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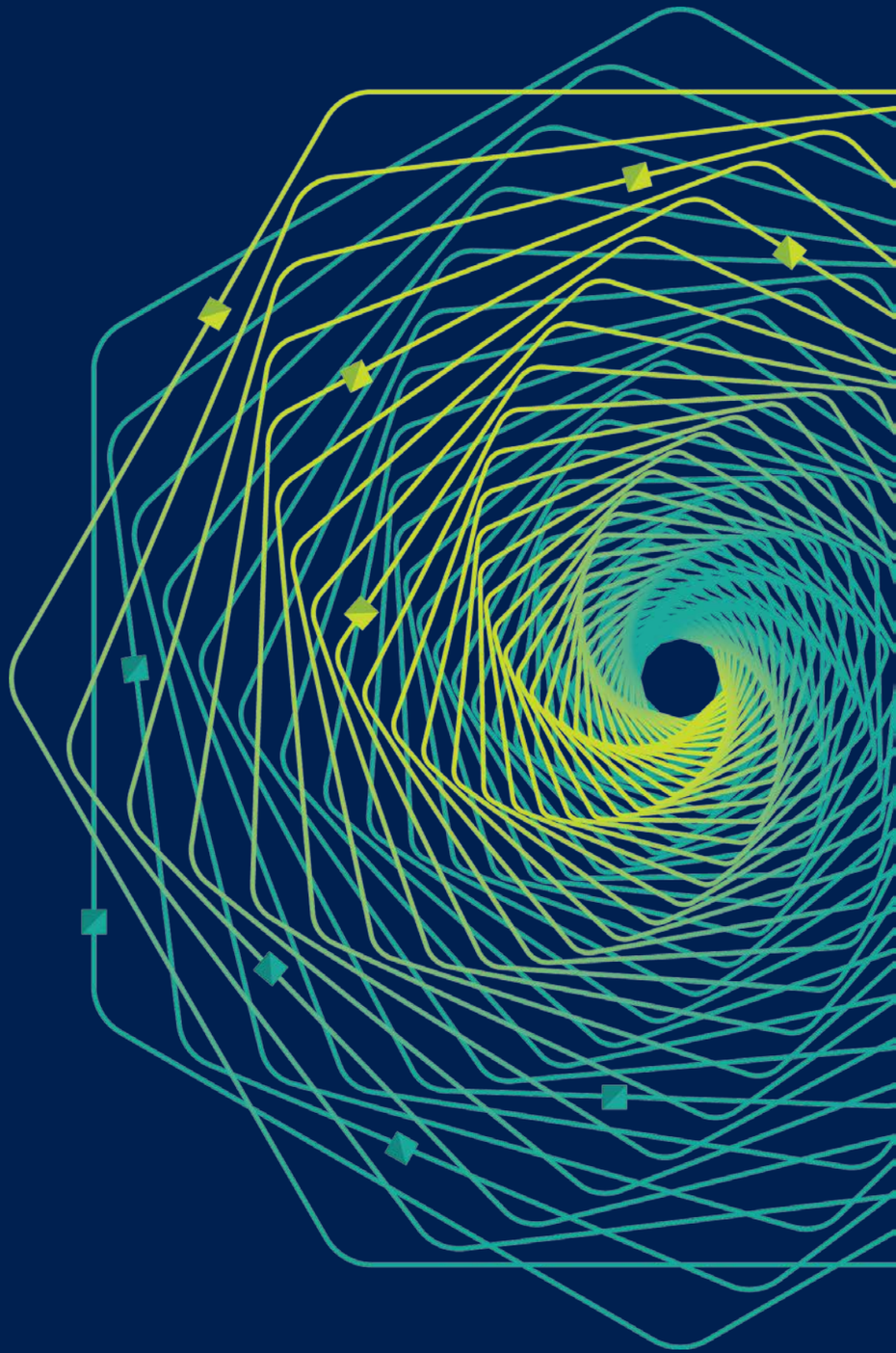
Research Faculty Summit 2018

Systems | Fueling future disruptions



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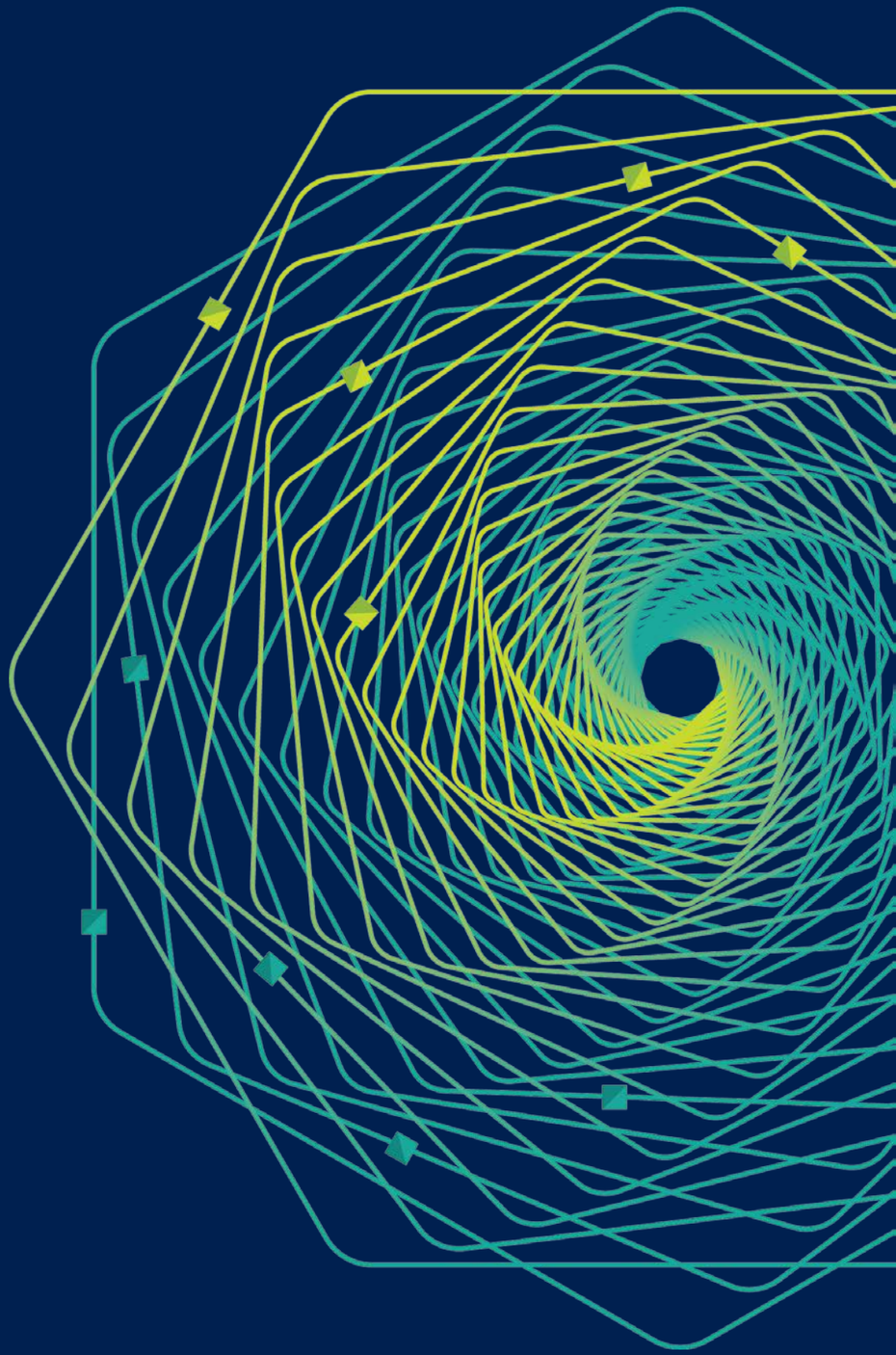
Accelerated Networking in Azure

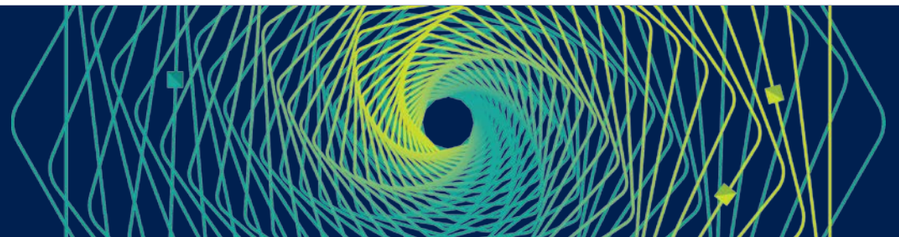
Sambhrama Mundkur

Principal Software Engineer, Azure Host Networking Group

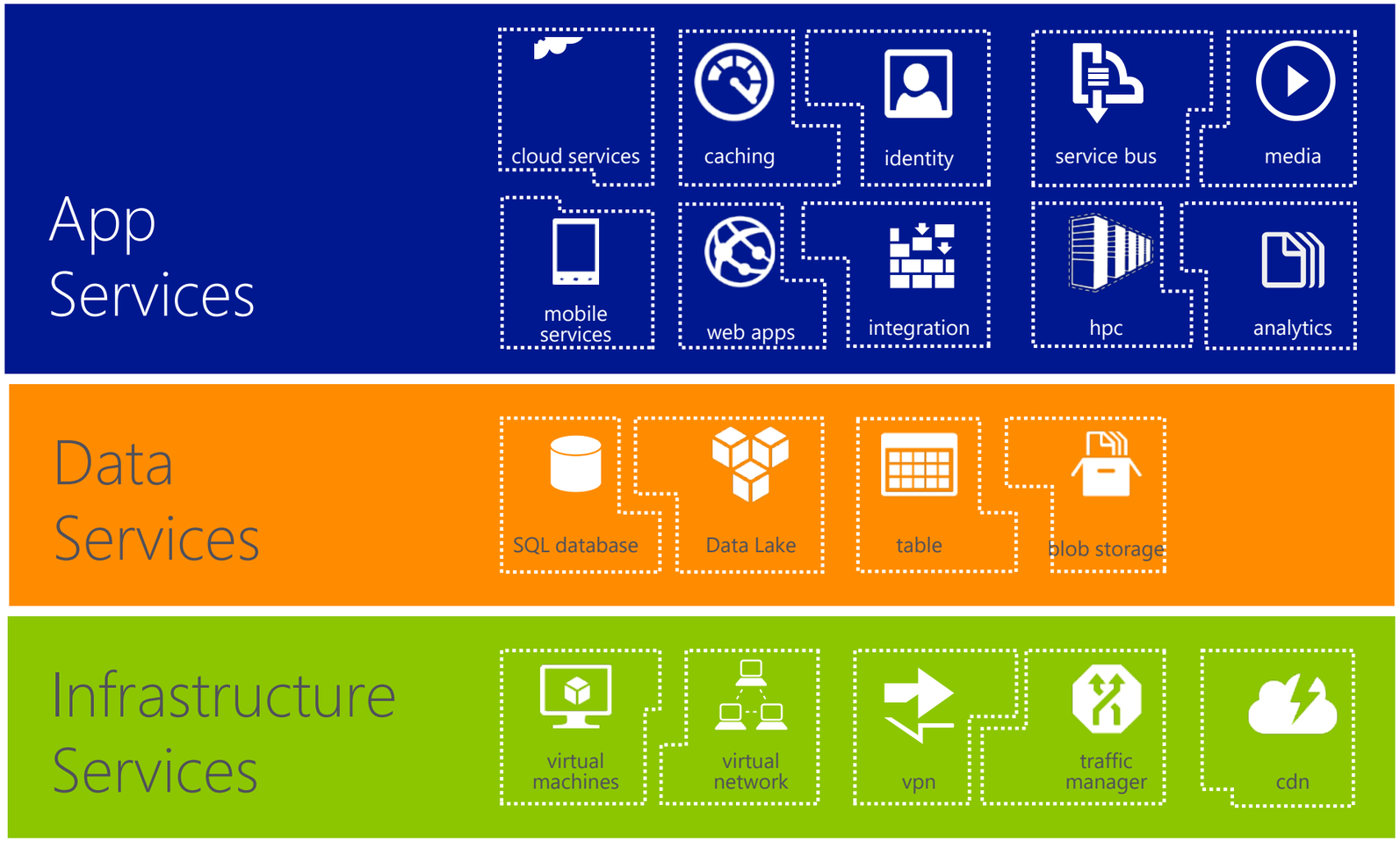


Agenda

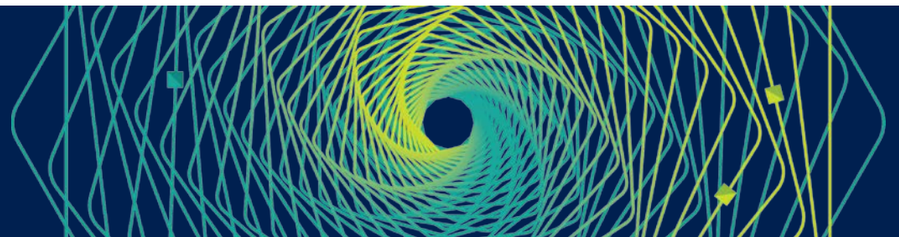
- Azure Background
- What does scale mean in cloud?
- SDN in Azure
- Challenges in Virtualization
- Scaling SDN with SmartNIC
- Conclusion



Microsoft Azure



	2010	2017
Compute Instances	100K	Millions
Azure Storage	10’s of PB	Exabytes
Datacenter Network	10’s of Tbps	Pbps



Azure Scale & Momentum

>85%
Fortune 500 using Microsoft Cloud

>120,000
New Azure customers a month

>9 MILLION
Azure Active Directory Orgs

>18 BILLION
Azure Active Directory authentications/week

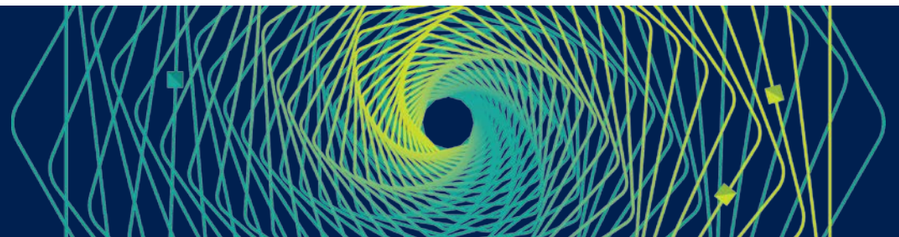
> 3 TRILLION
Azure Event Hubs events/week

>60 TRILLION
Azure storage objects

>900 TRILLION
requests/day

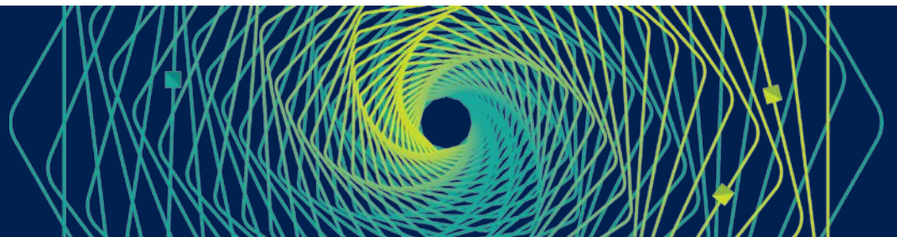
1 out of 3
Azure VMs
are Linux VMs

>110 BILLION
Azure DB requests/day



Other ways to think about scale

- Will have device failures, link failures, server failures all the time, multiple at a time
- Will have gray failures as well
  - Lossy links, switches dropping packets greater than x bytes, undetected corruption, etc.
- Must build great automation and highly available designs to detect and repair/remove such failures from the network, and you will still have ones your automation doesn't find
- IaaS customers (e.g. Enterprises) are not tolerant of single VM failures – they expect 4-5 9s of availability
- Must be able to service all parts of the network (including the host) and still achieve this availability
- Performance, availability, serviceability downtimes, are all measured by P99/P99.9, not P50

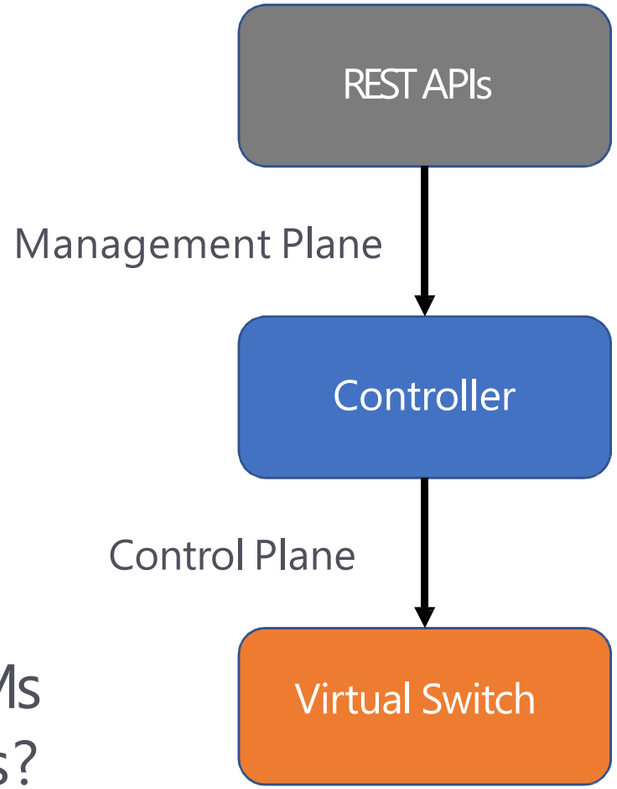


SDN: Building the right abstractions for Scale

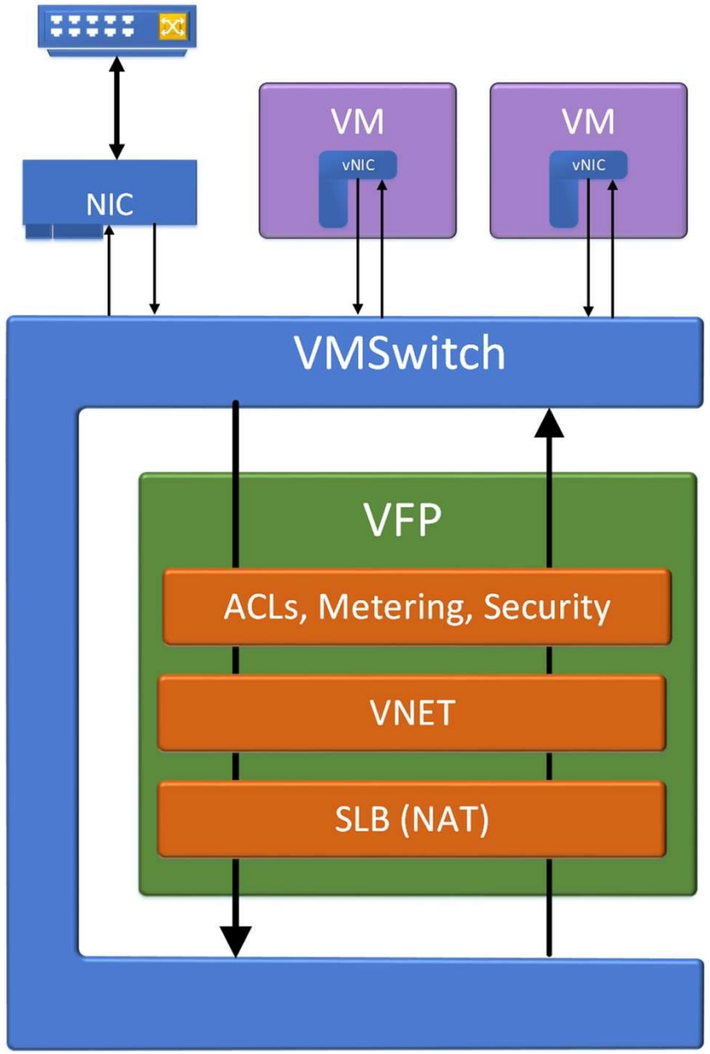
Abstract by separating management, control, and data planes

Example: ACLs

Management Plane	Create a tenant
Control Plane	Plumb these tenant ACLs to these switches
Data Plane	Apply these ACLs to these flows



Data plane needs to apply per-flow policy to millions of VMs
How do we apply billions of flow policy actions to packets?



Virtual Filtering Platform (VFP)
Azure's SDN Dataplane

- Acts as a virtual switch inside Hyper-V VMSwitch
- Provides core SDN functionality for Azure networking services, including:
  - Address Virtualization for VNET
  - VIP -> DIP Translation for SLB
  - ACLs, Metering, and Security Guards
- Uses programmable rule/flow tables to perform per-packet actions
- Supports all Azure dataplane policy at 40GbE+ with offloads

Flow tables: The right abstraction for the host

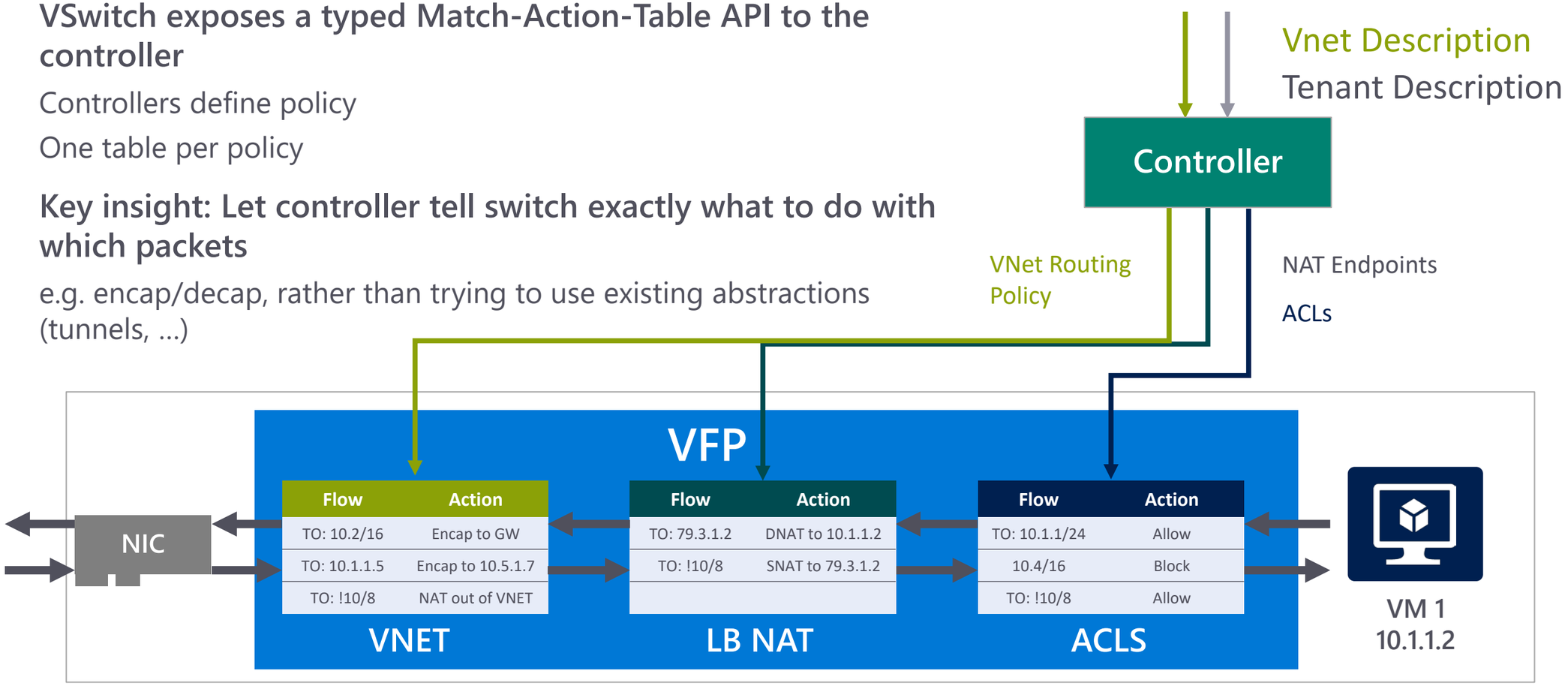
VSwitch exposes a typed Match-Action-Table API to the controller

Controllers define policy

One table per policy

Key insight: Let controller tell switch exactly what to do with which packets

e.g. encap/decap, rather than trying to use existing abstractions (tunnels, …)

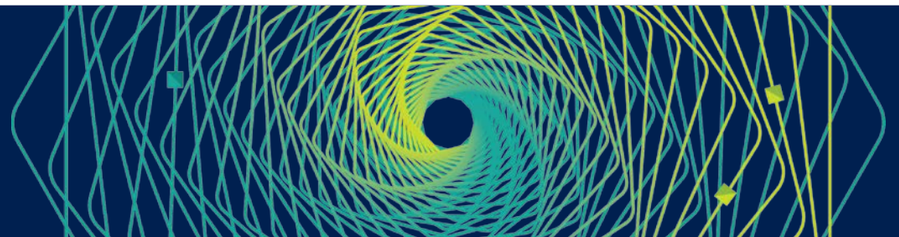


Host SDN Scale Challenges in Practice

- Hosts are Scaling Up: 1G → 10G → 40G → 50G → 100G
  - Reduces COGS of VMs (more VMs per host) and enables new workloads
  - Need the performance of hardware to implement policy without CPU
  - Not enough to just accelerate to ASICs – need to move entire stacks to HW

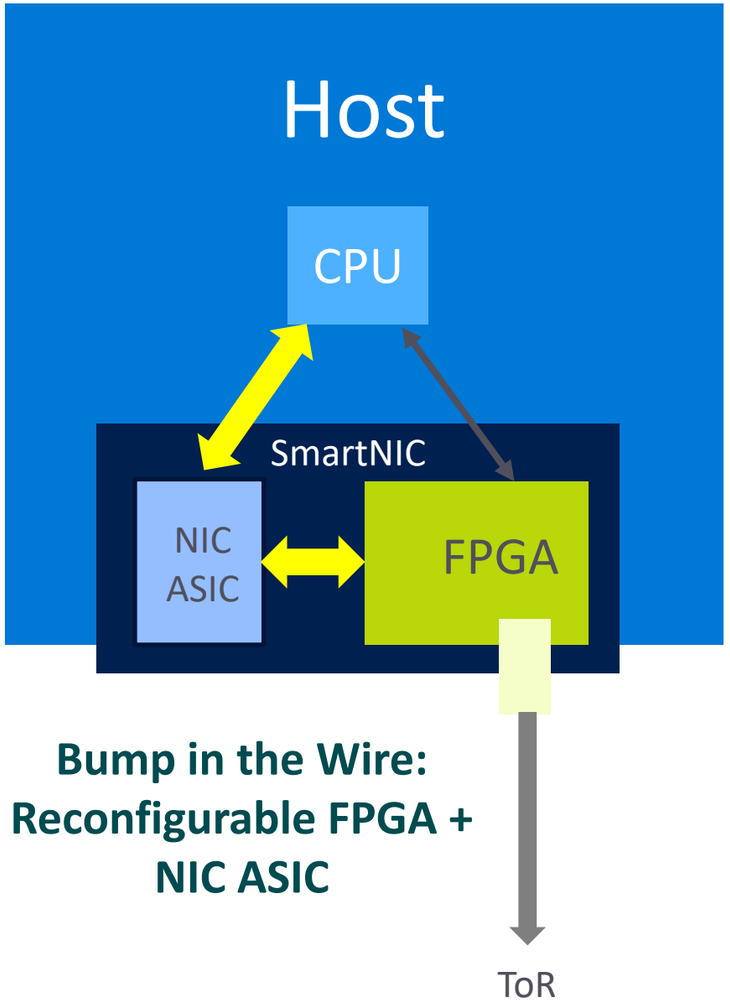
- Need to support new scenarios: BYO IP, BYO Topology, BYO Appliance
  - We are always pushing richer semantics to virtual networks
  - Need the programmability of software to be agile and future-proof—12-18 month ASIC cycle + time to roll new HW is too slow

  - How do we get the performance of hardware with programmability of software?



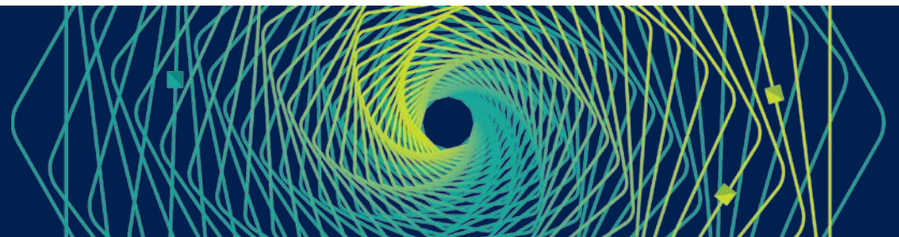
Our Solution:
Azure SmartNIC (FPGA)

- HW is needed for scale, perf, and COGS at 40G+
- 12-18 month ASIC cycle + time to roll new HW is too slow
- To compete and react to new needs, we need agility—SDN
- Programmed using Generic Flow Tables
  - Language for programming SDN to hardware
  - Uses connections and structured actions as primitives



Azure Accelerated Networking: Fastest Cloud Network!

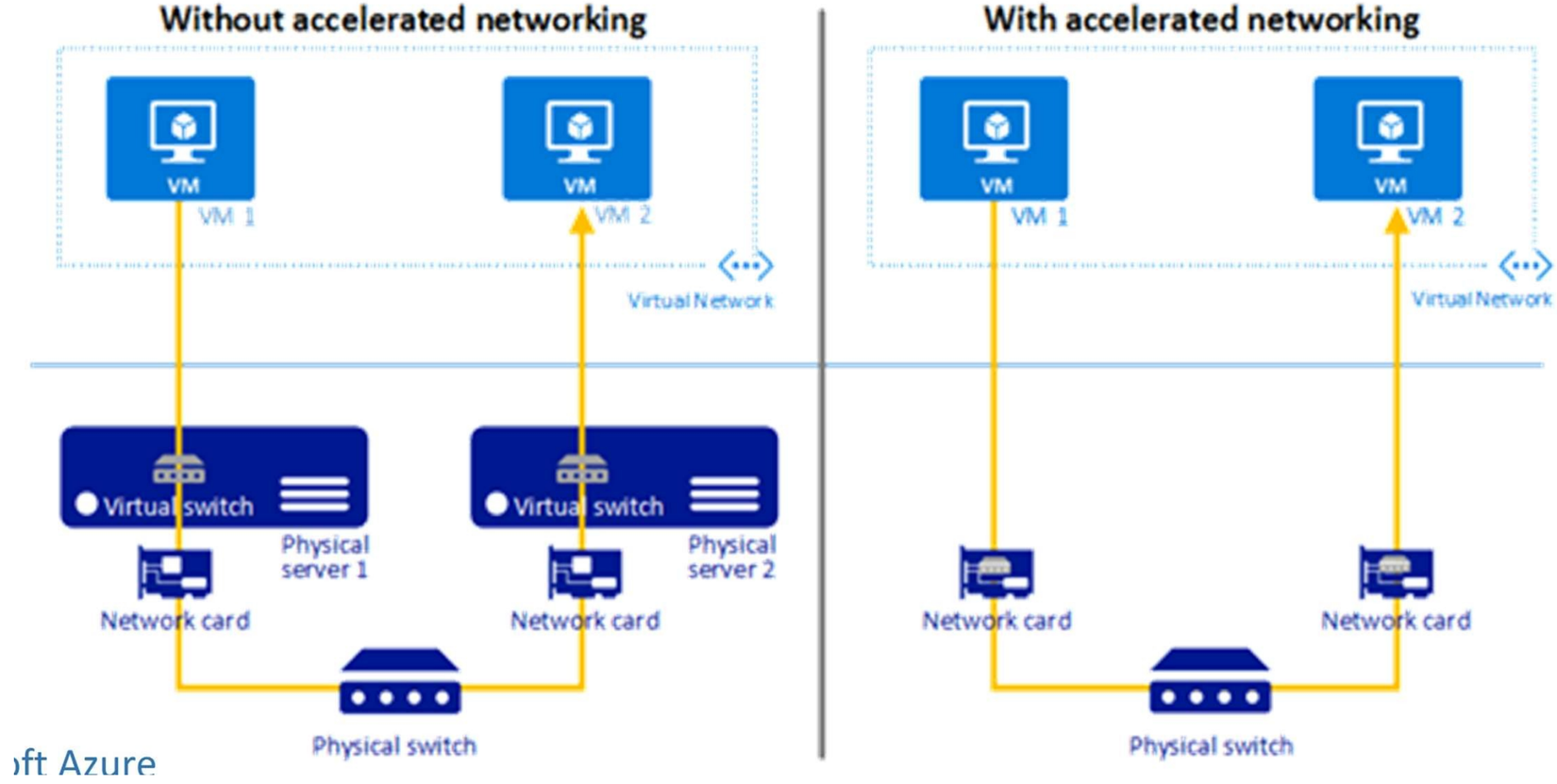
- Highest bandwidth VMs of any cloud
  - Standard compute (D series) VMs get 25Gbps
  - Big compute (M series) gets 32Gbps
  - Standard Linux VM with CUBIC gets 30+Gbps on a single connection
- Consistent low latency network performance
  - Provides SR-IOV to the VM
  - Up to 10x latency improvement – sub 25us within VM Scale Sets
  - Increased packets per second (PPS)
  - Reduced jitter means more consistency in workloads
- Enables workloads requiring native performance to run in cloud VMs
  - >2x improvement for many DB and OLTP applications



Accelerated Networking Internals

SDN/Networking policy applied in software policies in the host

FPGA acceleration used to apply all



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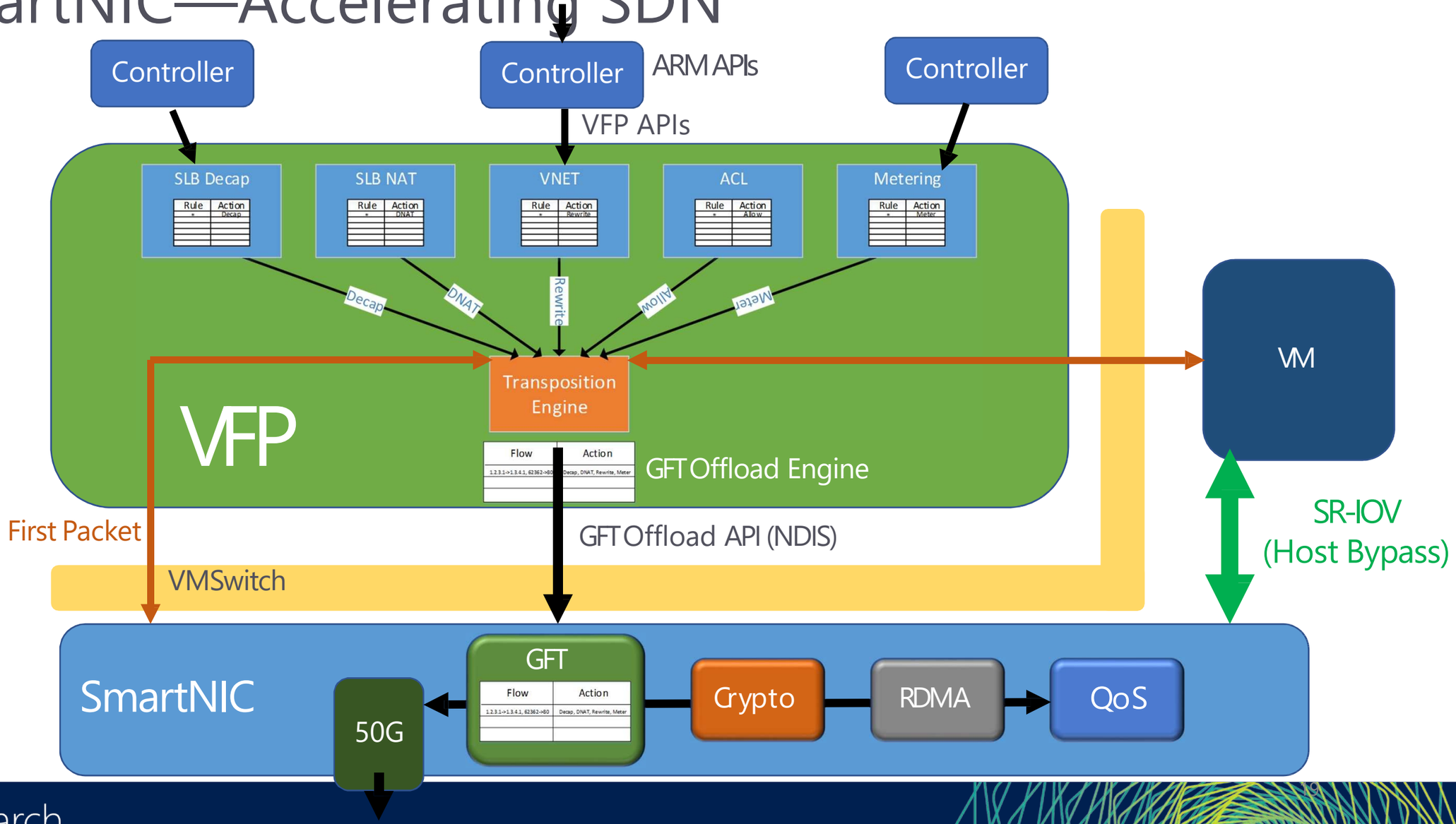
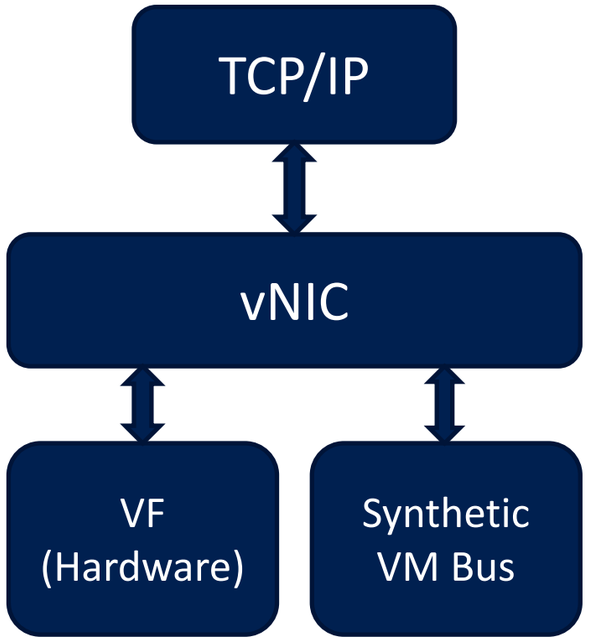
SmartNIC—Accelerating SDN



Serviceability is Key

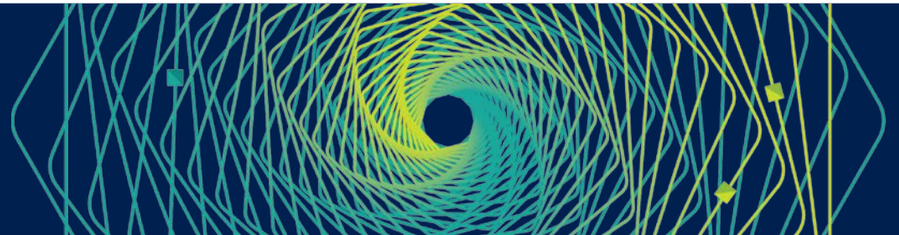
- All parts of this system can be updated, any of which require us to take out the hardware path
  - FPGA image, driver, GFT layer, Vswitch/VFP, NIC PF driver
- IaaS requires high uptime and low disruption —can't take away the NIC device from under the app, and can't reboot the VM / app
- Instead, we keep the synthetic vNIC and support transparent failover between the vNIC and VF



Lesson: A huge amount of the effort to deploy SR-IOV was in making all parts of this path rebootlessly serviceable without impact

Lessons Learnt

- Design for serviceability upfront
- Use software development techniques for FPGAs
- Better perf means better reliability
- HW/SW co-design is best when iterative
- Failure rates remain low
- Upper layers should be agnostic of offloads



Questions?

Thank you

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