NFV for the Cloud

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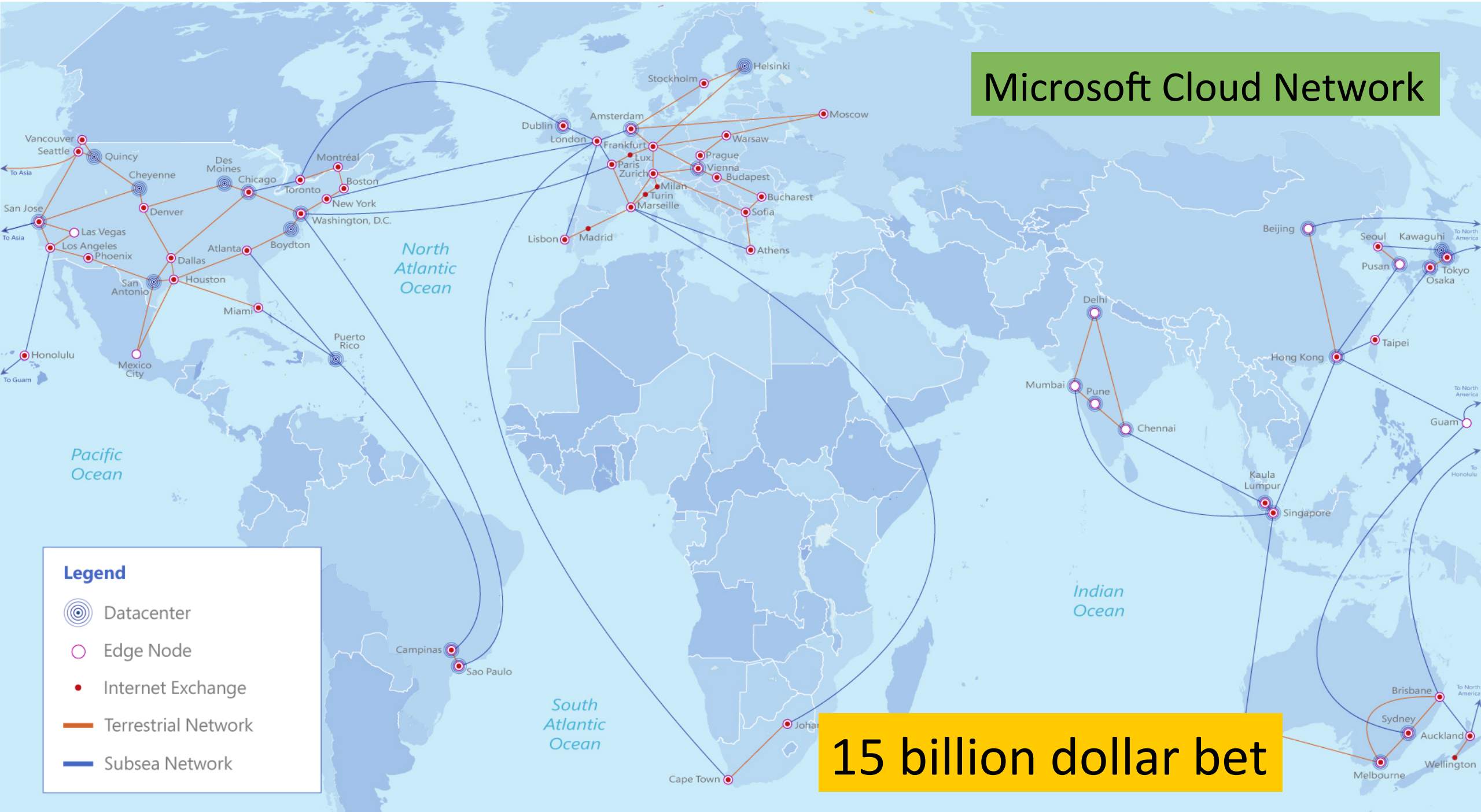
Microsoft Cloud Network
15 billion dollar bet
Legend
Datacenter
Edge Node
Internet Exchange
Terrestrial Network
Subsea Network
North Atlantic Ocean
Pacific Ocean
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Vancouver
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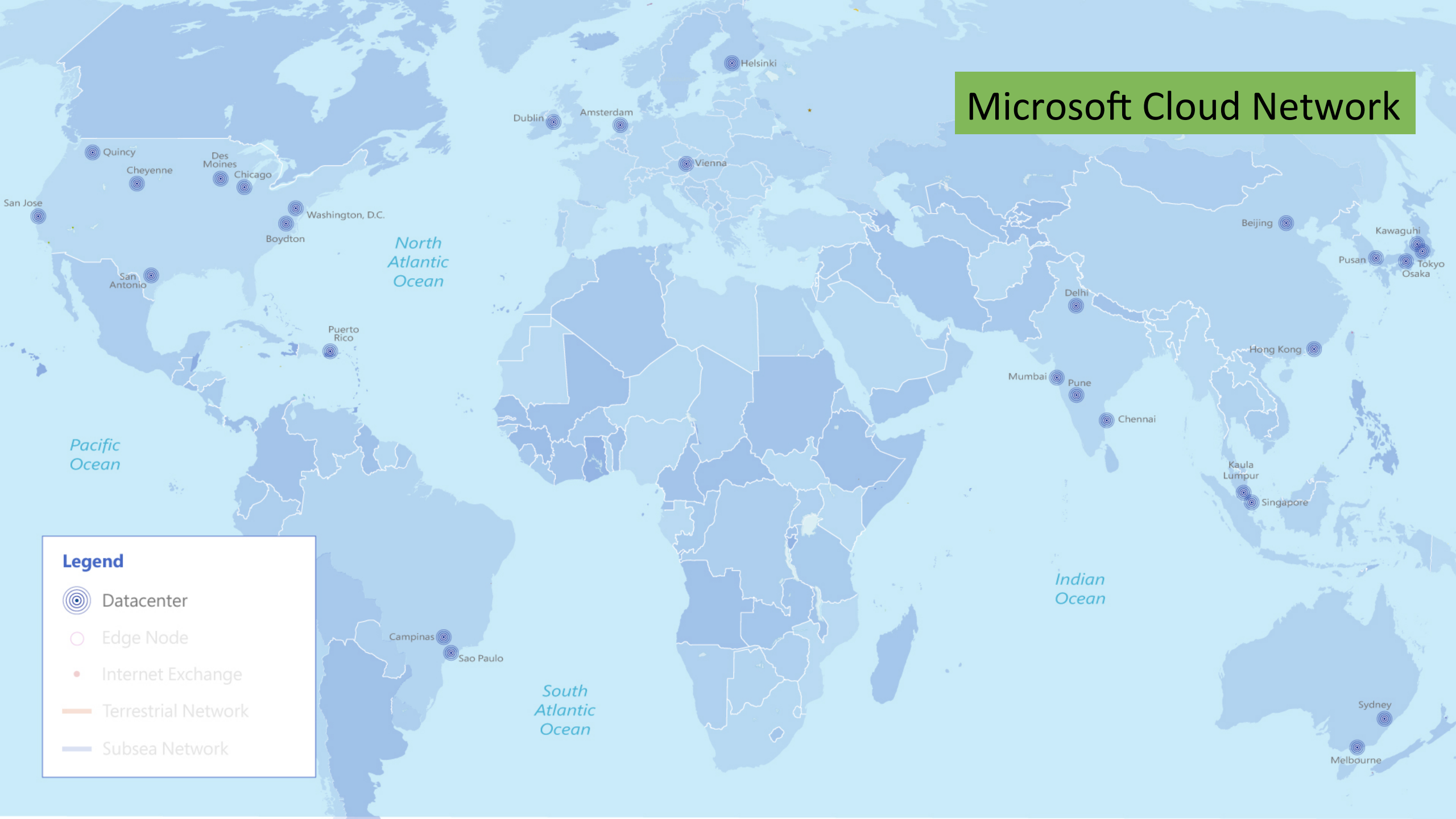
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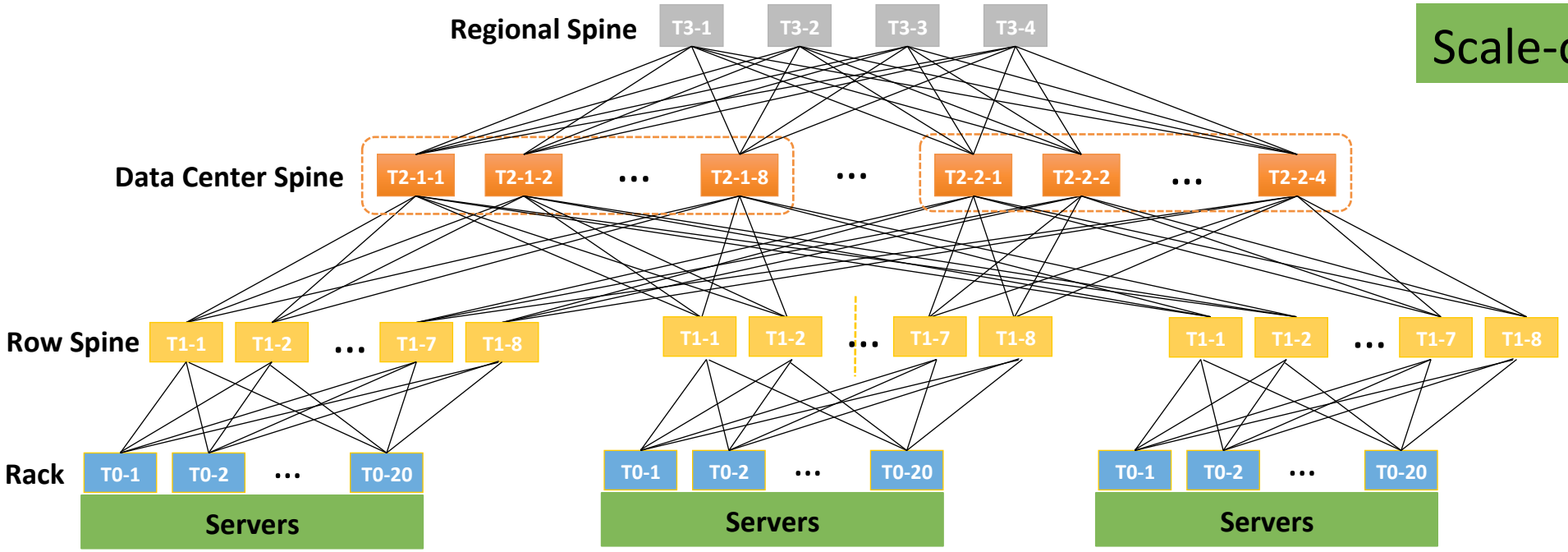
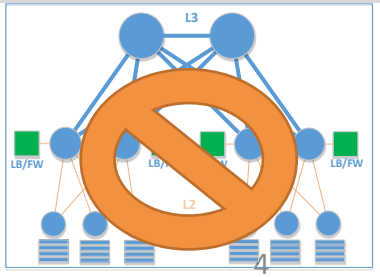
Physical Network: Azure Clos Fabrics (VL2)



Scale-out, active-active

Scale-up, active-passive



Outcome of >10 years of history, with major revisions every six months

Challenge of Multi-tenant Cloud Networking

- Provide on-demand network services to customer networks
  - Routing
  - Segmentation

  } Virtual Networking

  - Load Balancer
  - NAT
  - VPN
  - WAN Connectivity
  - Application Security
  - DDoS Protection
  - …

  } Virtualized Network Functions (VNFs)

The job of Network Function Virtualization (NFV) is to enable VNFs

Agenda

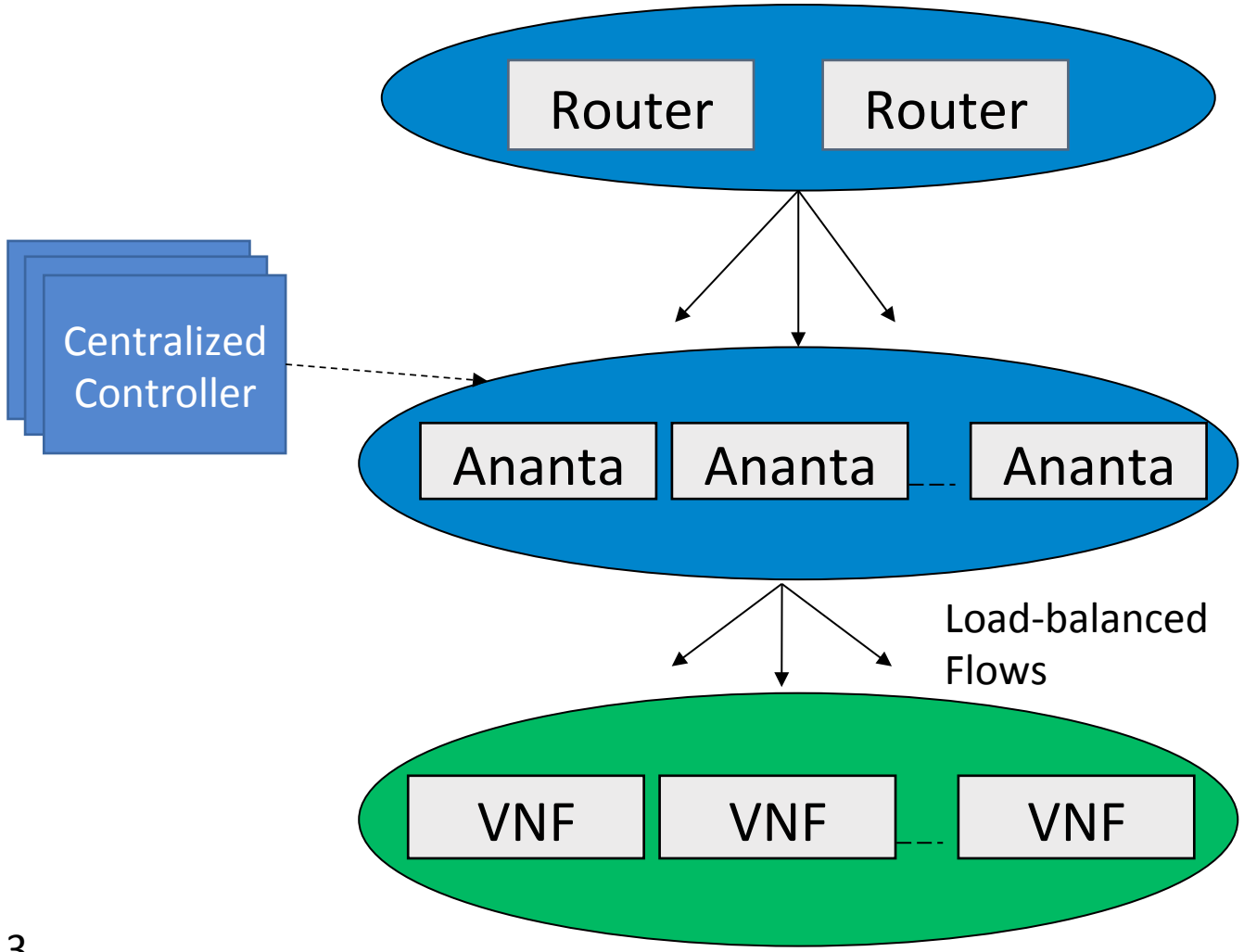
- Requirements for NFV
- Approach
- Example VNFs: VPN, Express Route, Application Gateway
- Lessons learnt
- Call for action for P4 community

Requirements for NFV Infrastructure

- No specialized, fixed-function hardware
  - VNFs need to be implemented on programmable hardware
  - Evolve at the speed of software
- On-demand provisioning
  - 1000s of instances in seconds
- Scale-out to meet availability and capacity
  - Once the data center is built, reprogram hardware to meet customers' needs
- Support both single-tenant and multi-tenant VNFs
  - Support legacy as well as cloud-scale VNFs

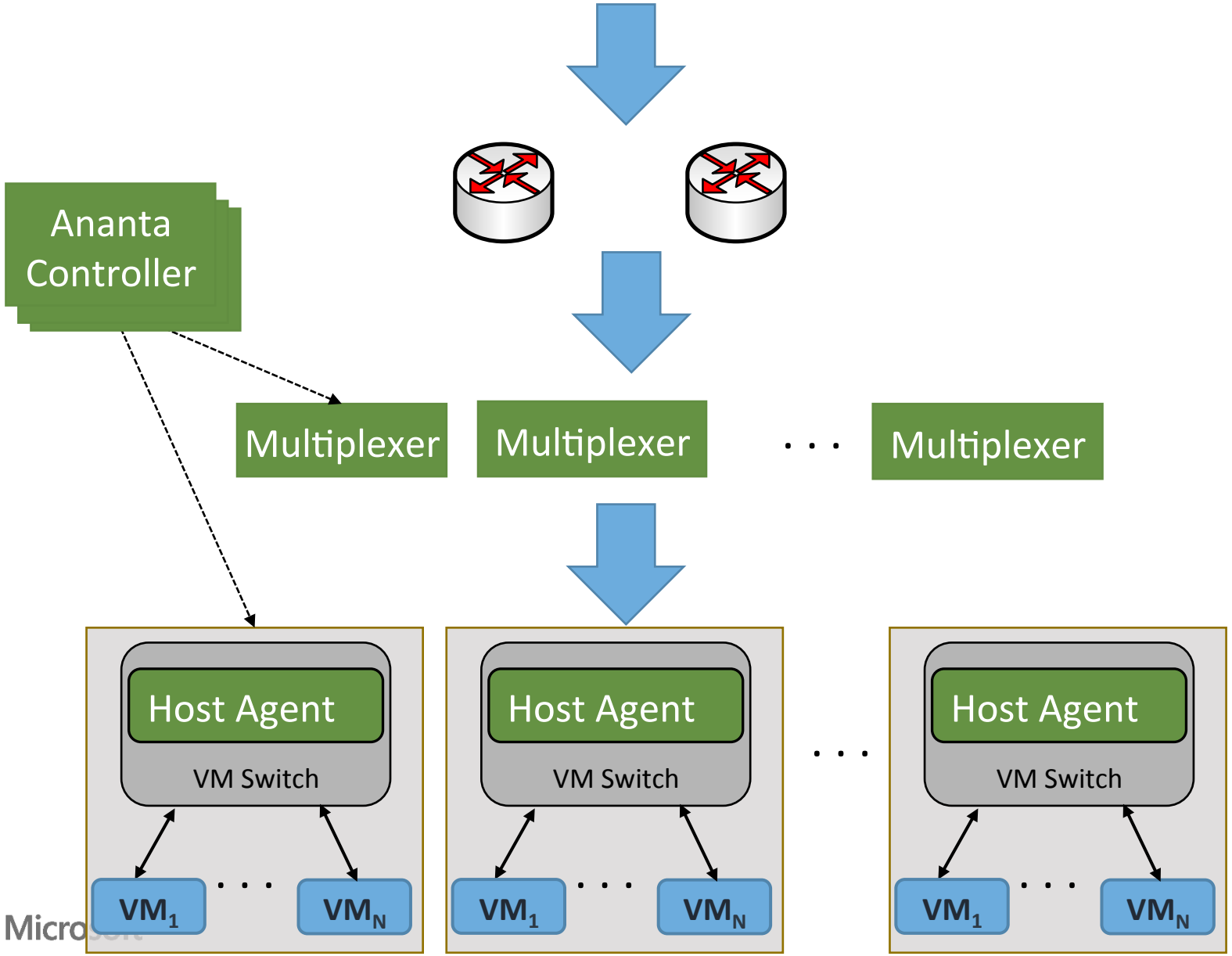
Approach: Scale VNFs via Layer-4 LB

- **Key Ideas**
  - Ananta*: Scale-out Layer-4 load balancing via SDN
  - Ananta provides load balancing and high availability for individual VNFs
  - Centralized control plane and scale-out data plane for each VNF, e.g., VPN, Application Security, DPI



*Ananta: Cloud Scale Load Balancing, SIGCOMM 2013

Ananta: Cloud Scale Load Balancing



Idea: decompose load balancing into tiers.

1st Tier: Provides packet-level (layer-3) load spreading, implemented in routers via ECMP.

2nd Tier: Provides **connection-level** (Layer-4) load spreading and health monitoring

3rd Tier: Provides stateful NAT implemented in the virtual switch in every server.

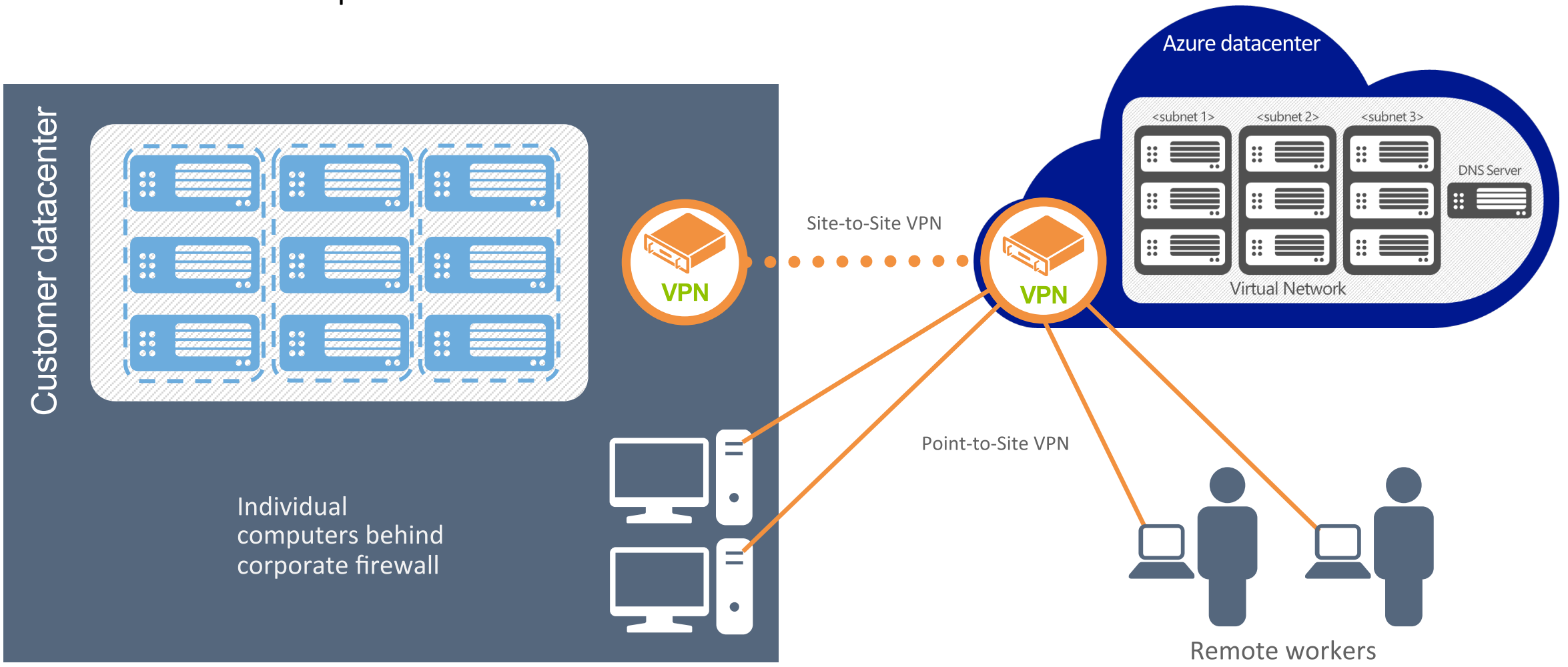
Example VNFs

- VPN
- Express Route
- Application Gateway

VPN – Hybrid Cloud over the Internet

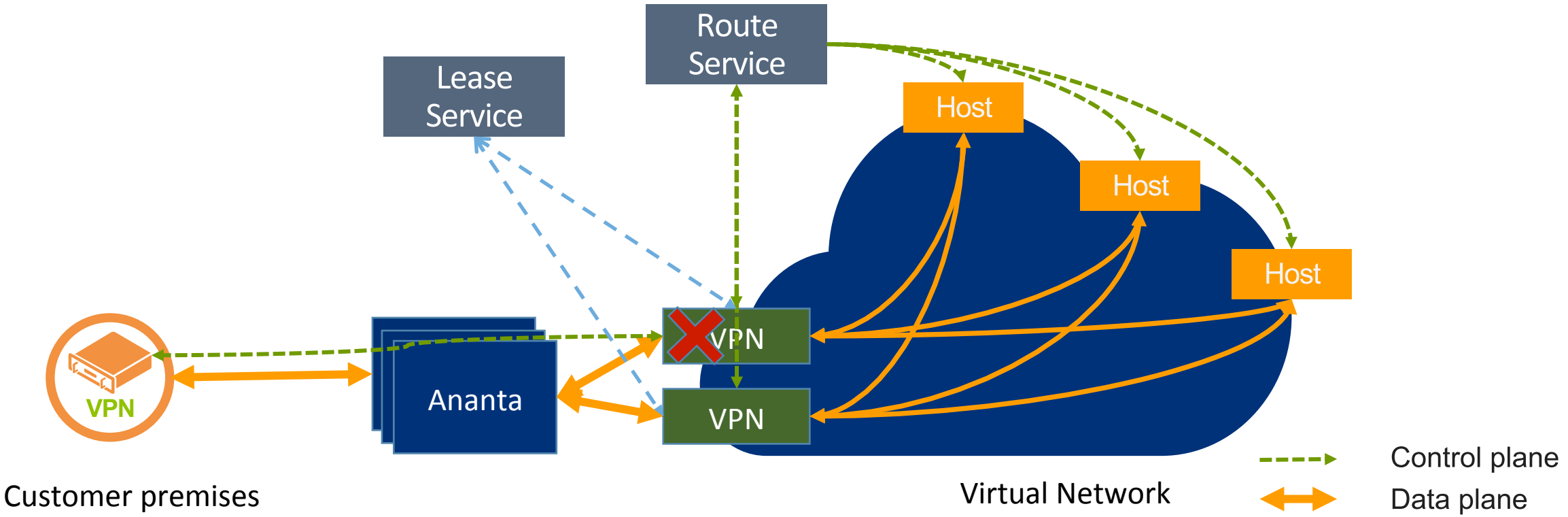
Securely connect to Virtual Network over the Internet

Traverses firewalls and proxies



IPSEC VPN High Availability

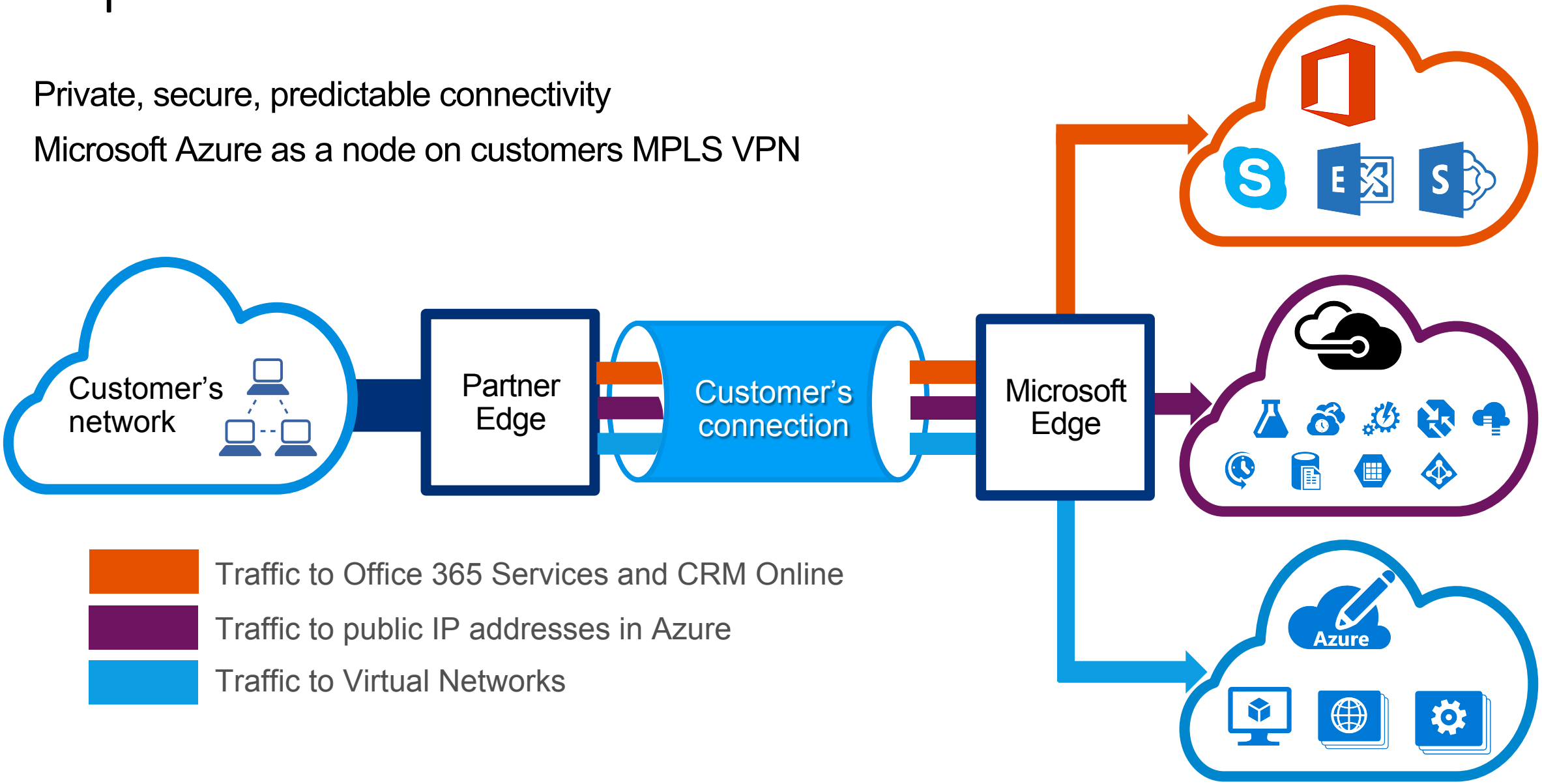
- Active-passive instances, deployed in a virtual network
- Leader election picks active instance
- LB Probe to route traffic to the active instance



Express Route – Software Defined WAN

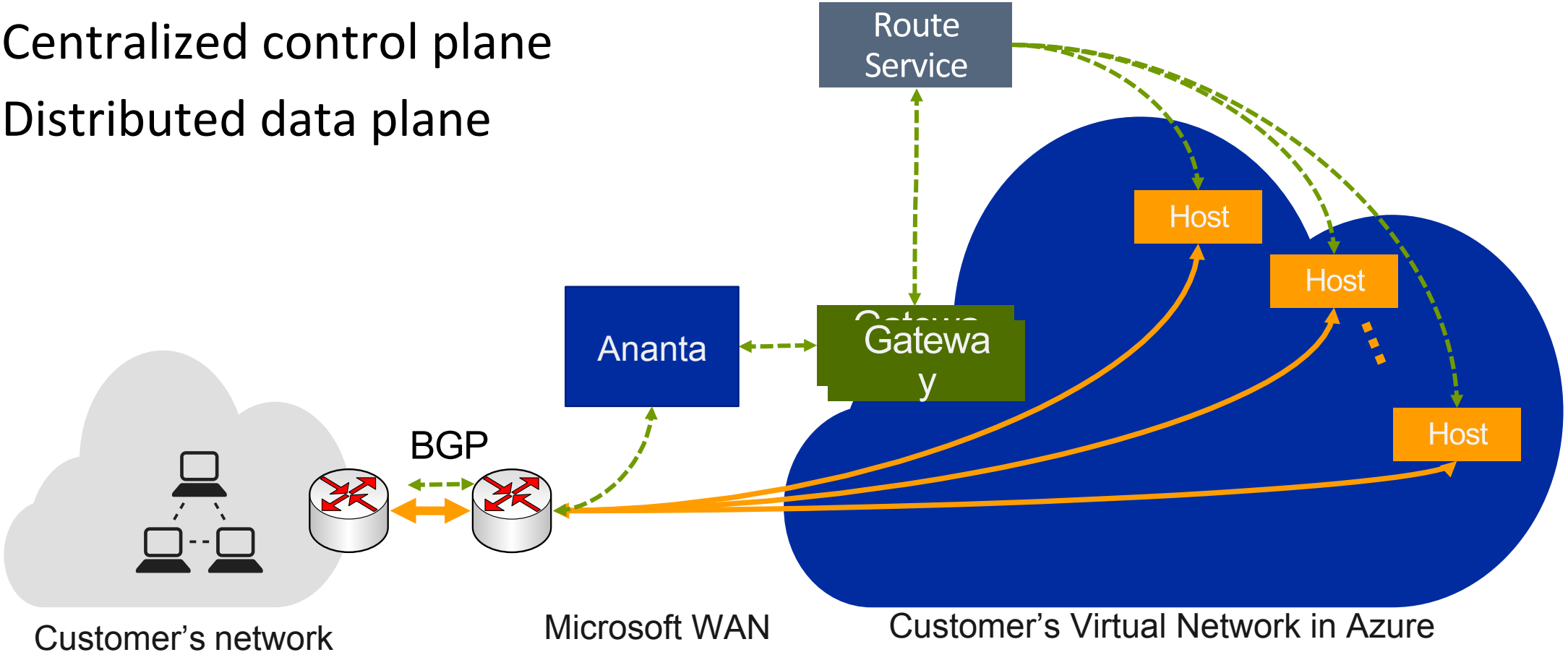
Private, secure, predictable connectivity

Microsoft Azure as a node on customers MPLS VPN



Data Center-Scale Distributed Router

- Active-active instances
- Centralized control plane
- Distributed data plane



Microsoft Cloud Network

ExpressRoute Partners

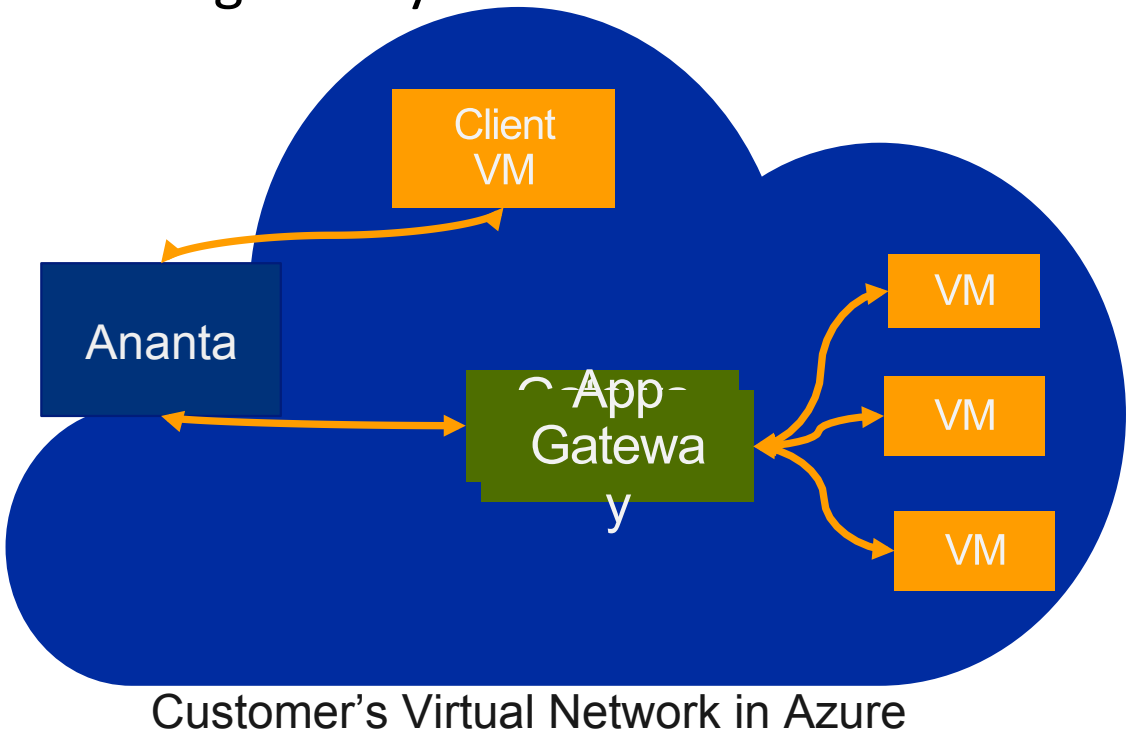
EQUINIX · TelecityGroup (where content meets connectivity) · Level(3) · BT · AT&T · verizon · OPTUS yes · colt · intercloud systems · Aryaka · zayo · orange · PCCW 電訊盈科 · dimension data · NEXTDC · NTT Communications · SingTel · inxn · IIJ Internet Initiative Japan · TATA COMMUNICATIONS · xo communications · Nimbo · Inc. 500

Legend

- Datacenter
- Edge Node
- Internet Exchange
- Terrestrial Network
- Subsea Network

Azure Application Gateway

- Active-active instances
- SSL offload, session affinity, URL rewrite, visibility, …
- NFV Infrastructure synchronizes configuration, monitors performance and scales gateways



Azure NFV Ecosystem

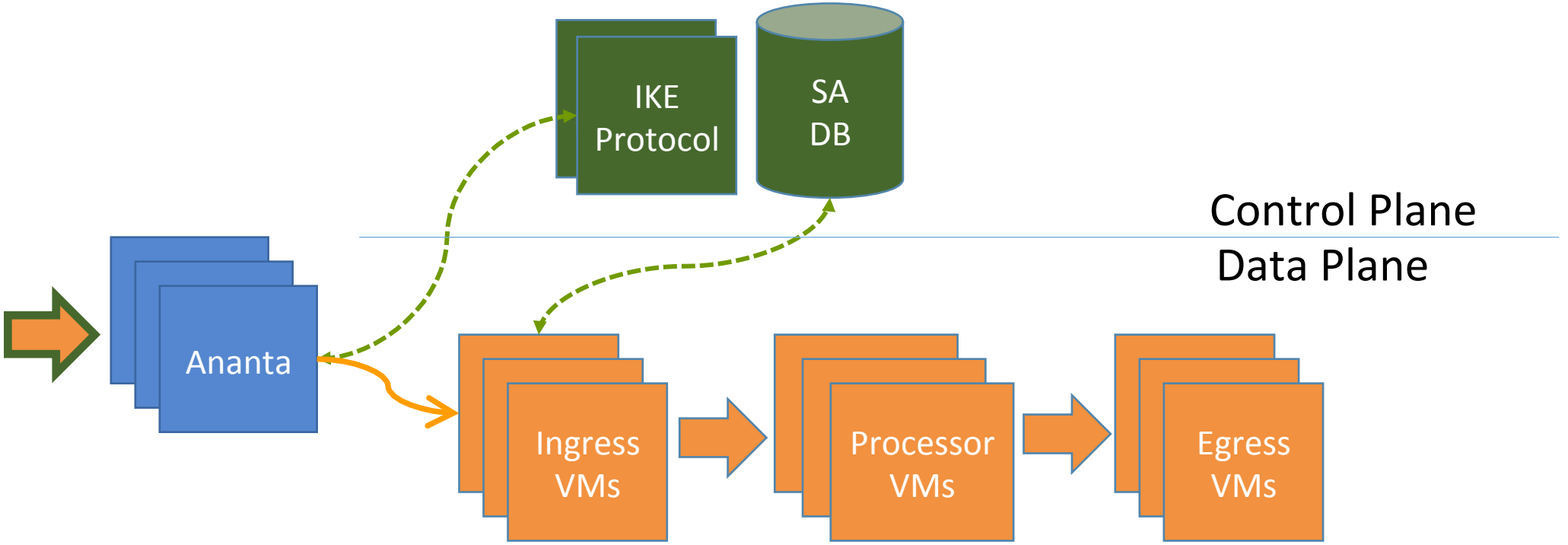
- The same LB and HA features are available to third-parties as well
- Third-party VNFs available now:
  - F5, Citrix, Barracuda, Cisco, A10, Riverbed, Brocade, …

Lessons learnt

- Active-passive does not work
  - Maintenance windows too painful for customers
  - Example: VOIP server in the cloud
  - **Conclusion**: Decompose and scale-out each VNF

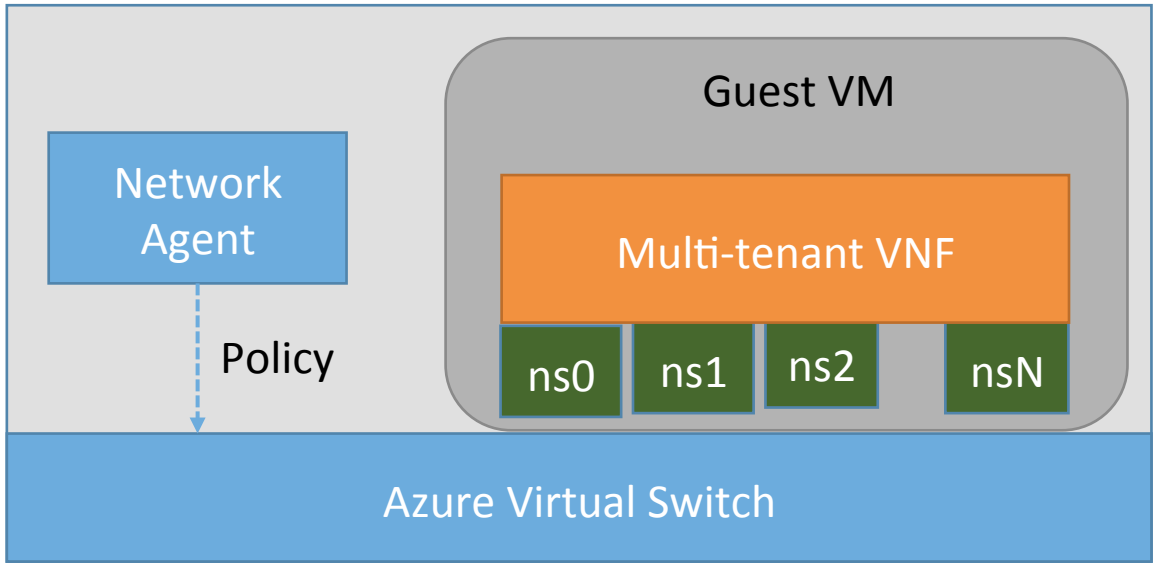
- Single-tenant services are too expensive
  - Multi-tenancy in VMs does not provide sufficient performance isolation
  - **Conclusion**: network needs to provide isolation support

Applying SDN to IPSEC



Multi-tenant virtual networking

- Leverage networking namespaces (Windows compartments)
- Azure Virtual Switch delivers namespace metadata to the VM
- Virtual Switch supports *cut-through forwarding* for high-performance



Call to action for P4

- In-network performance isolation
  - By the time packets hit a server, it's already too late!
- Support stateful packet processing functions
  - Most flows in the data center create state at the virtual network edge
  - Support functions that create per-flow state from data path, e.g., LB, FW
- Support on different hardware and form factors
  - ASIC, NPU, FPGA; NIC, Router
  - Currently, most networking is done on x86 due to its programmability
  - Enable best price/performance for specific needs
- Visibility and diagnostics key to at scale network operation
  - EverFlow, PingMesh examples of visibility tools

Appendix