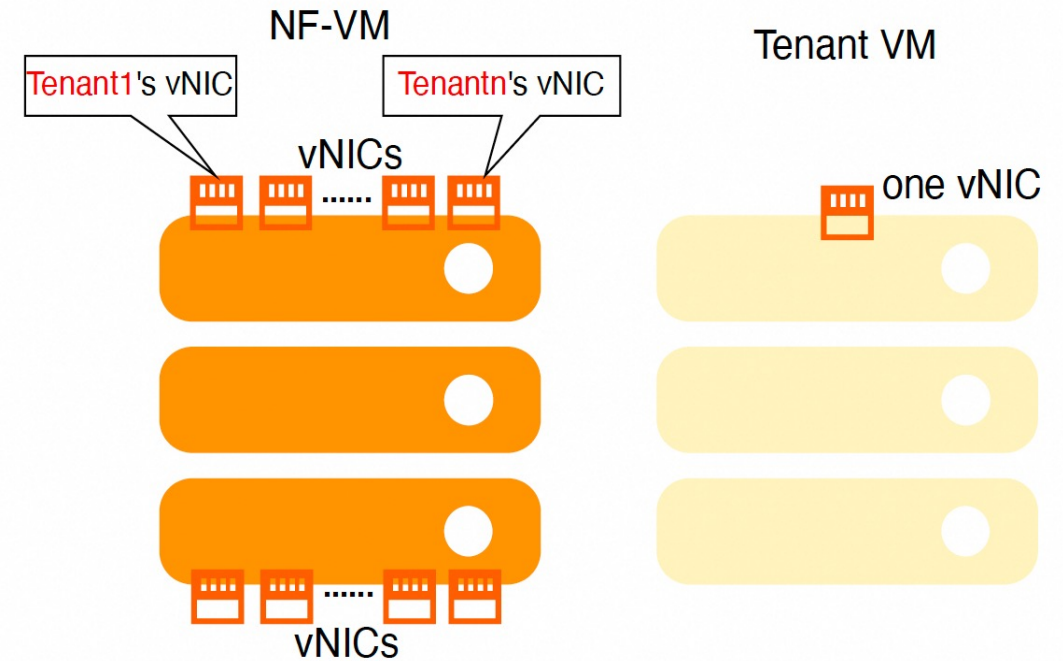
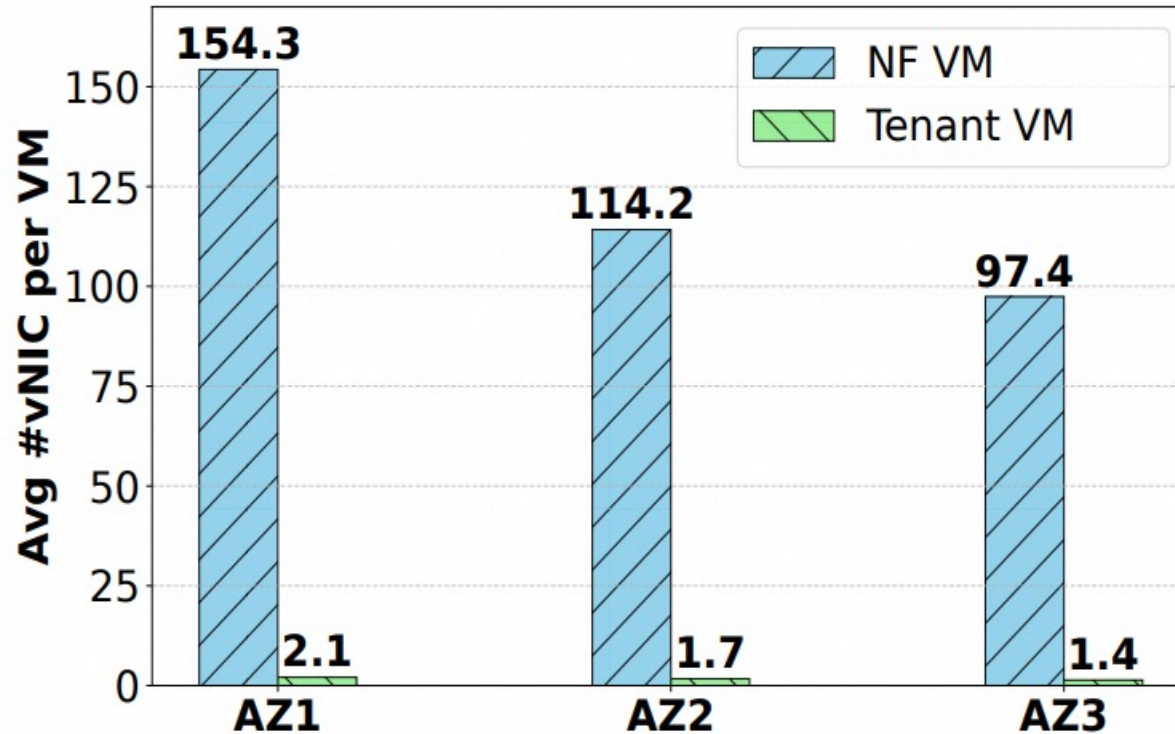


ACL based on
the trie tree based security groups



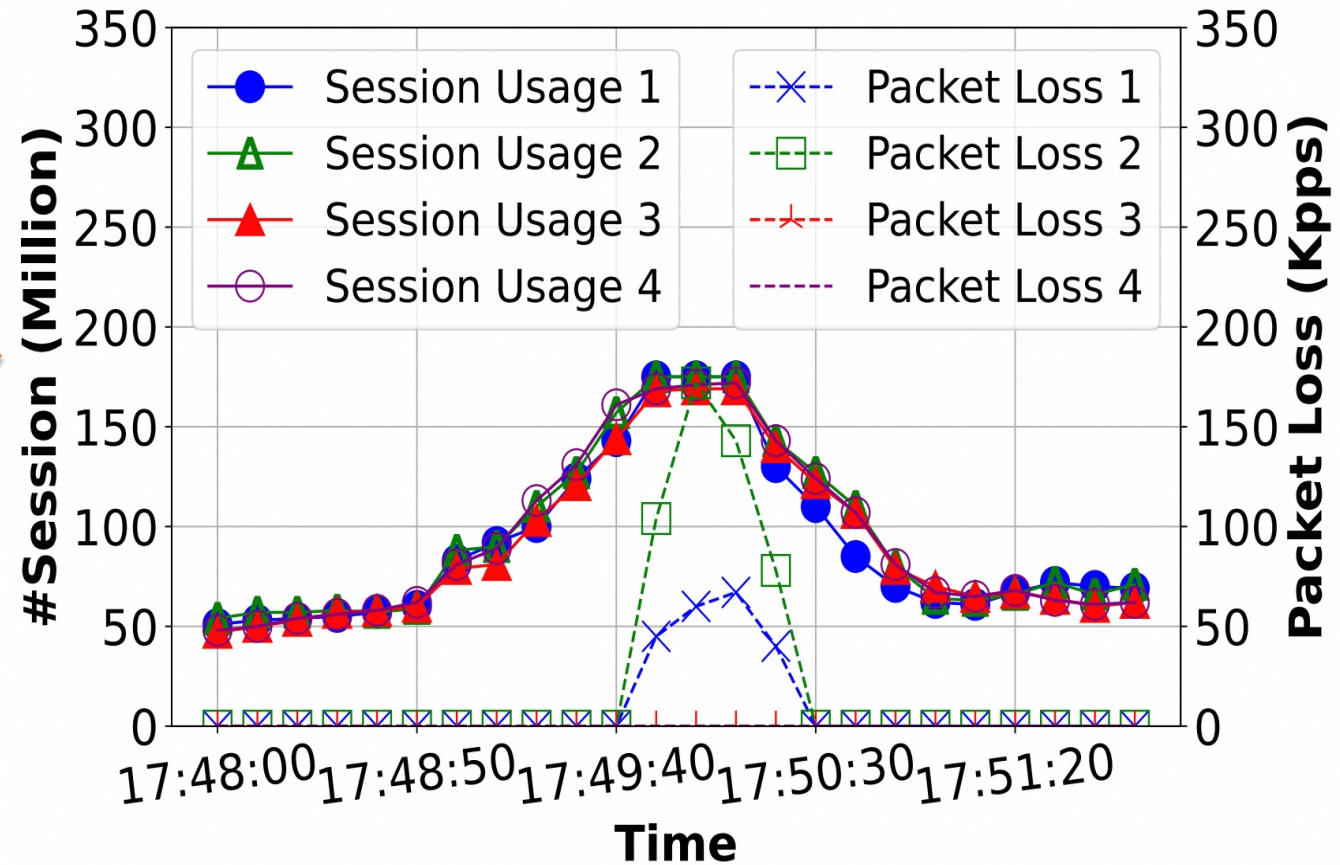
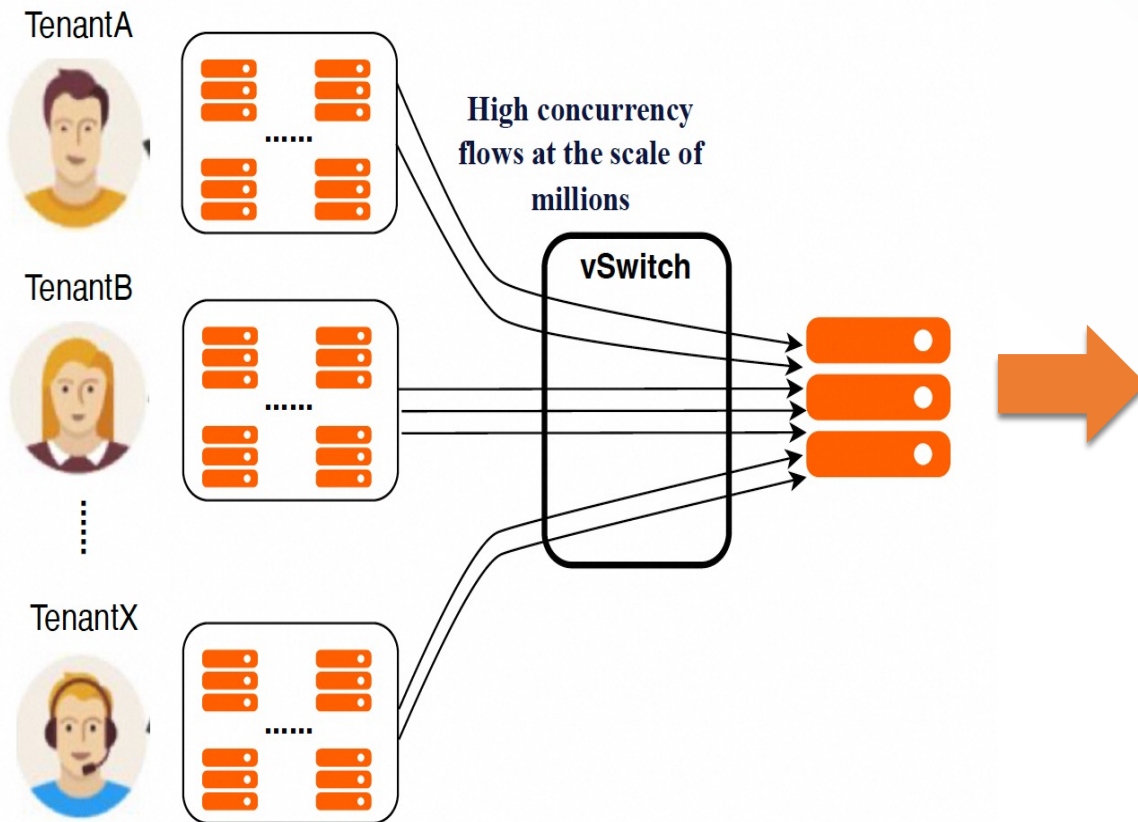
The vSwitch records the flow's session at the granularity of the VXLAN layer VNI and the inner five-tuple.

NF's massive occupation of vNICs provided by vSwitch.

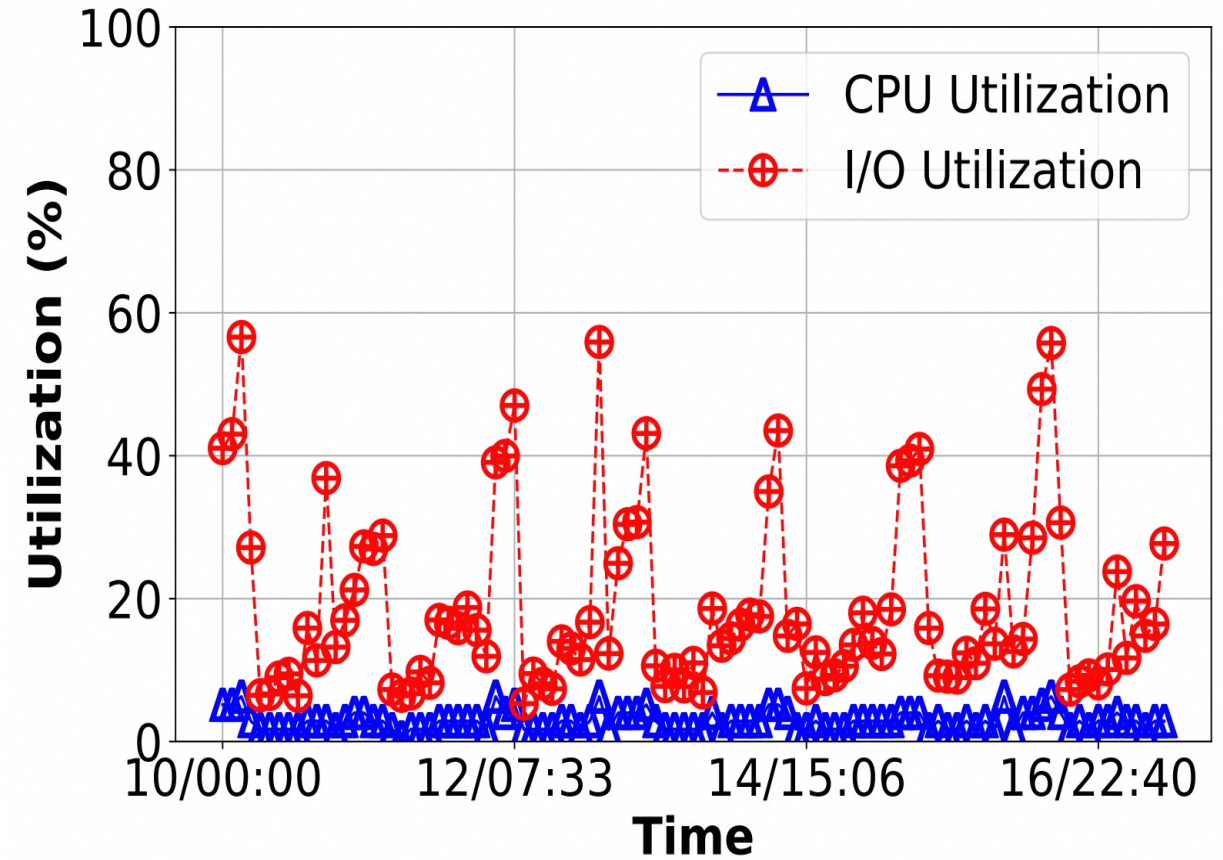
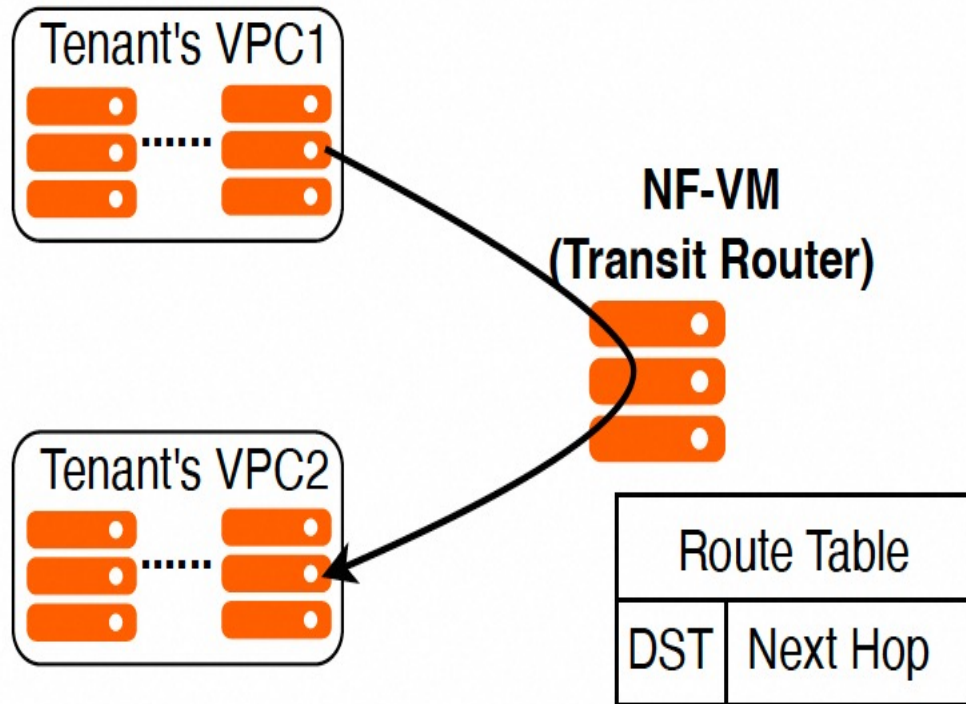


NF-VM requires **multiple vNICs** to differentiate traffic among multiple tenants.

NF's massive occupation of sessions in vSwitch.



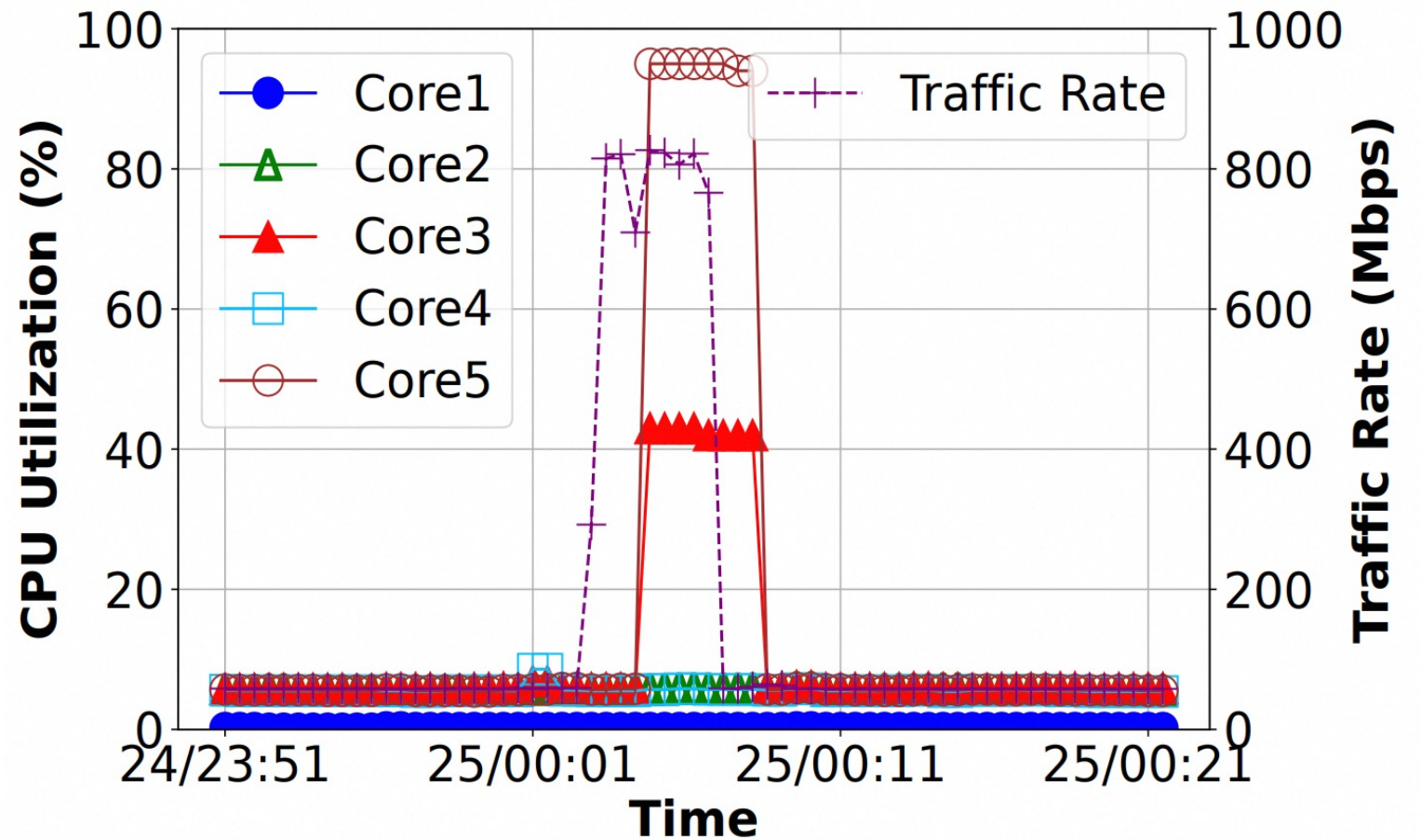
NF's I/O bandwidth can be saturated despite low CPU load.



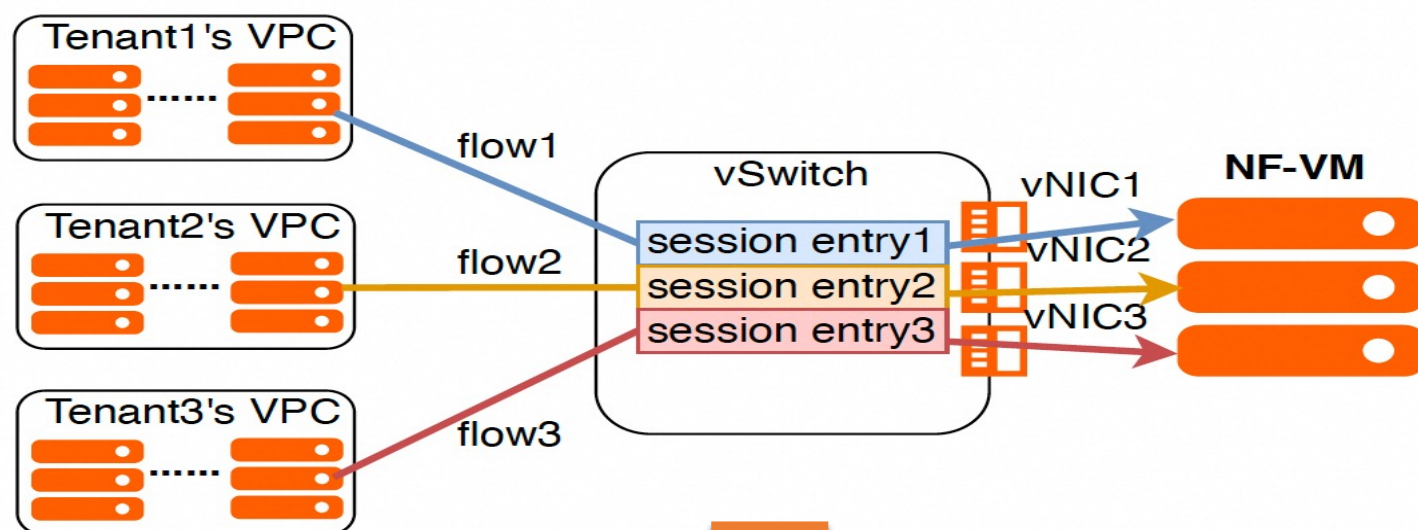
NF's CPU can be overloaded by heavy-hitter flows



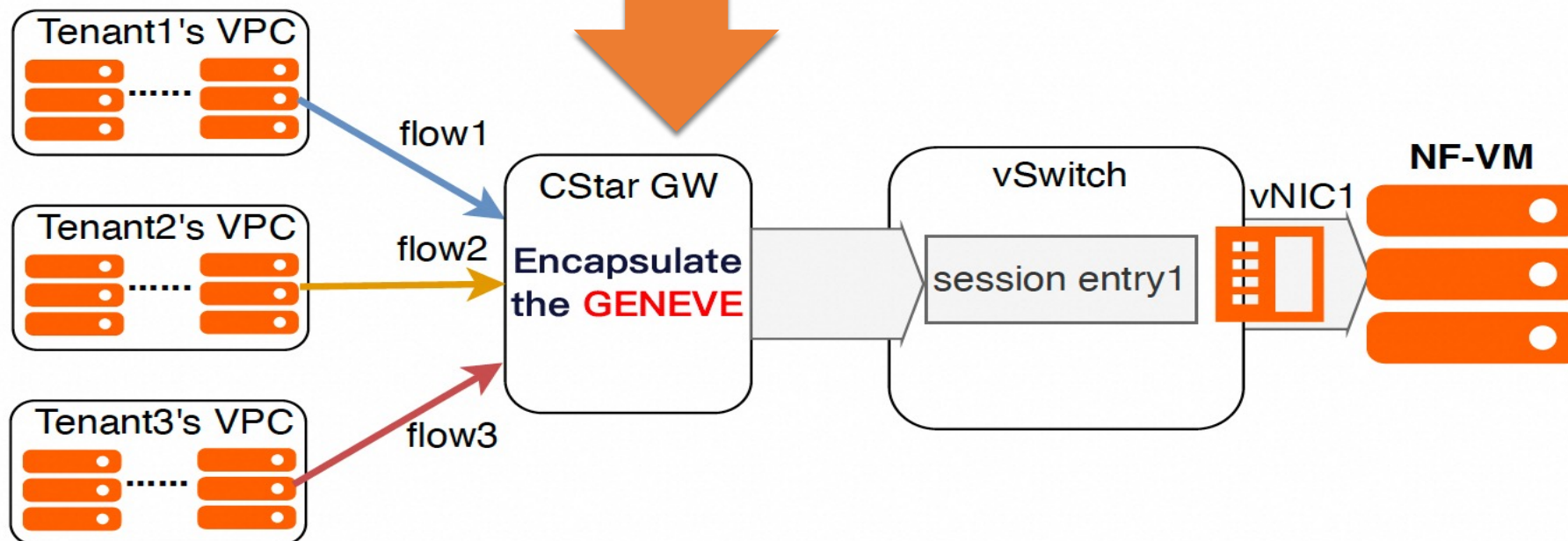
heavy-hitter flows



Overview

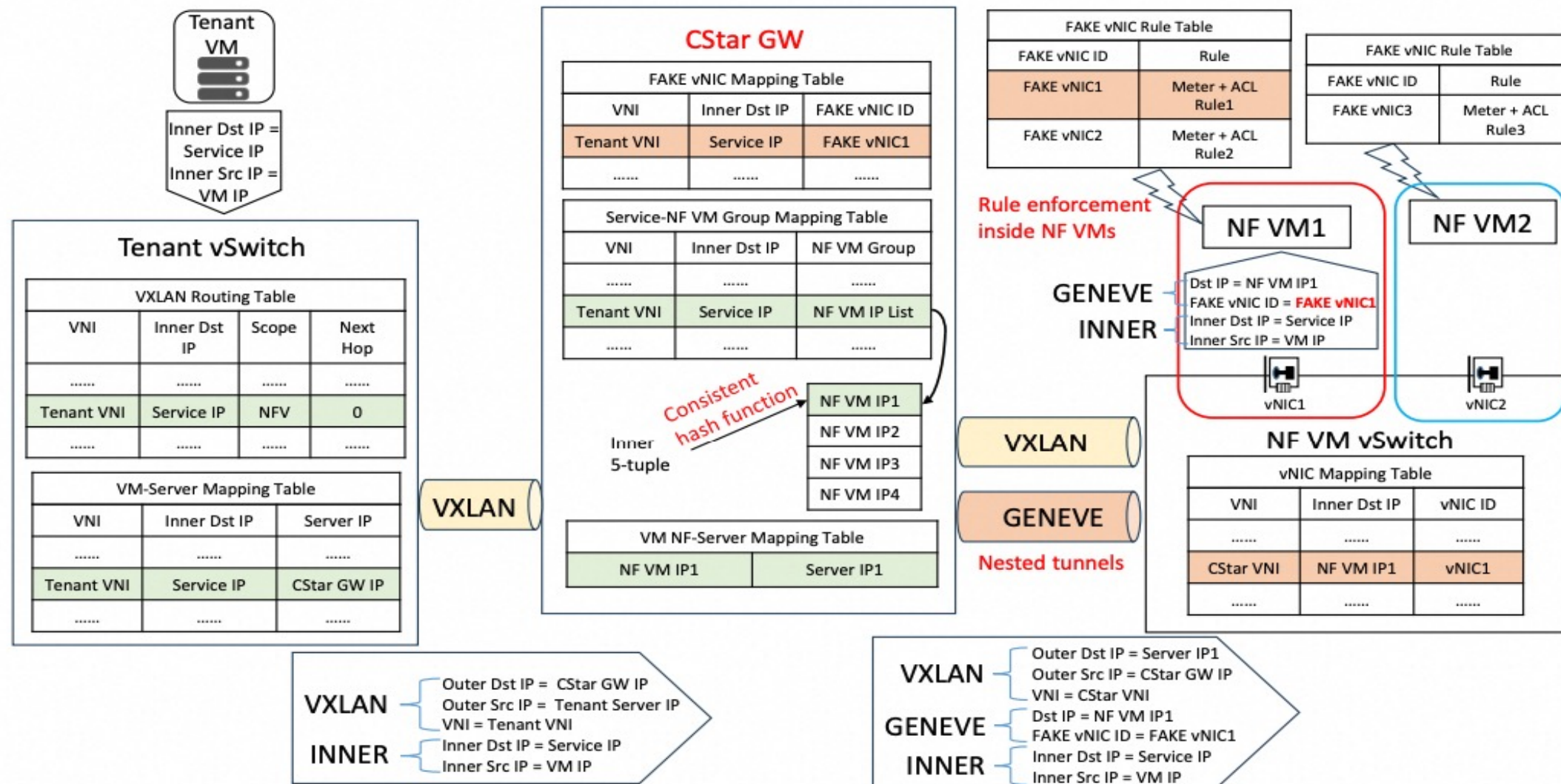


Without GW



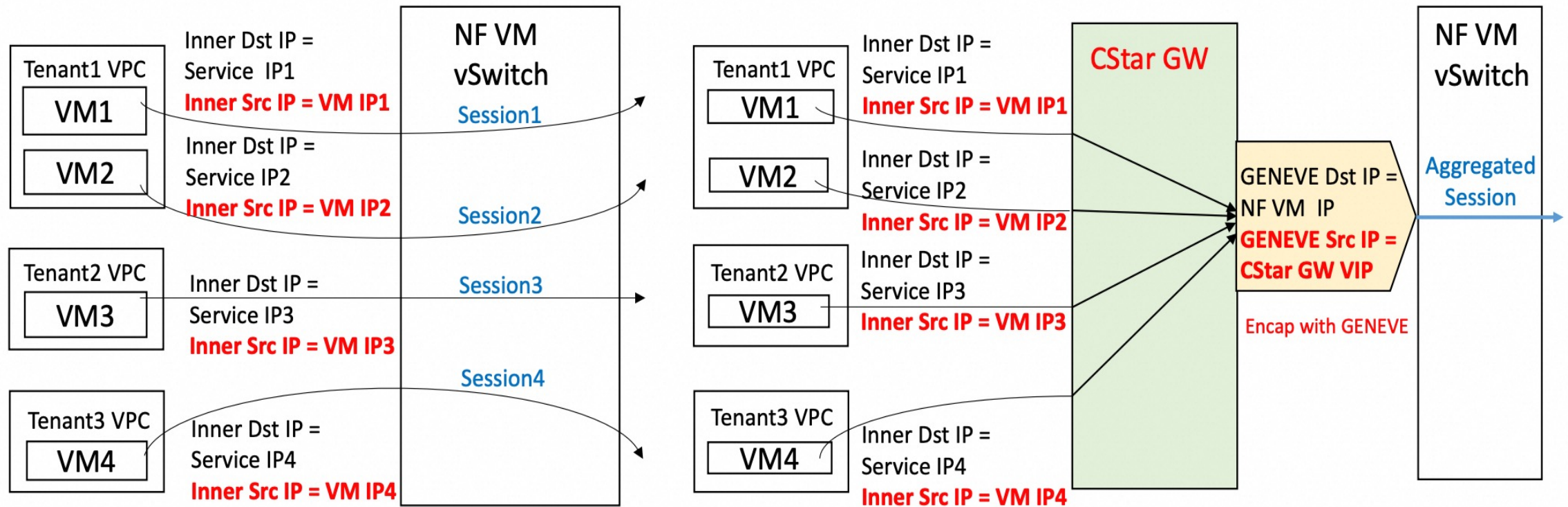
With GW

vNIC overhead reduction through NF-specific configuration encapsulation in nested tunnels

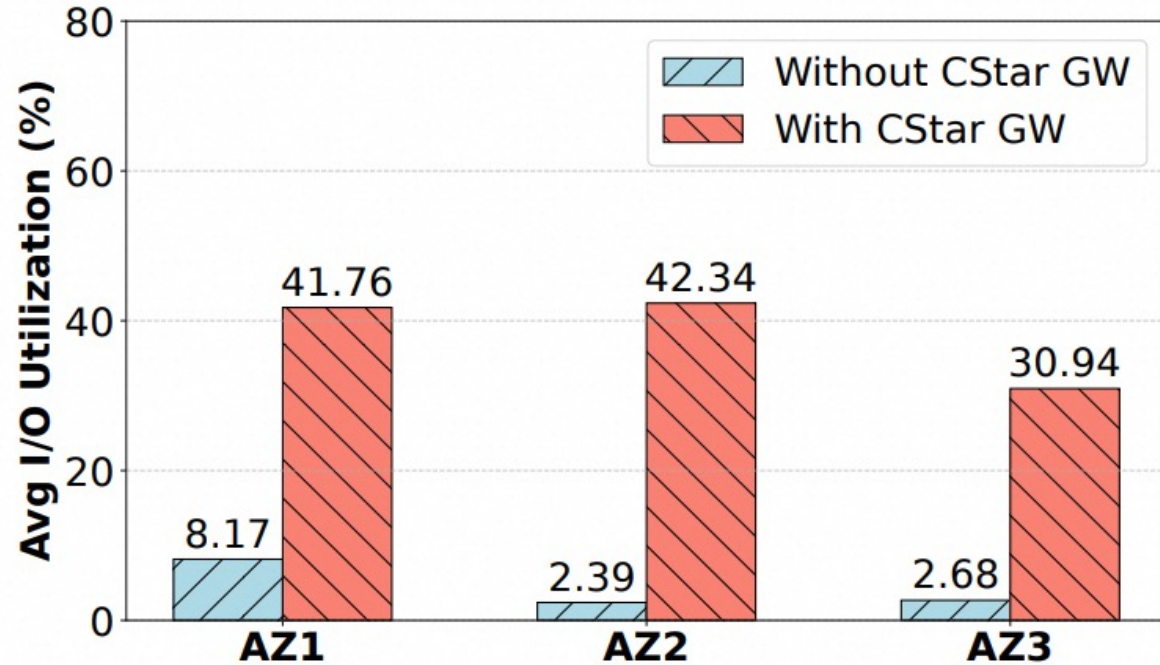


DESIGN

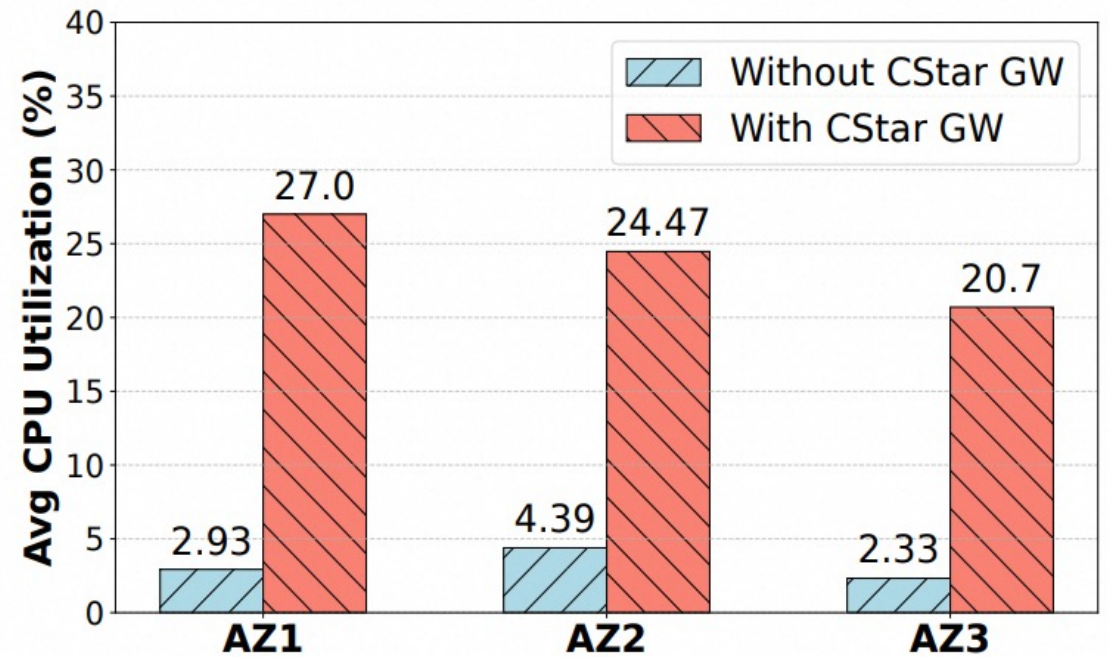
Session aggregation via tunnel encapsulation at the gateway



- The CStar GW **reduces the number of sessions** the vSwitch needs to track by adding an additional **GENEVE layer with a unified five-tuple** based on the inner layer.



I/O utilization improvement
with CStar GW



CPU utilization improvement
with CStar GW

After deploying the CStar GW, the average I/O and CPU utilization of VMs across the three AZs improved by **at least five times.**

The number of NF VMs allocated in the AZs before and after the deployment of CStar GW.

	AZ1	AZ2	AZ3
Without CStar GW	92	124	127
With CStar GW	18	7	11

In the three AZs, the number of NF-VMs used **decreased by 80%, 94%, and 91%**, respectively, **after deploying the CStar GW** compared to when it was not used. It significantly **reduces the cost of purchasing VMs**, thereby increasing the cloud provider's profit.

In this work, we introduce the CStar GW and design a set of nested tunneling-based protocols to address the resource mismatch problems including limitations in vNICs and sessions for the vSwitch to host NF VMs when building scalable NFV products using standard VMs.

This solution significantly reduces the cost of deploying NFV systems on public clouds based on standard VMs, without requiring intrusive changes to the underlying cloud virtualization architecture. It offers a viable path for other cloud service providers seeking to deliver cost-effective, cloud-based NFV services.

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Q & A