Overlay-based virtual networking
vs
OpenFlow-controlled switch fabrics
in IaaS Clouds

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Overview

- Cloud tenant networking requirements
- How to build it:
  - Virtualized physical devices
  - OpenFlow switch fabric
  - IP overlays
- Choose overlays, but what about the control plane?
- MidoNet SDN solution
- Questions

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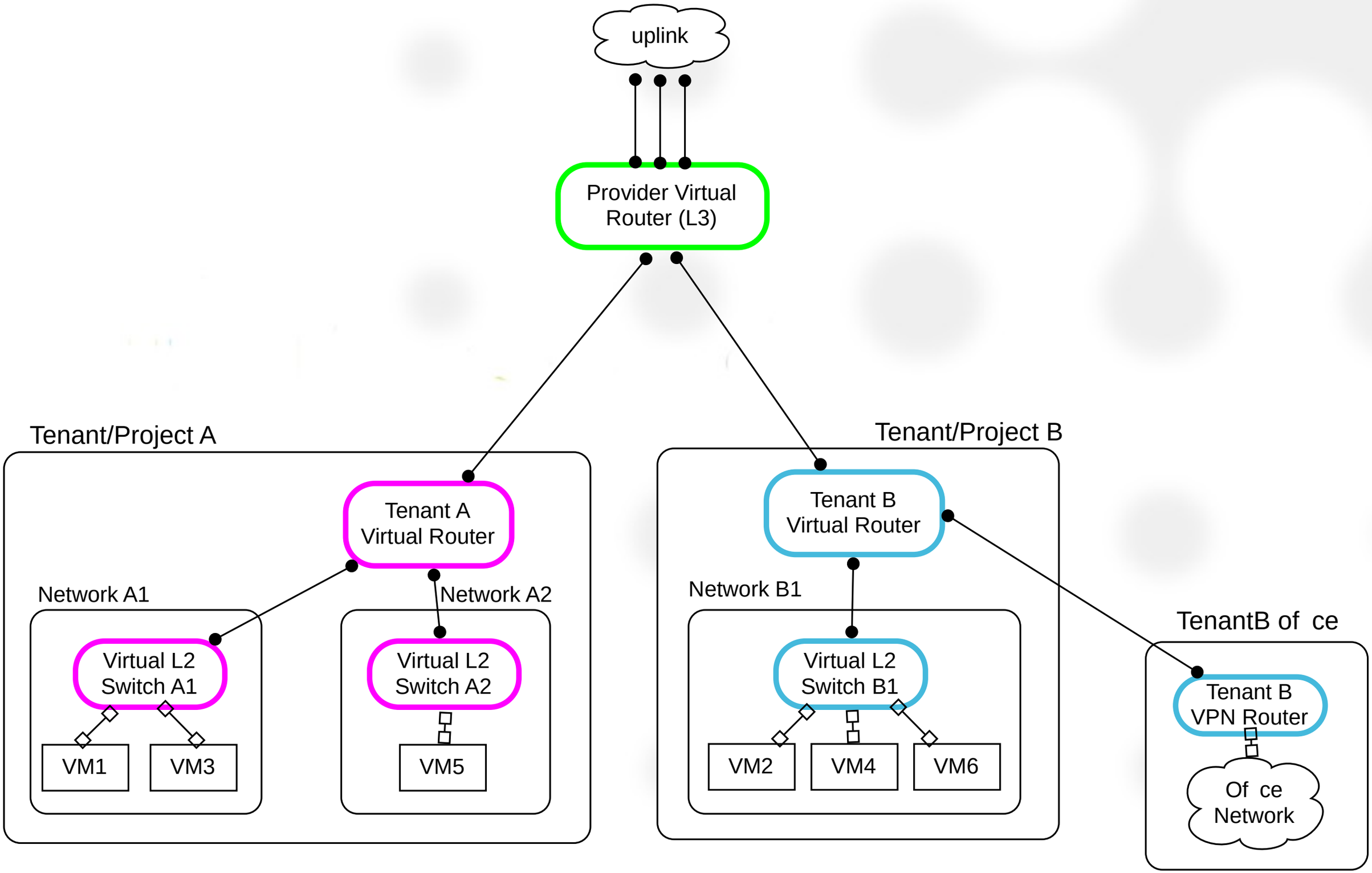
Requirements



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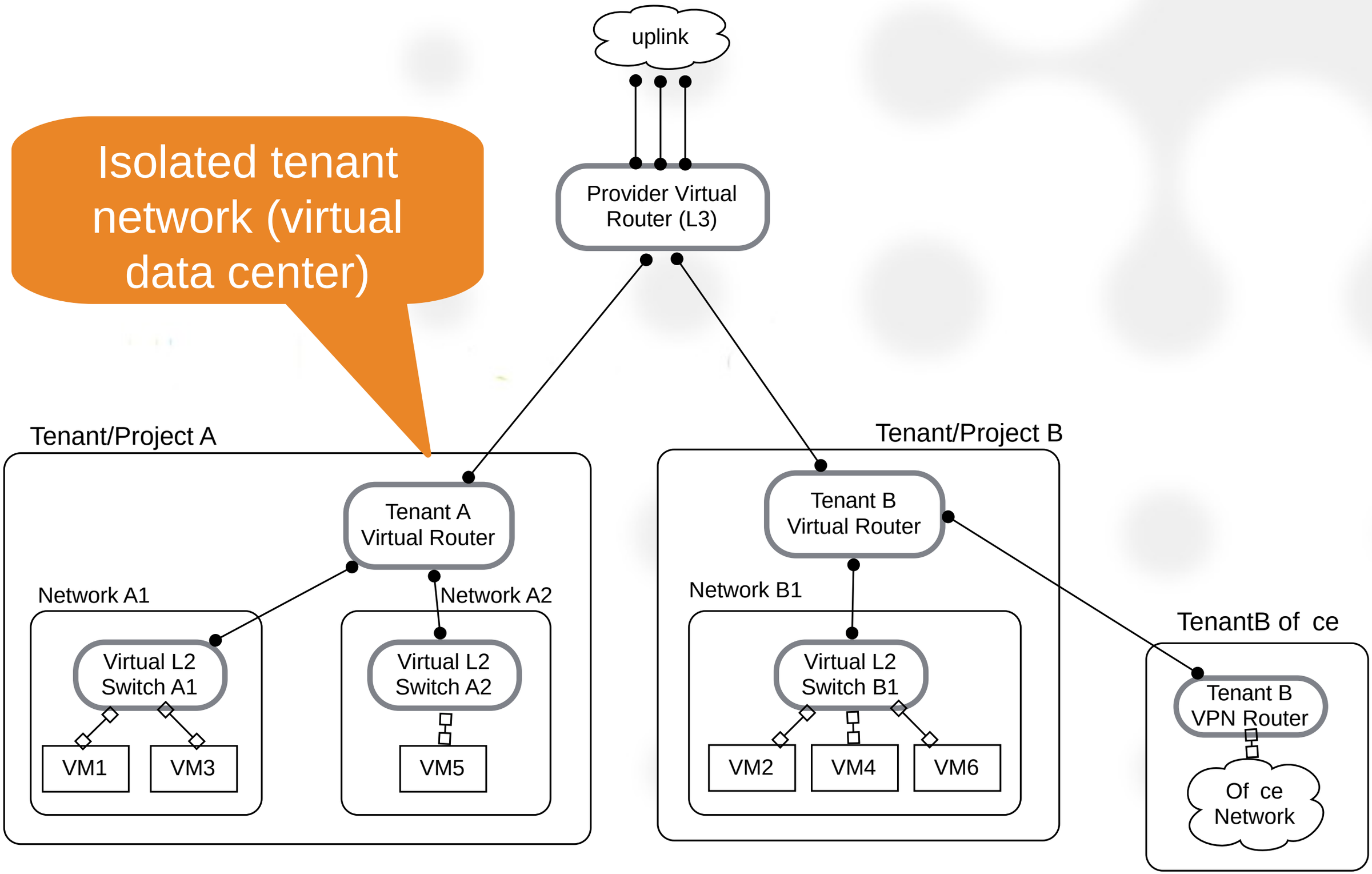
Requirements



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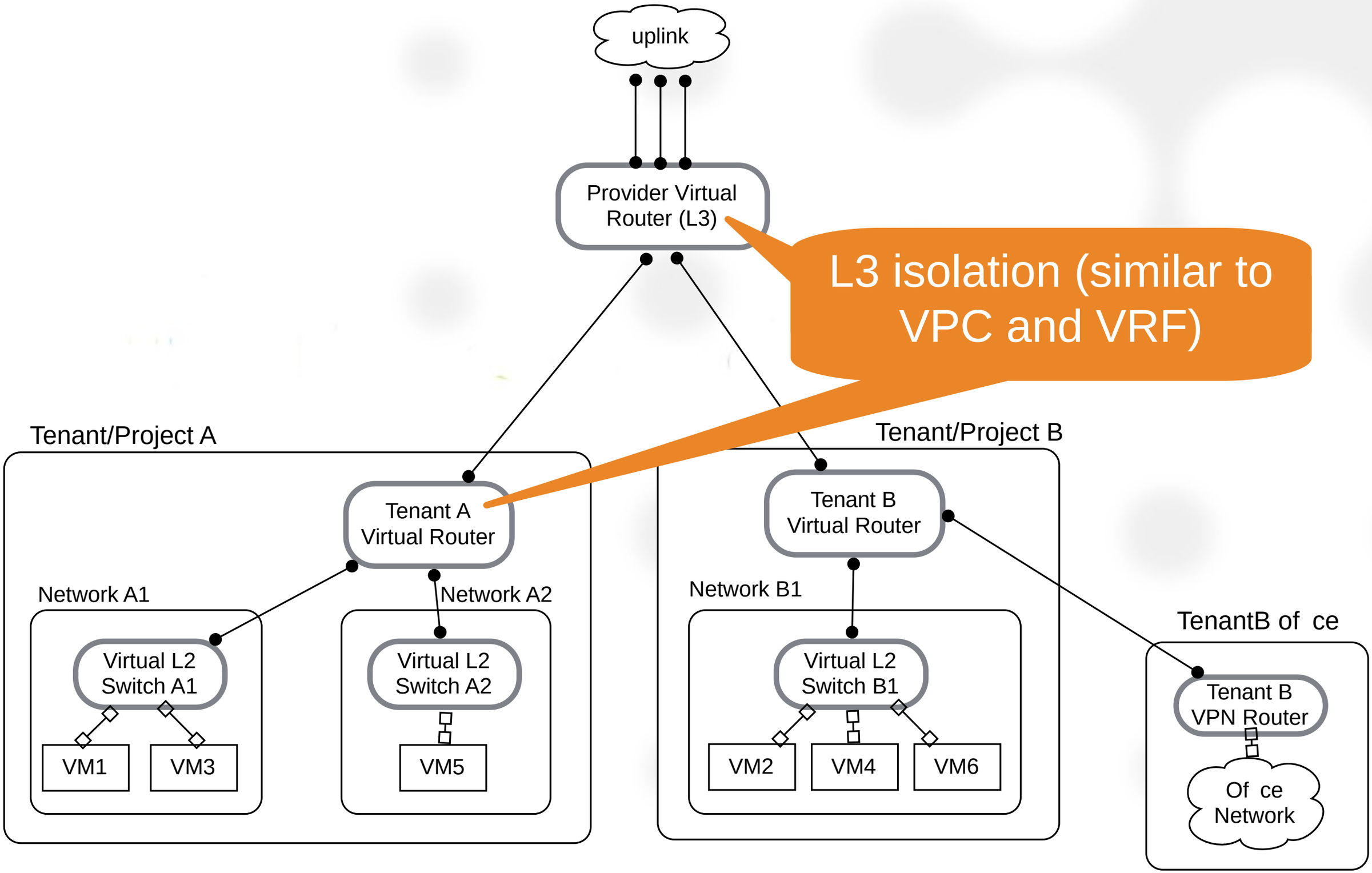

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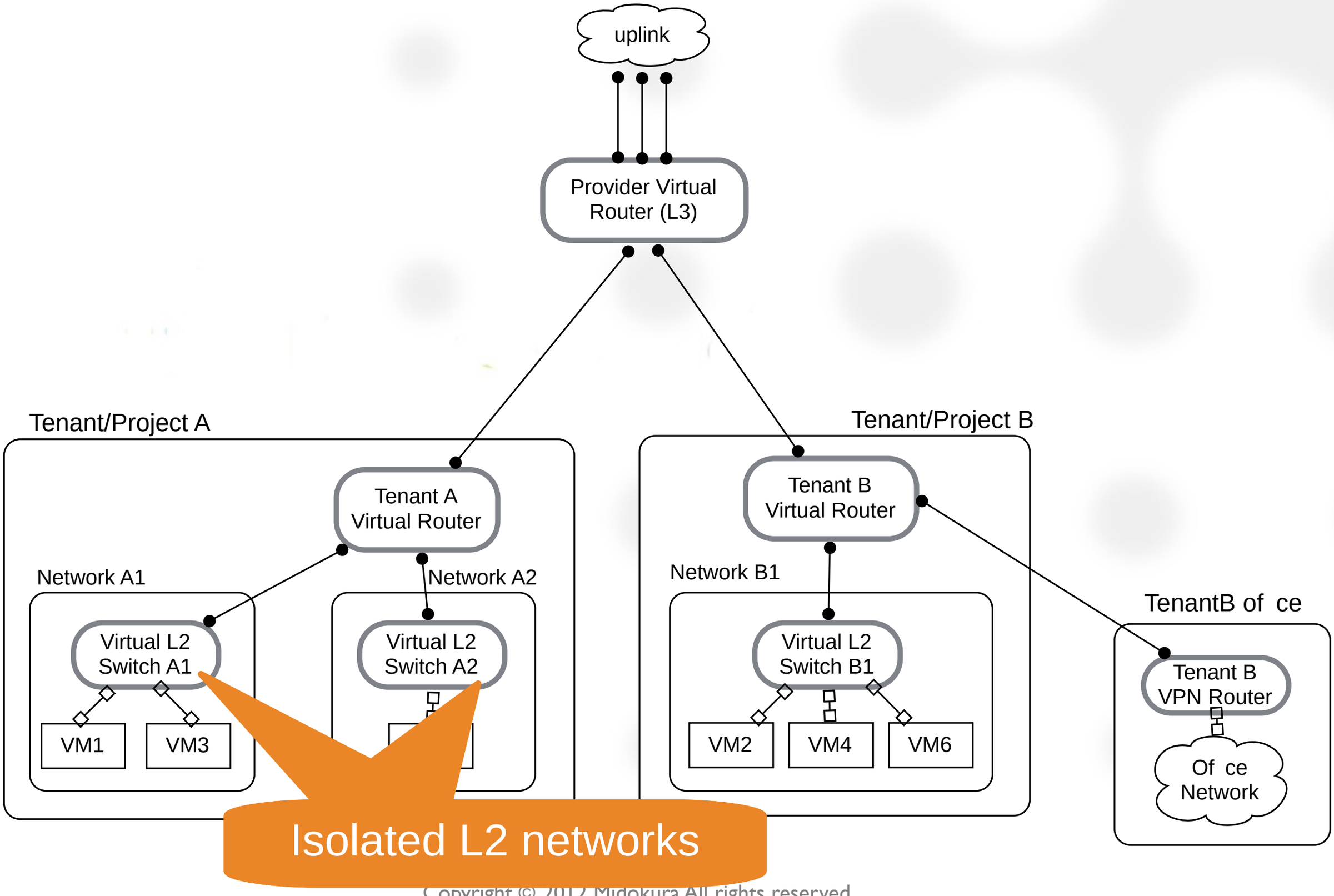

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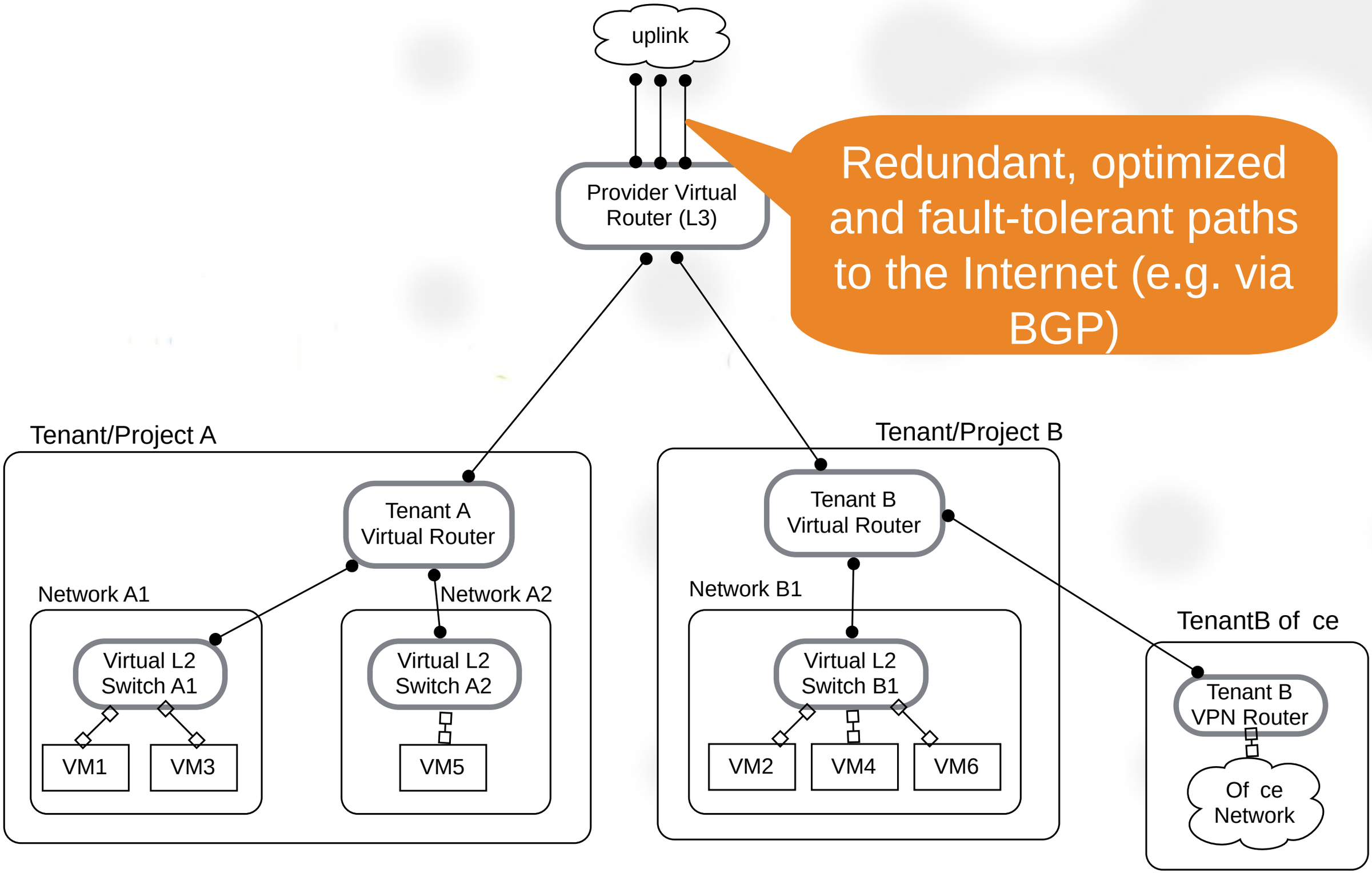

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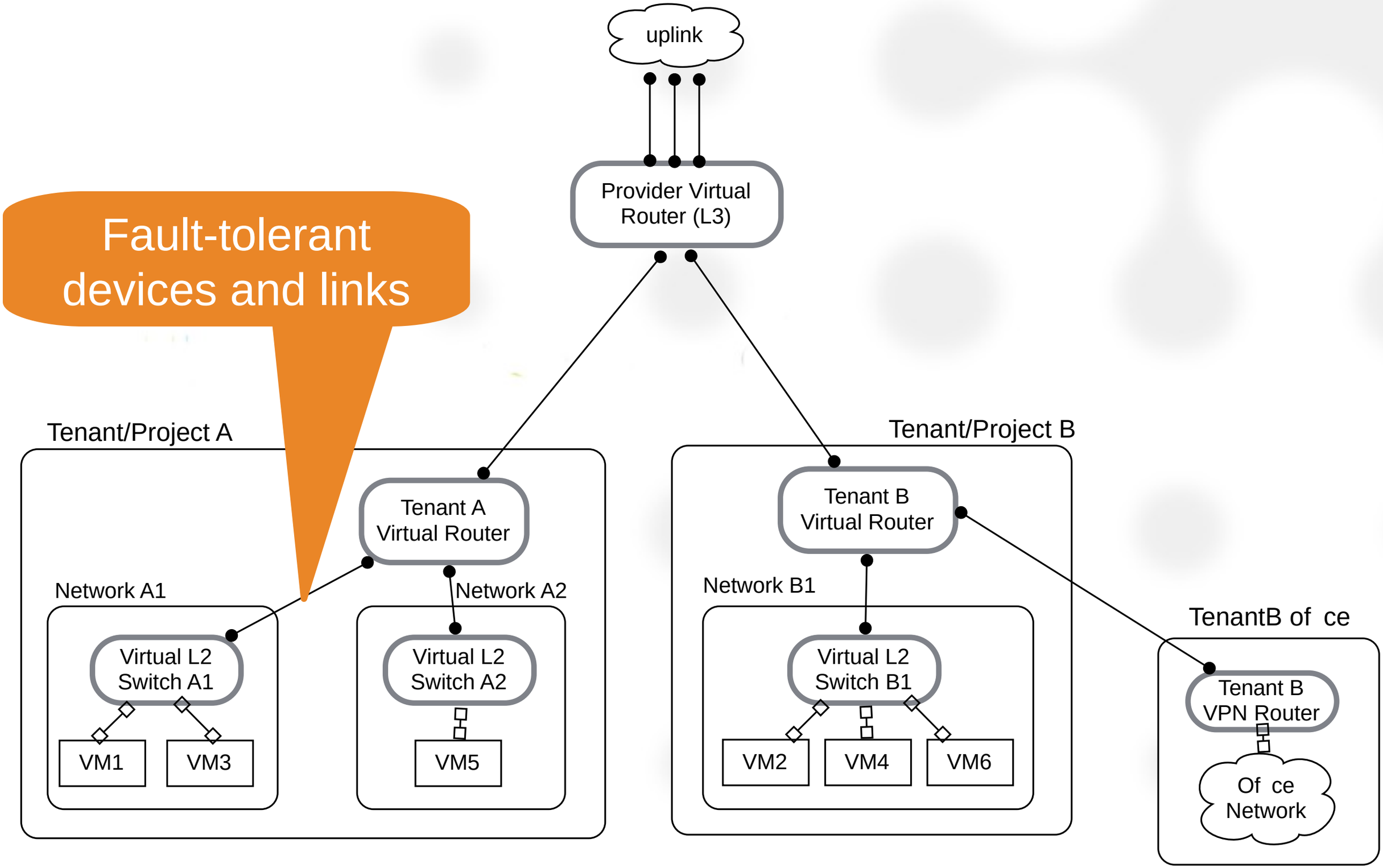
Requirements

Fault-tolerant devices and links



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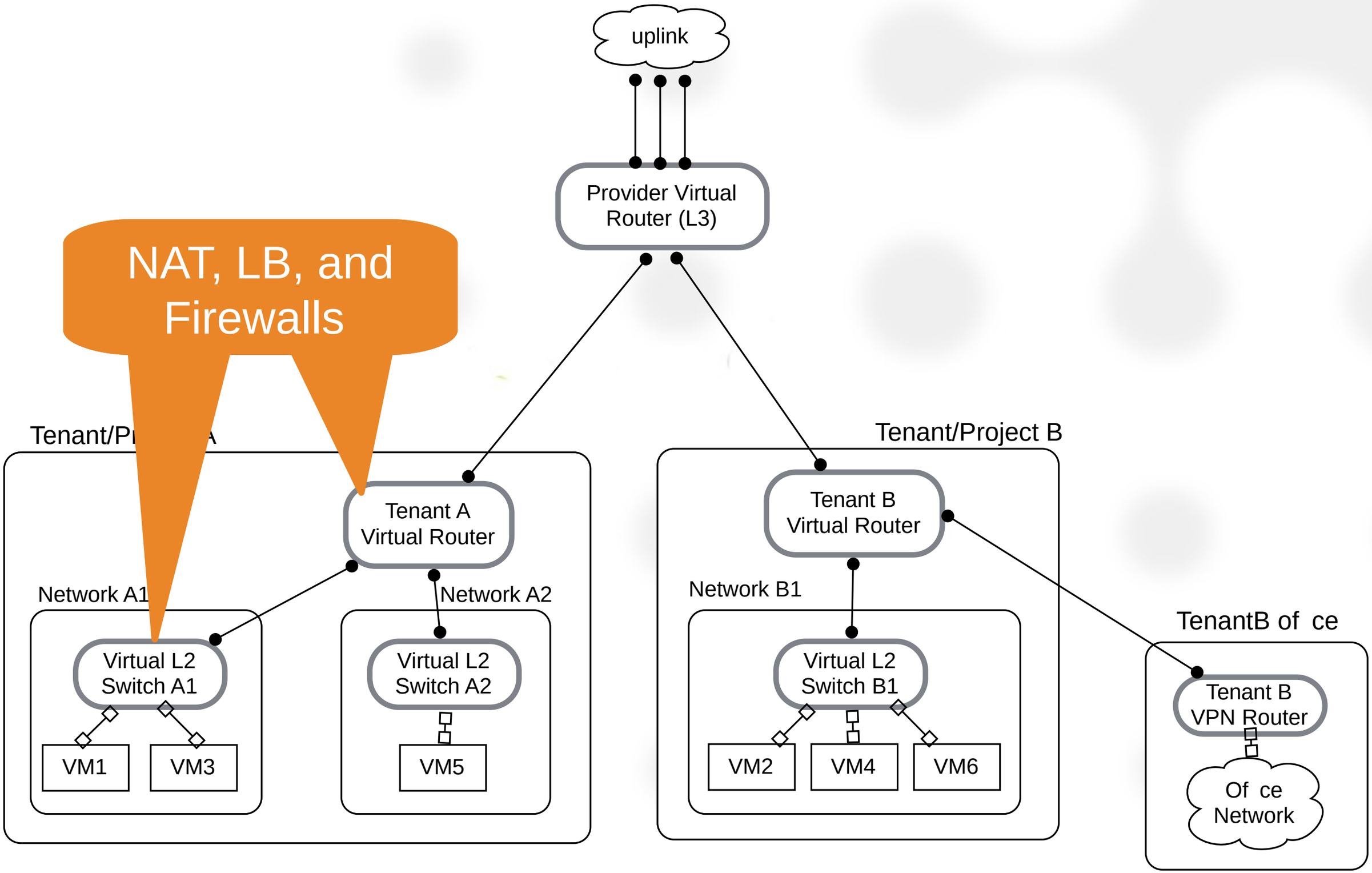

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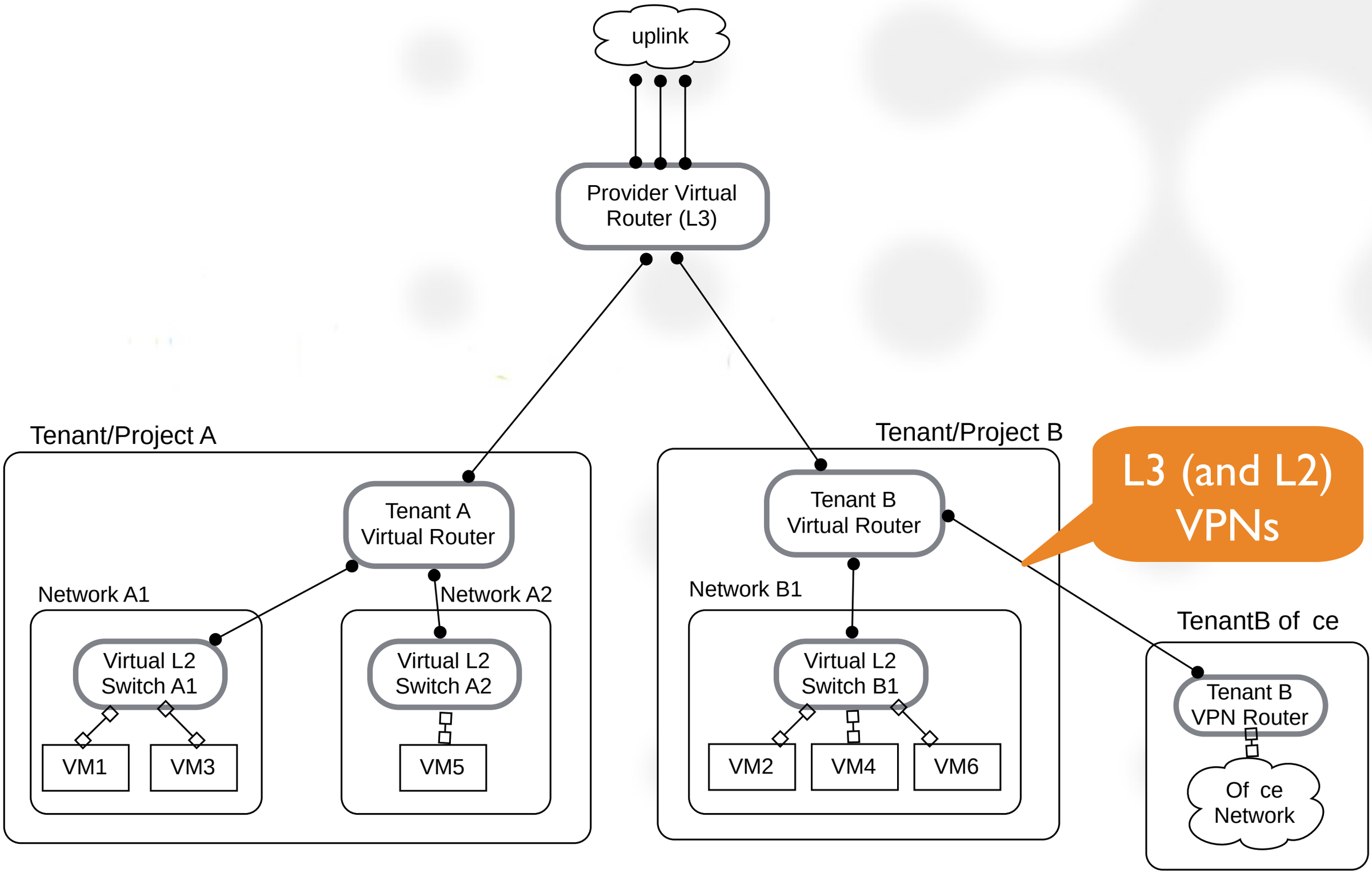

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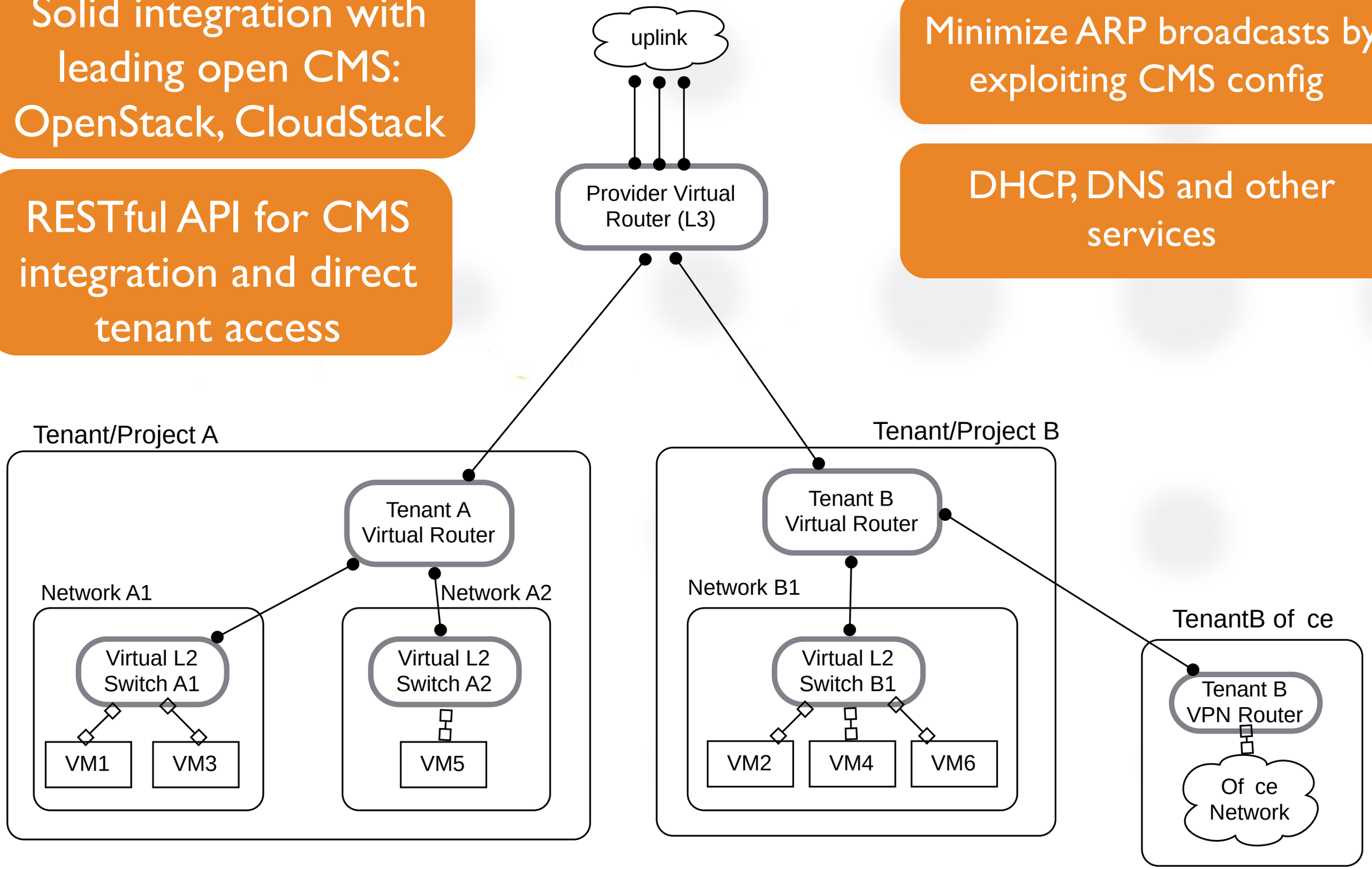
Requirements

Solid integration with leading open CMS: OpenStack, CloudStack

RESTful API for CMS integration and direct tenant access



Minimize ARP broadcasts by exploiting CMS config

DHCP, DNS and other services

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Requirements: recap

- Multi-tenancy
- Scalable, fault-tolerant devices (or device-agnostic network services).
- L2 isolation
- L3 routing isolation
  - VPC
  - Like VRF (virtual routing and fwd-ing)
- BGP gateway
- Scalable control plane
  - ARP, DHCP, ICMP
- Floating IP
- Stateful NAT
  - Port masquerading
  - DNAT
- ACLs
- Stateful (L4) Firewalls
  - Security Groups
- LB health checks
- VPNs at L2 and L3
  - IPSec
- REST API
- Integration with CMS
  - OpenStack
  - CloudStack

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How to build it?

1. Virtualized physical devices
2. Centrally controlled OpenFlow-based hop-by-hop switching fabric
3. Edge to edge overlays

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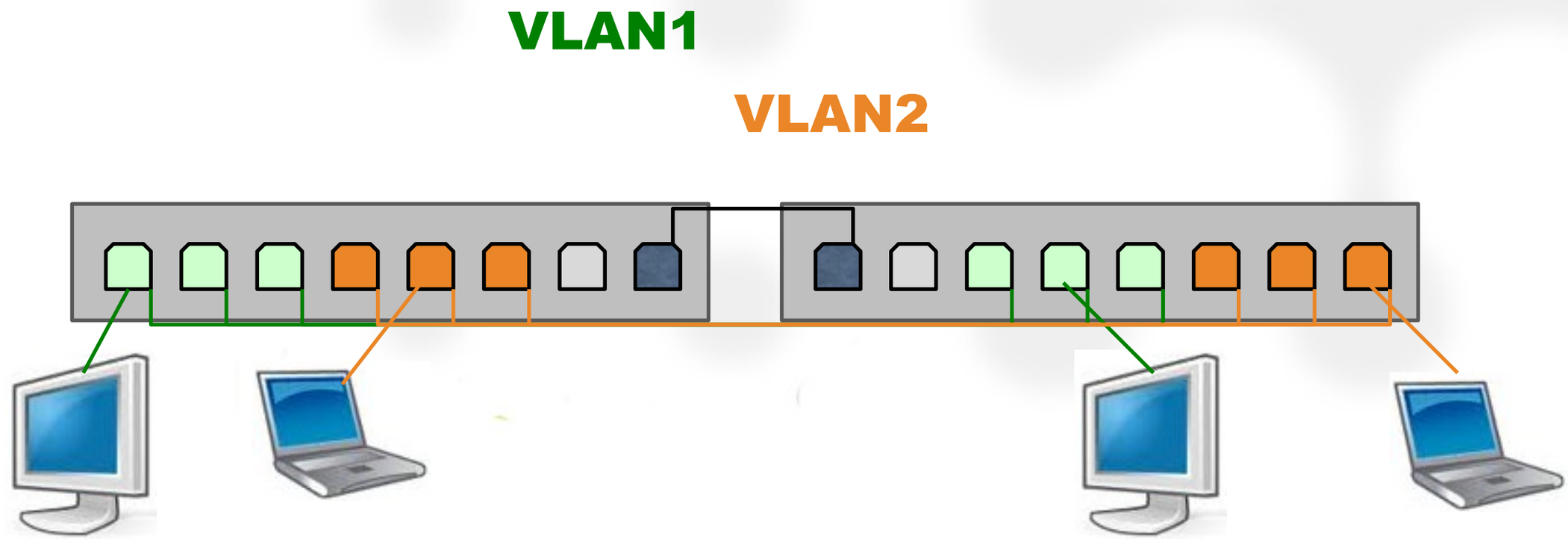
1 Virtualized physical devices

VLAN



- 4096 limit on number of unique tags
- Large spanning trees terminating on many hosts
- High churn in switch control planes due to MAC learning
- Need MLAG for L2 multi-path (vendor specific)

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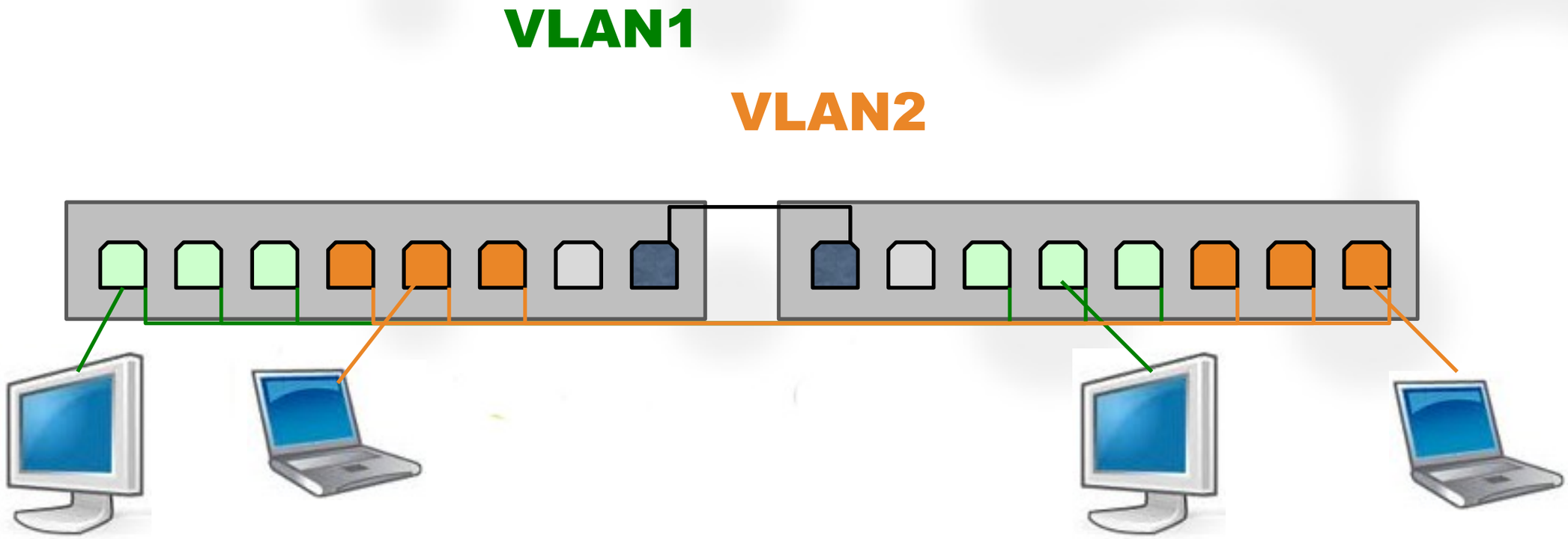
1 Virtualized physical devices

VLAN (more)



- L2 isolation
- What about L3 and Internet access?
- Use VRF or virtual appliances? Fault-tolerance?

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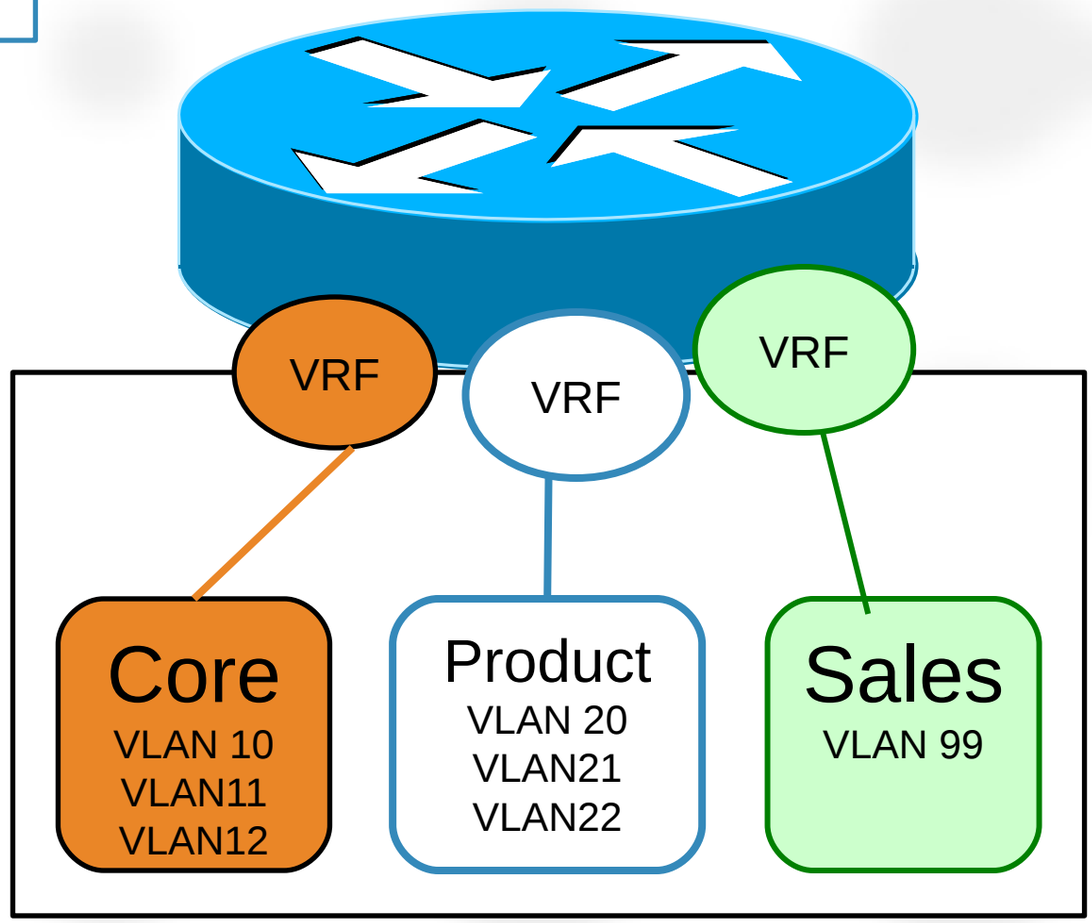
1 Virtualized physical devices

VRF



出典： http://infrastructureadventures.com/tag/vrf-lite/

- Not scalable to cloud scale
- Expensive hardware
- Not fault tolerant (HSRP?)
- L2 and L3 isolation. What about NAT, LB, FW?

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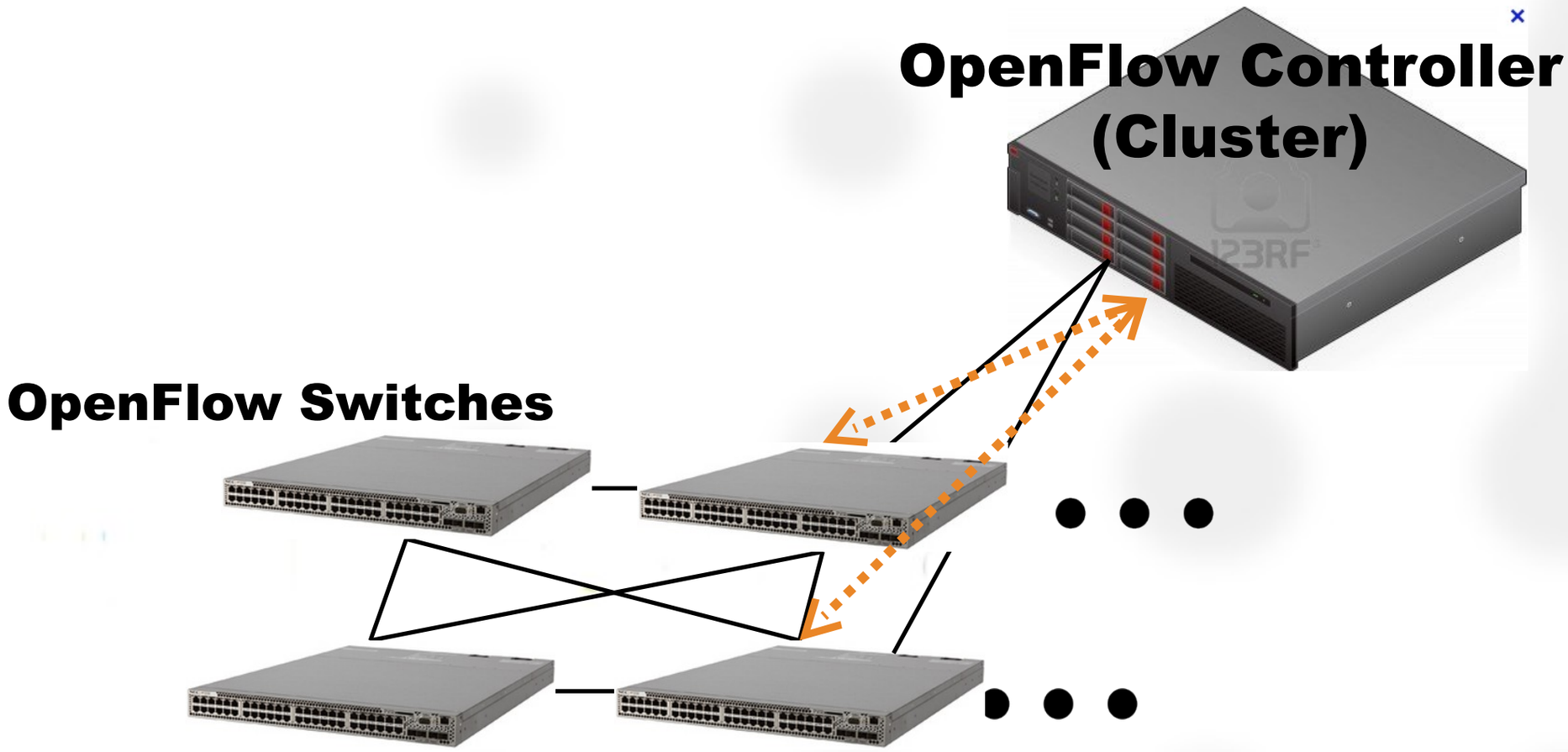
2 OpenFlow hop-by-hop switch fabric



- Fabric extends to the compute host software switch?
  - •State in each switch is proportional to the virtual network state
  - •Need to update all switches in path when provisioning new virtual devices or updating them.
  - •Not scalable, slow and non-atomic switch updates.

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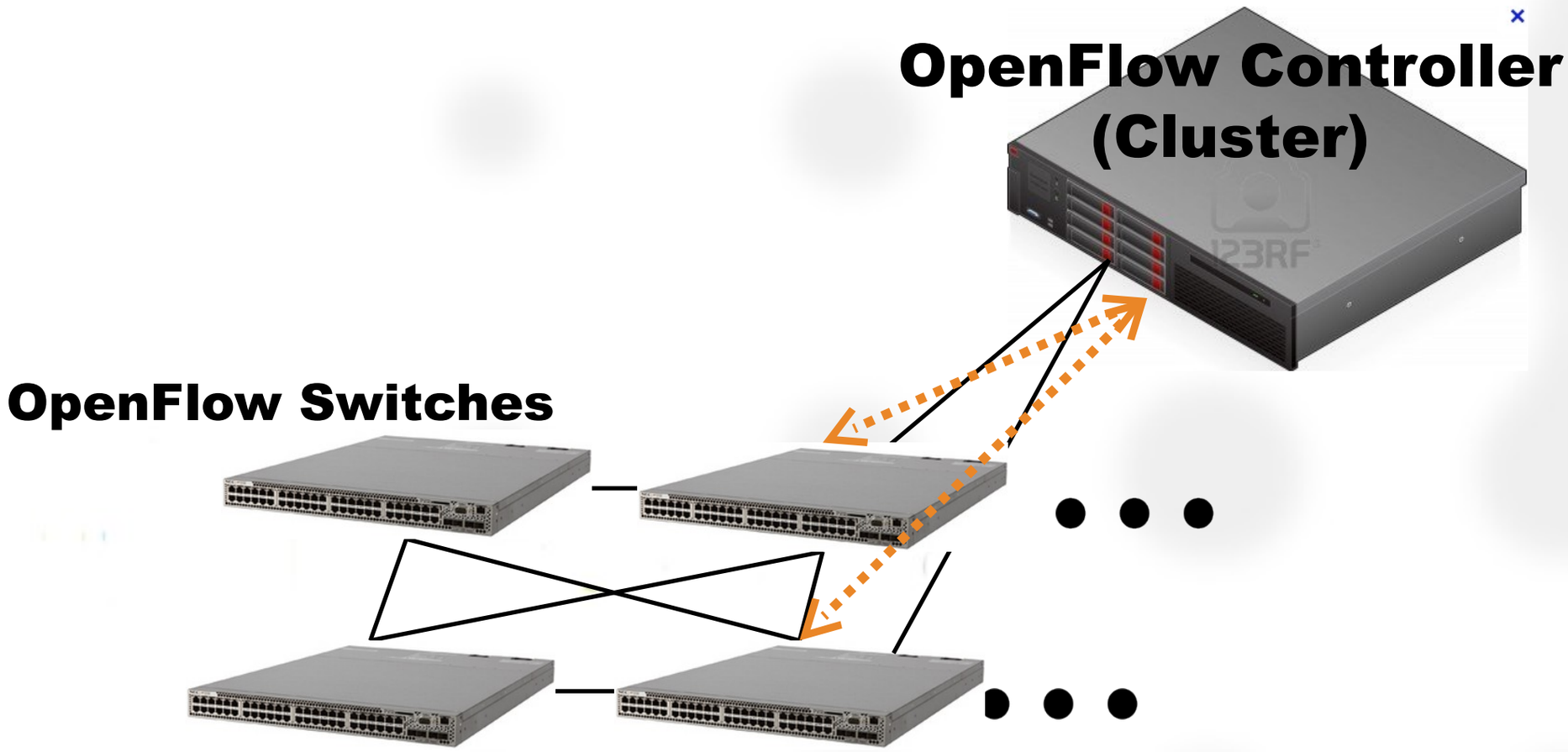
2 OpenFlow hop-by-hop switch fabric (more)



- Flow rules for VM flows (microflows)?
- Flow rules for virtual device simulation?

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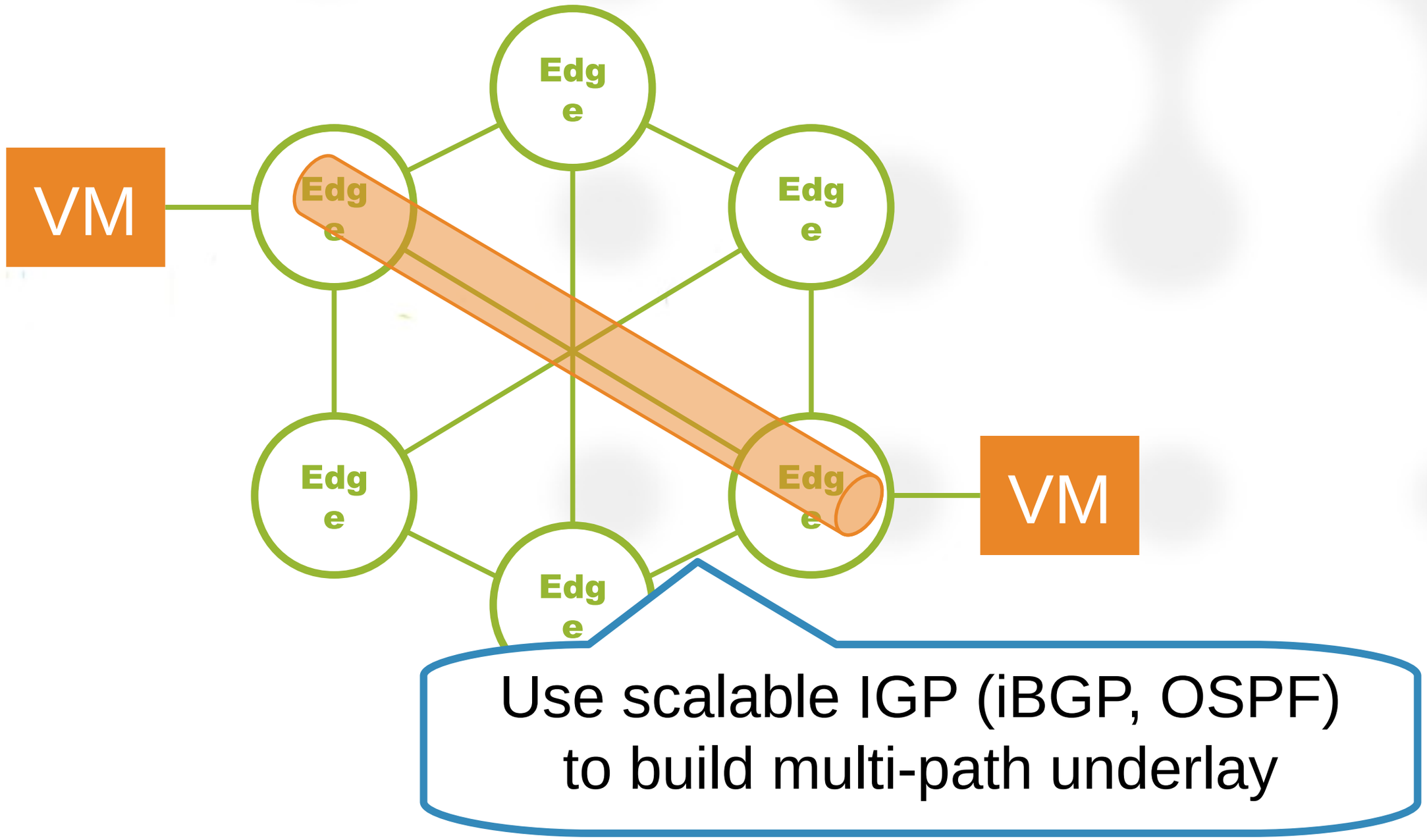
3 Edge-to-Edge Overlays



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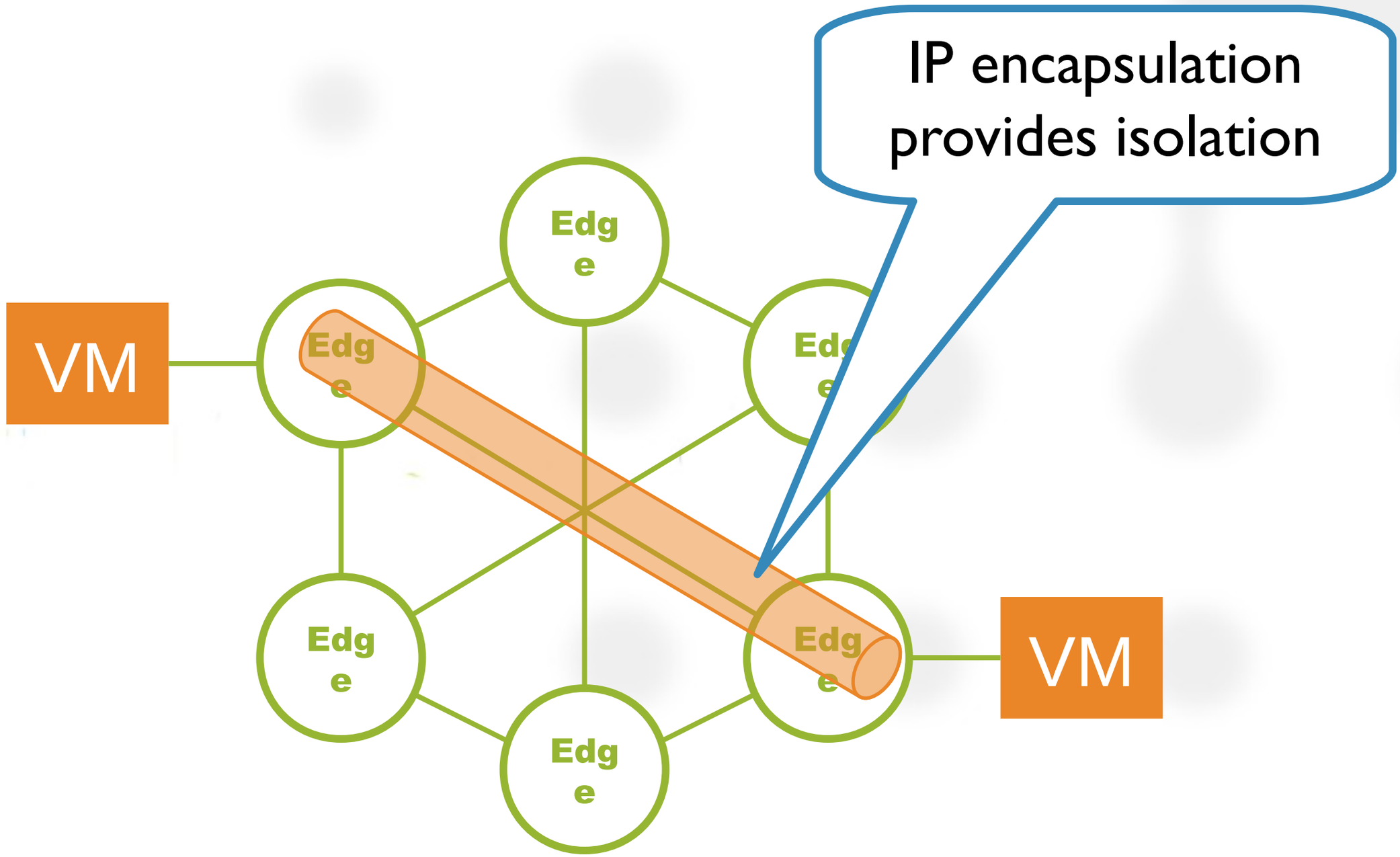

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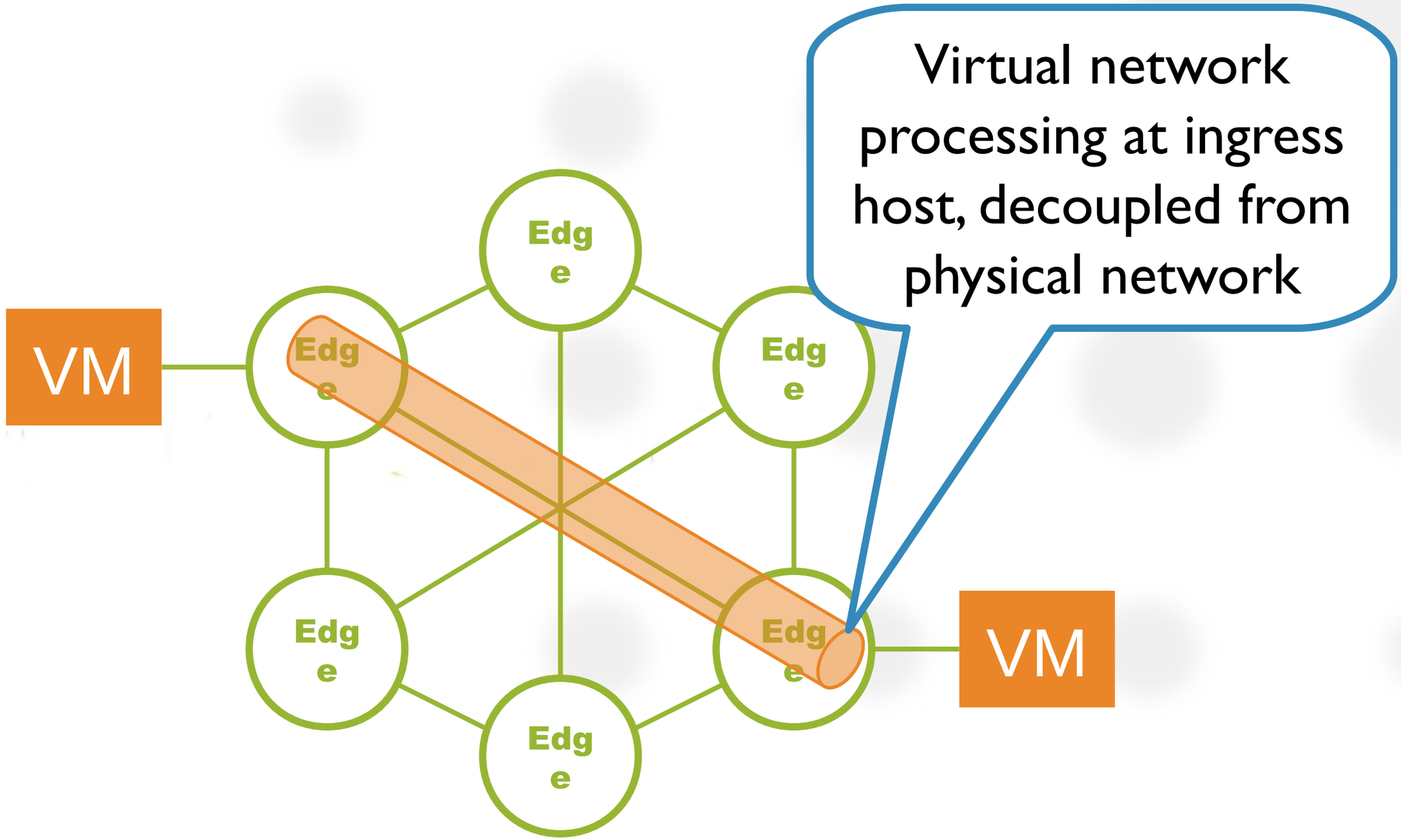

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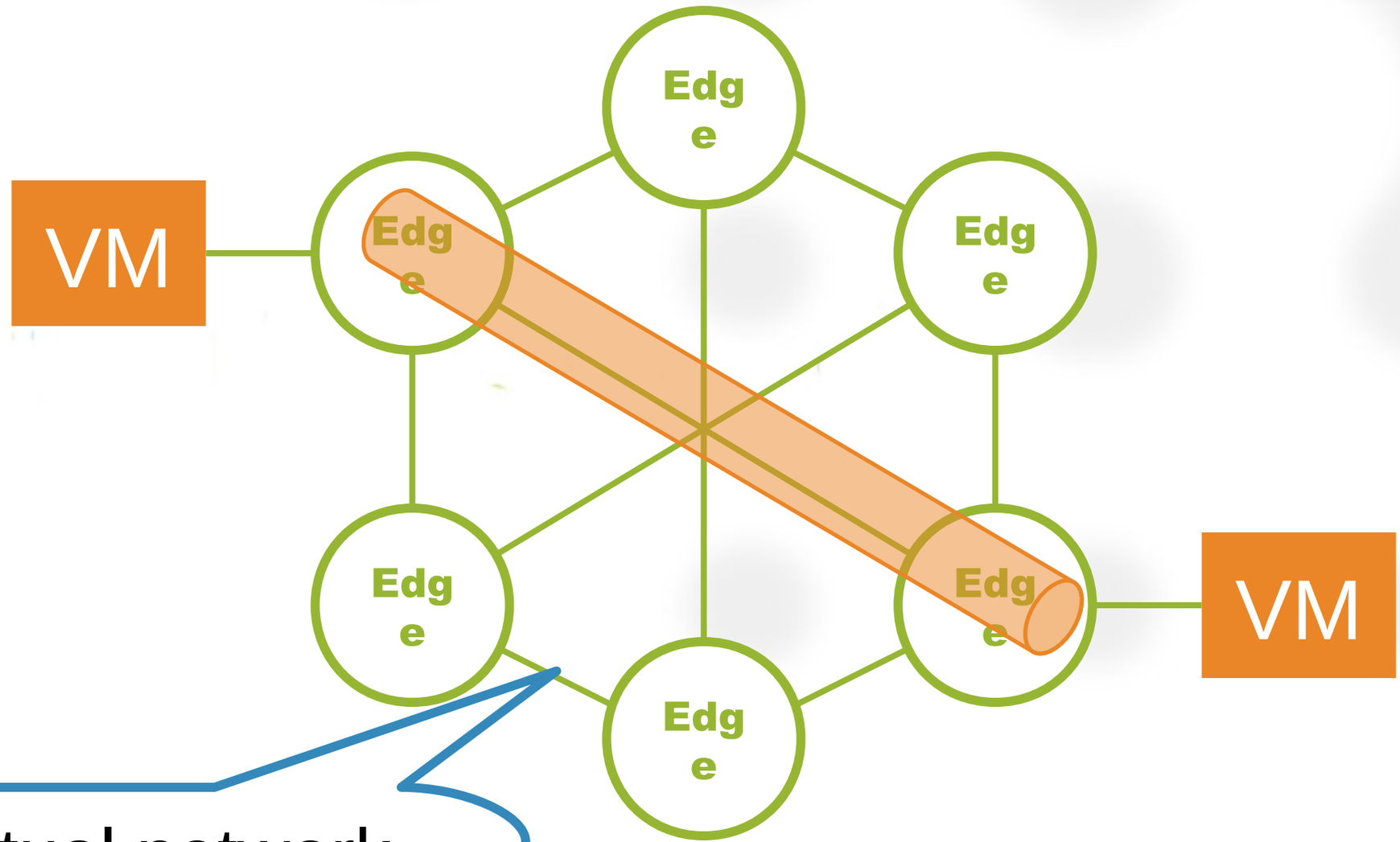

Virtual network changes don't affect underlay state

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3 Edge-to-Edge Overlays

- Packet processing on x86 CPUs (at edge)
  - Intel DPDK facilitates packet processing
  - Number of cores in servers increasing fast
- Clos Networks (for underlay)
  - Spine and Leaf architecture with IP
  - Economical and high E-W bandwidth
- Merchant silicon (cheap IP switches)
  - Broadcom, Intel (Fulcrum Micro), Marvell
  - ODMs (Quanta, Accton) starting to sell directly
  - Switches are becoming just like Linux servers
- Optical intra-DC Networks

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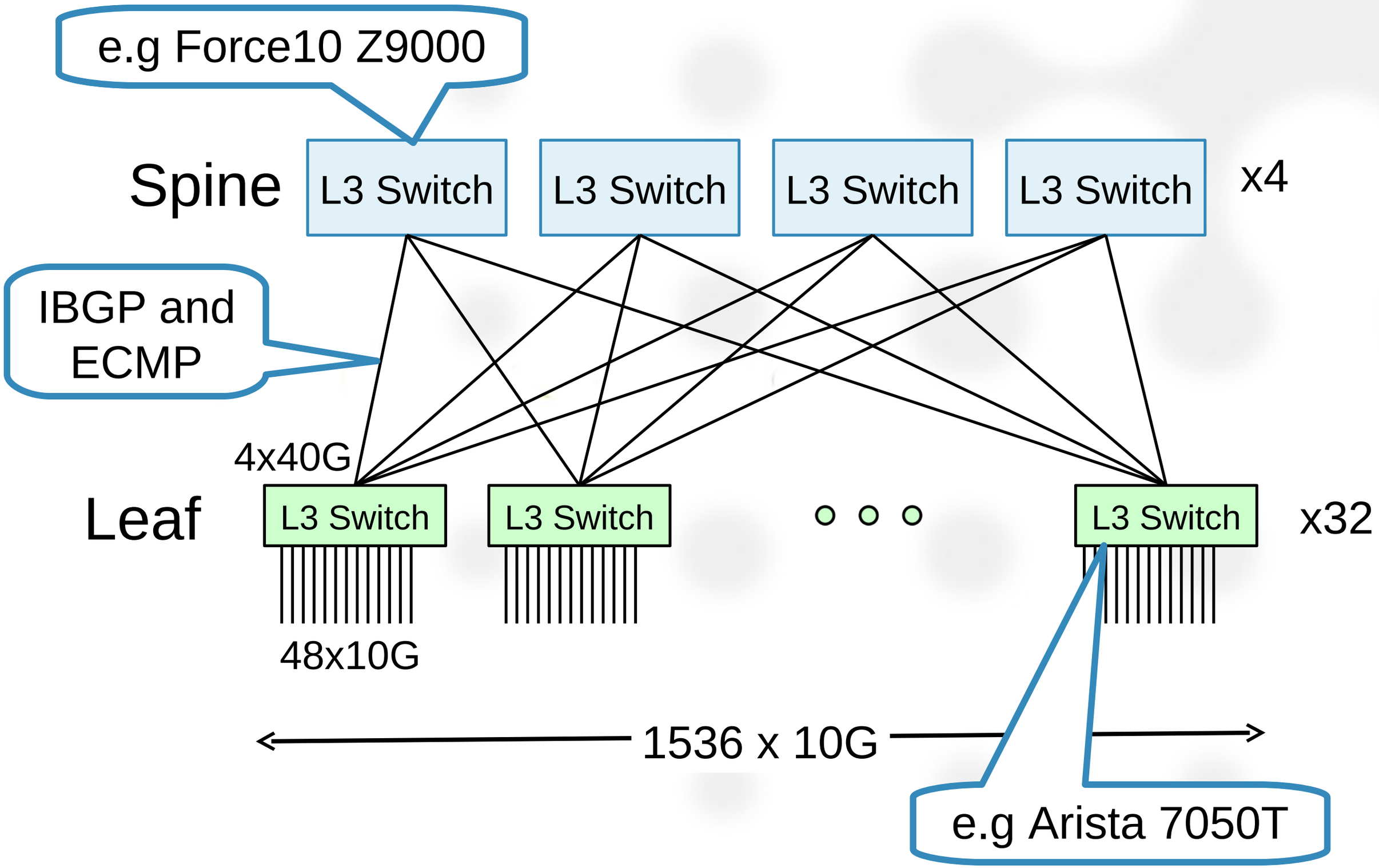
Spine and Leaf Network Architecture



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Overlays are the right approach!

But not sufficient...

We still need a scalable control plane.

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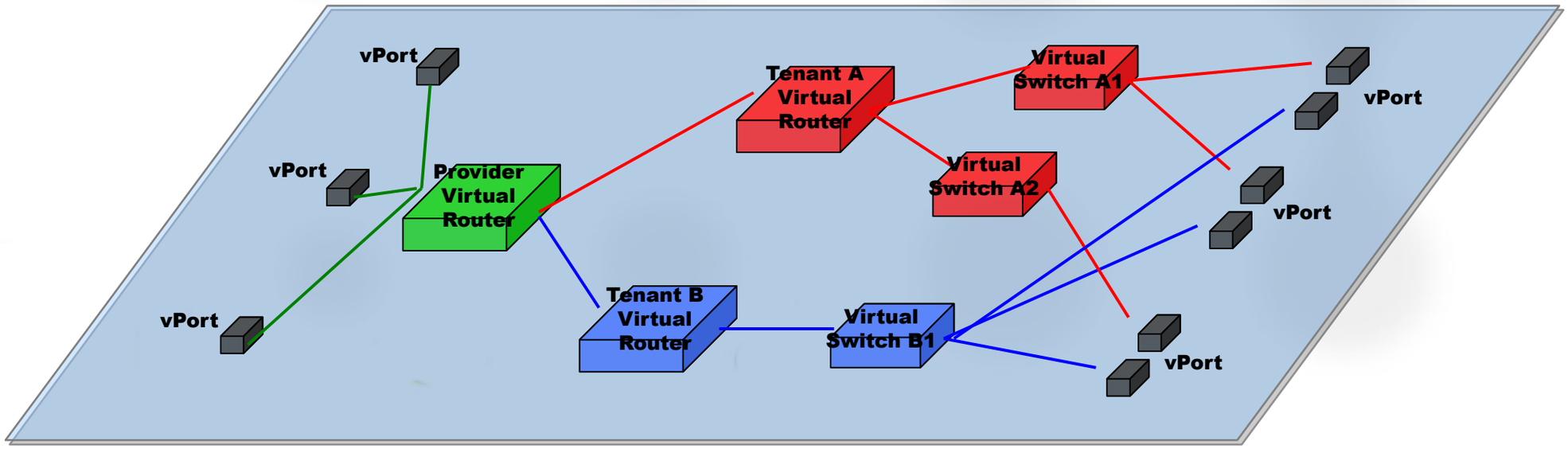
Logical Topology



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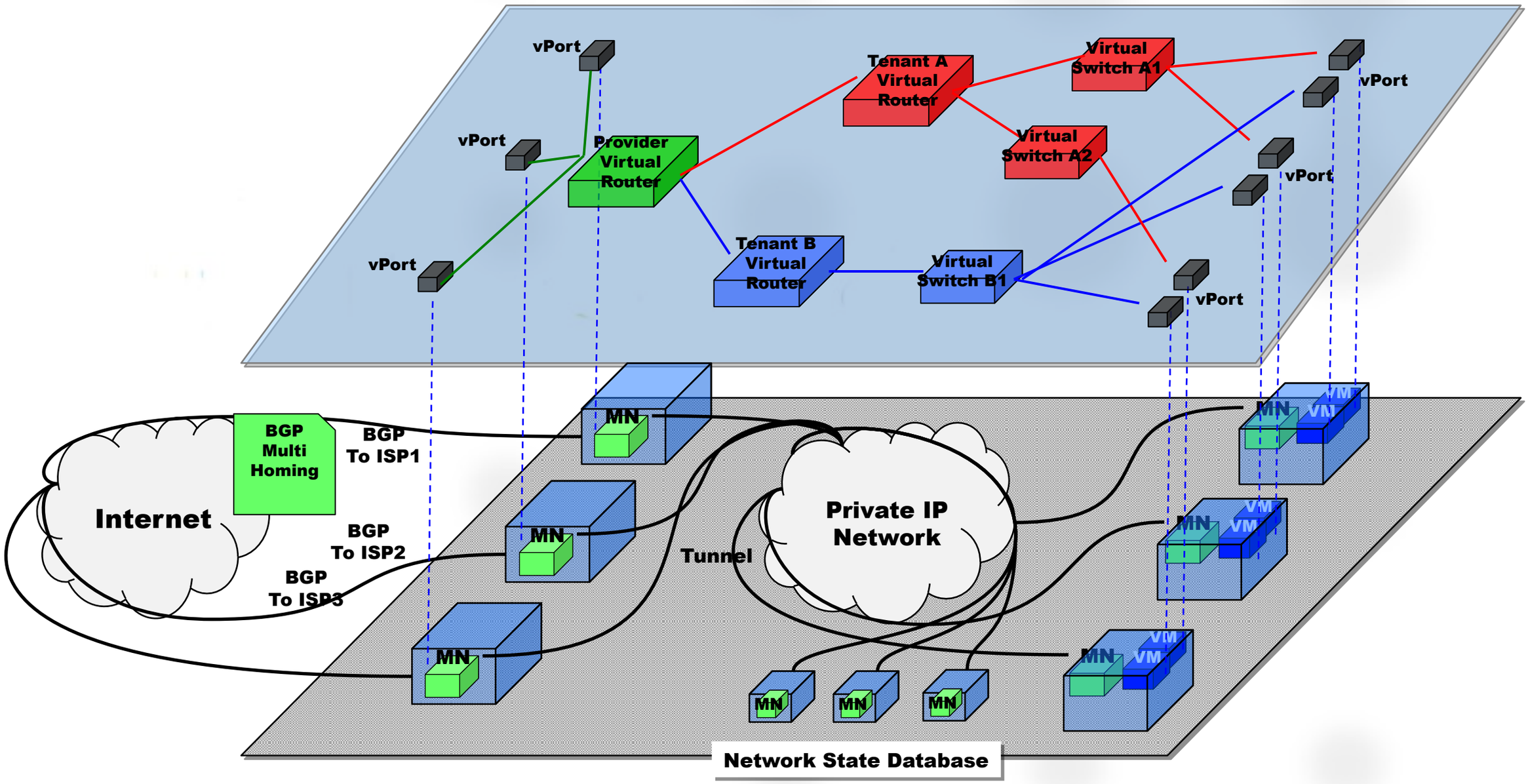
Logical Topology



Physical Topology

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MidoNet SDN Solution

Dashboard

MidoNet REST API

Distributed State

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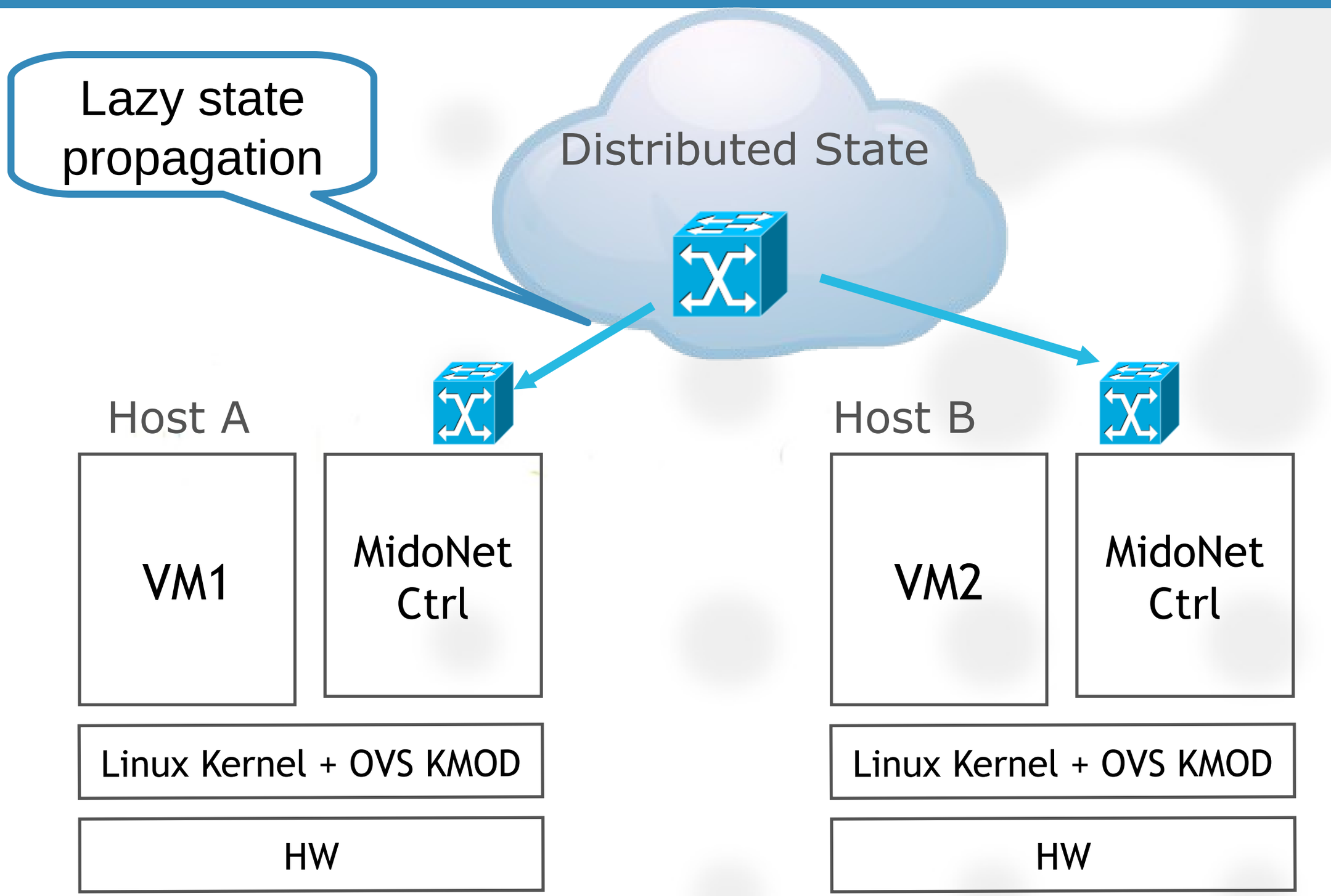
MidoNet SDN Solution



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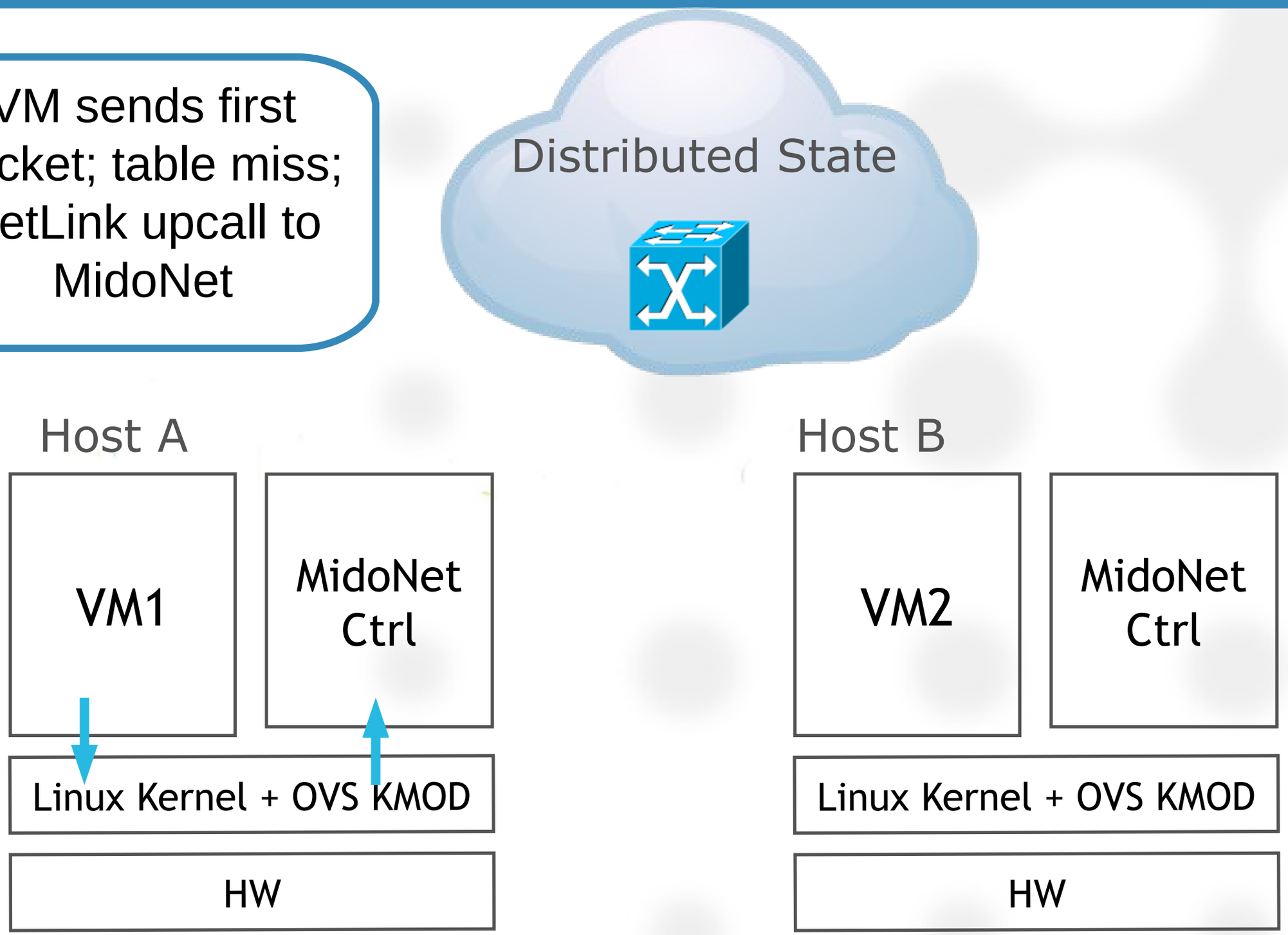
MidoNet SDN Solution

VM sends first packet; table miss; NetLink upcall to MidoNet



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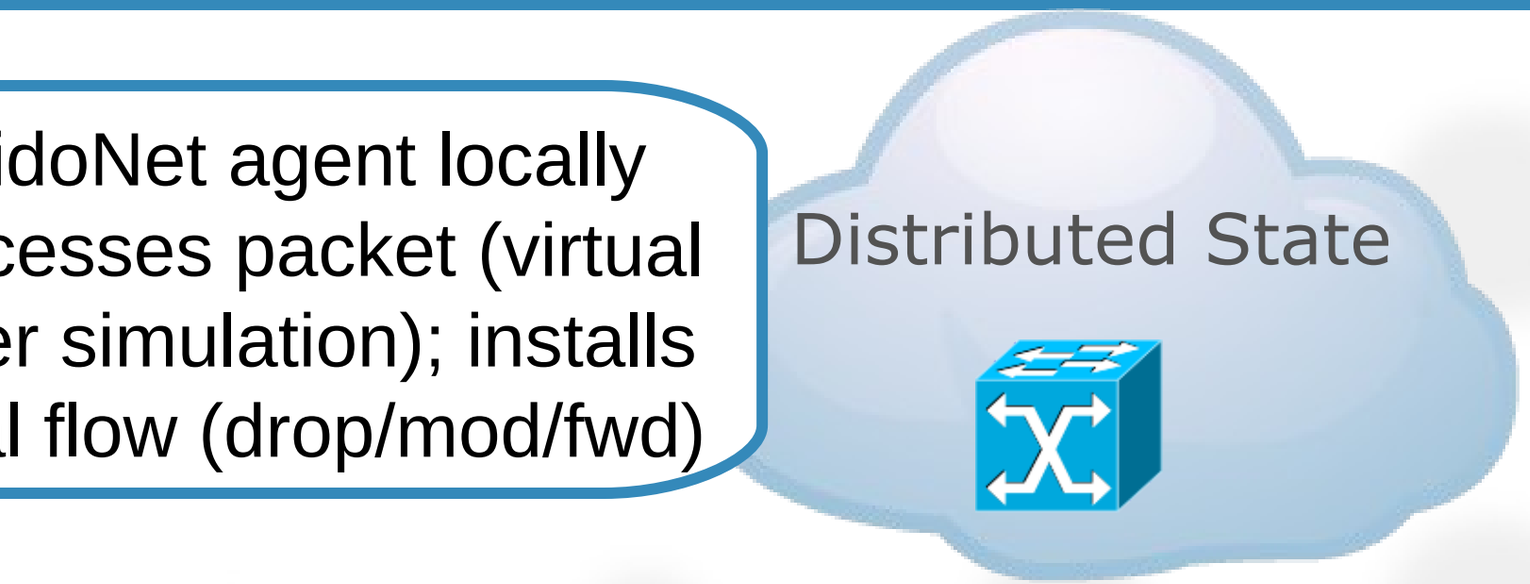
MidoNet SDN Solution

MidoNet agent locally processes packet (virtual layer simulation); installs local flow (drop/mod/fwd)



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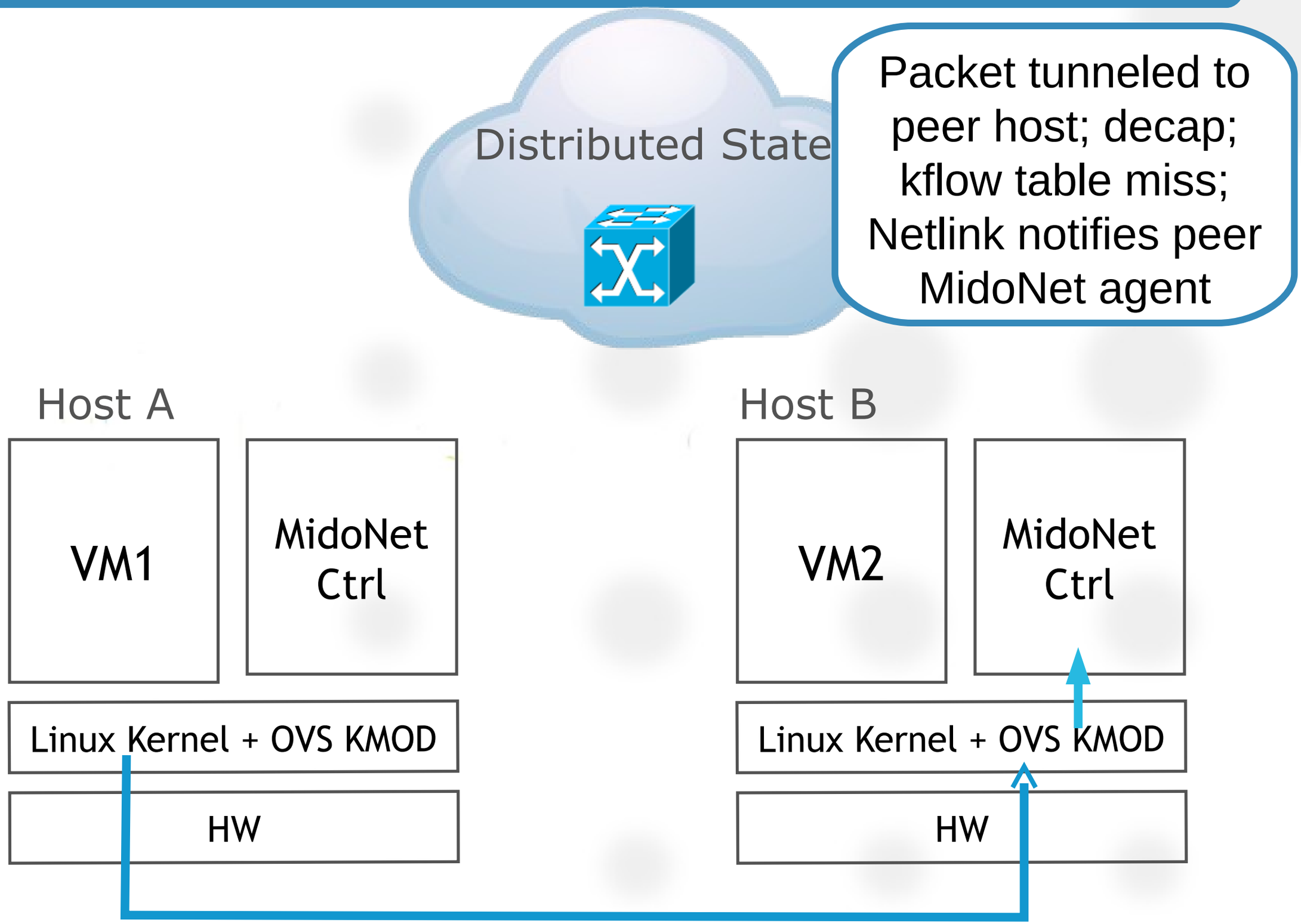
MidoNet SDN Solution



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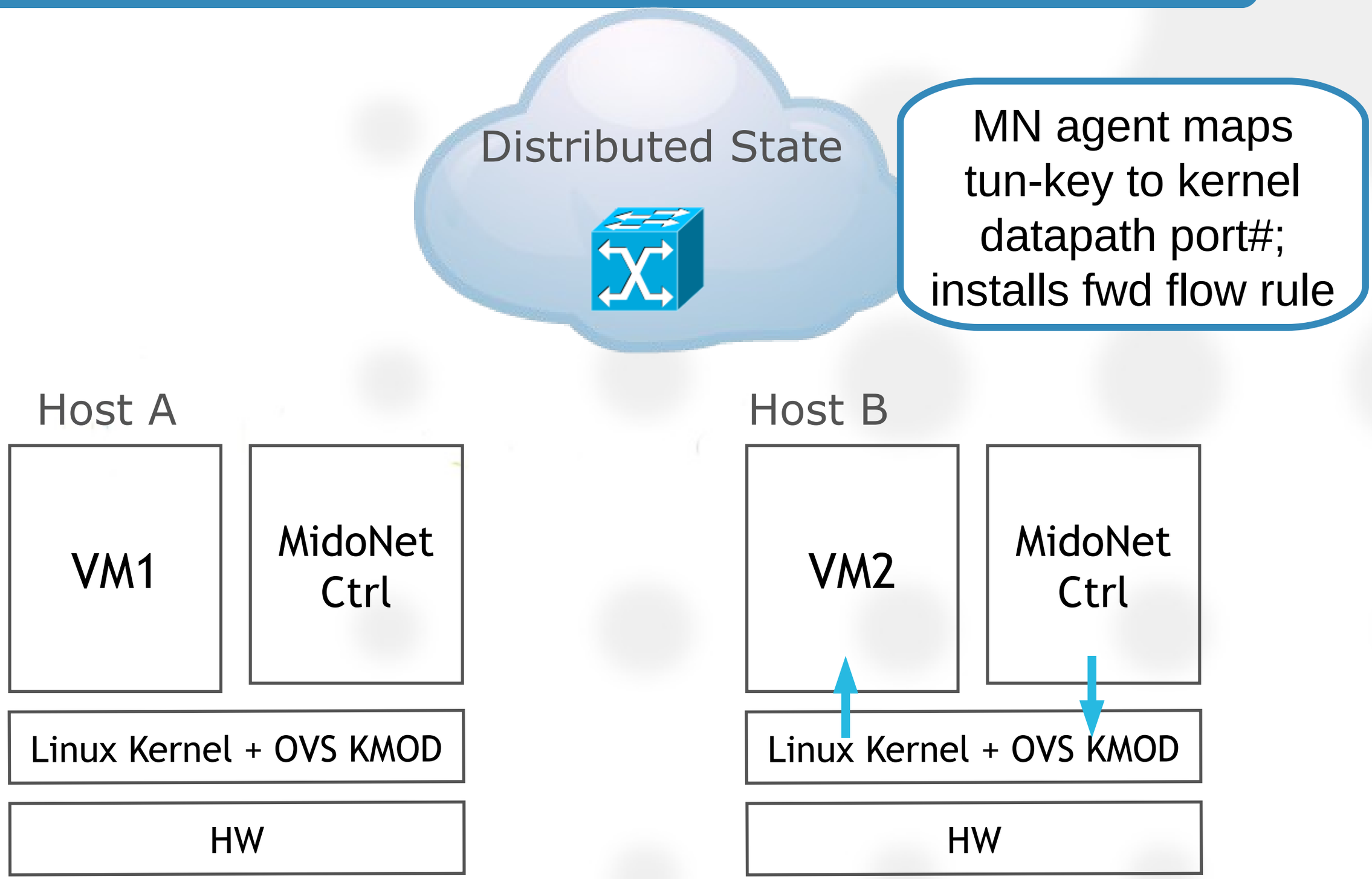
MidoNet SDN Solution



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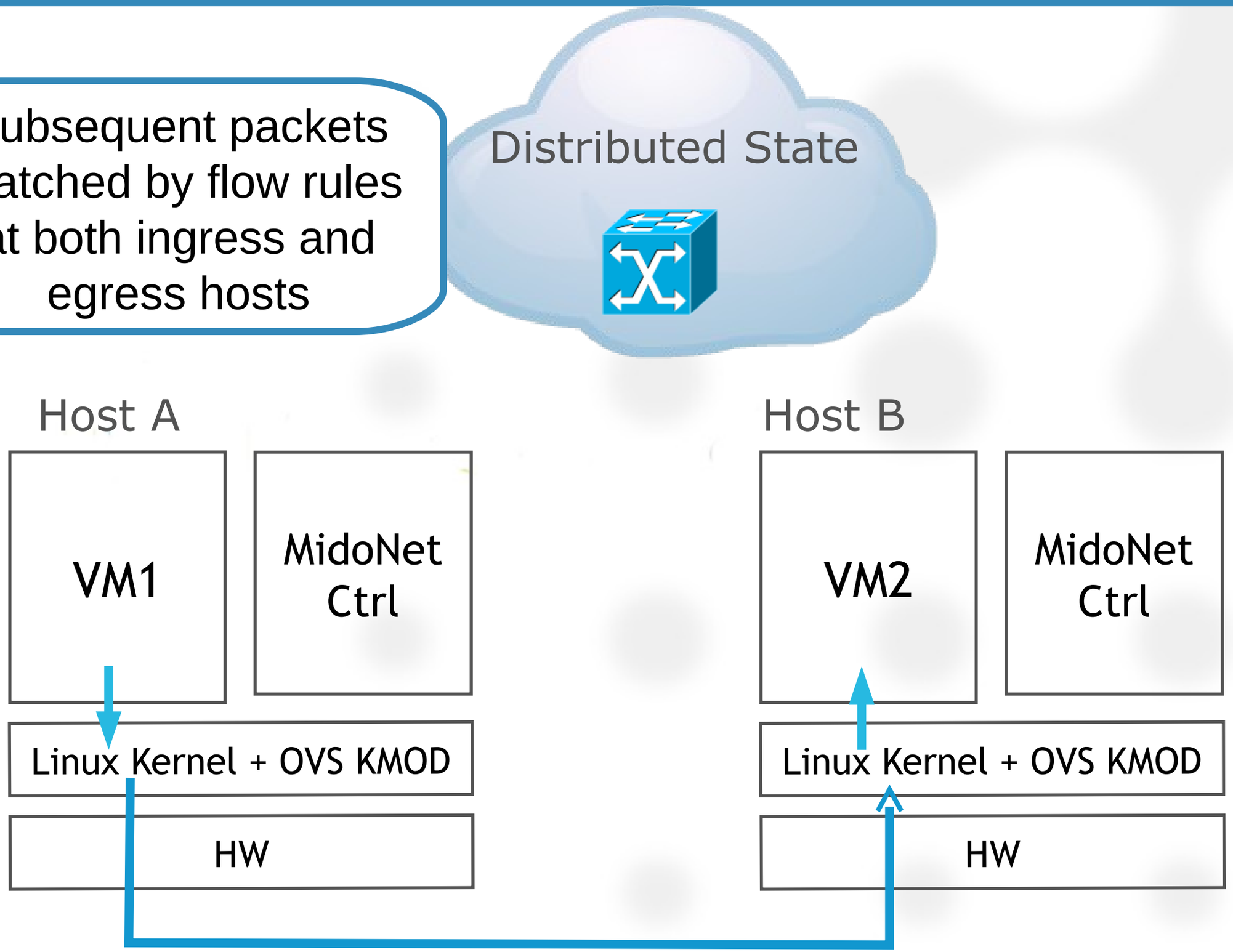
MidoNet SDN Solution

Subsequent packets matched by flow rules at both ingress and egress hosts



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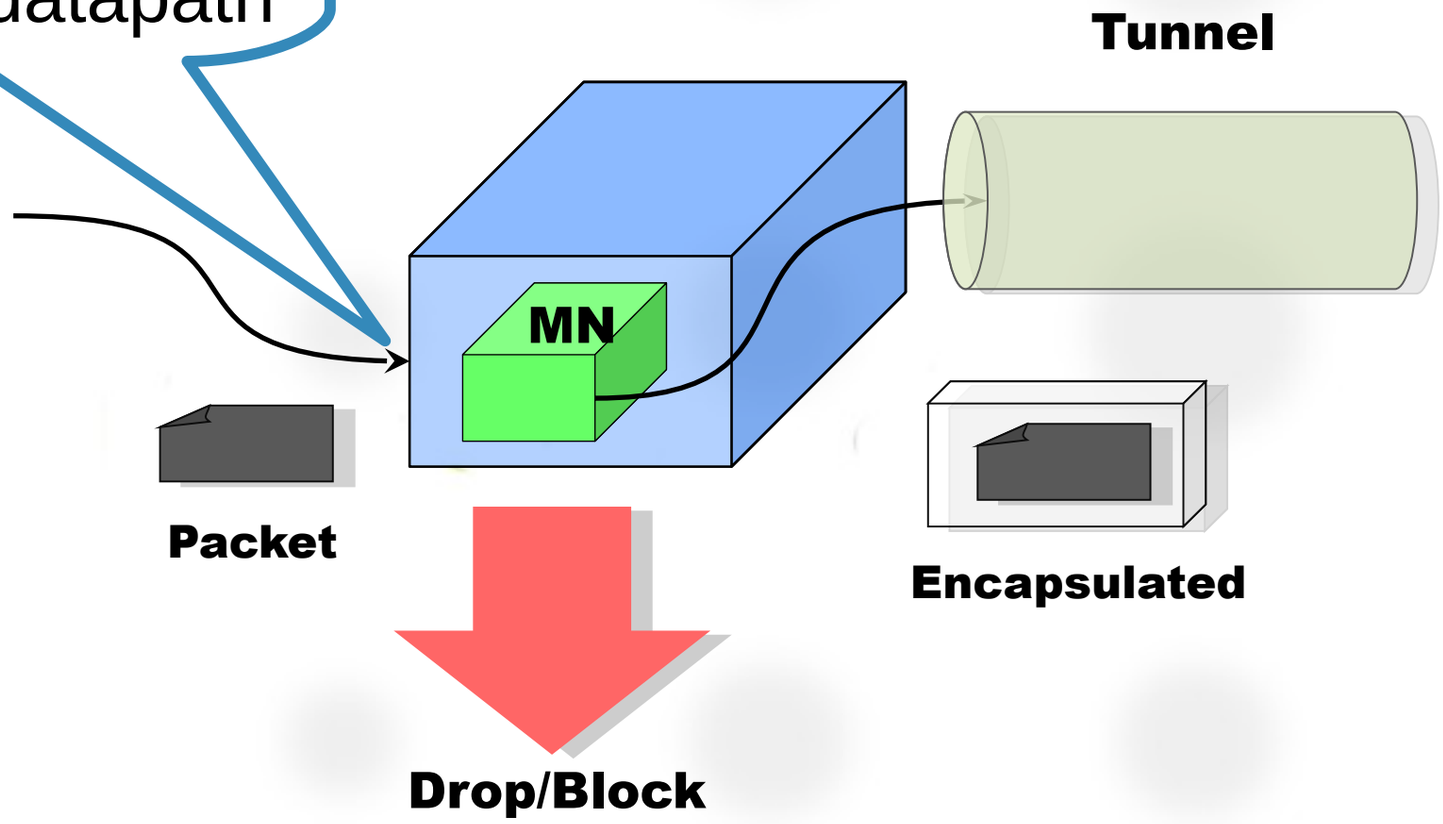
MidoNet SDN Solution

Packet from VM, VPN, or external BGP peer enters kernel datapath



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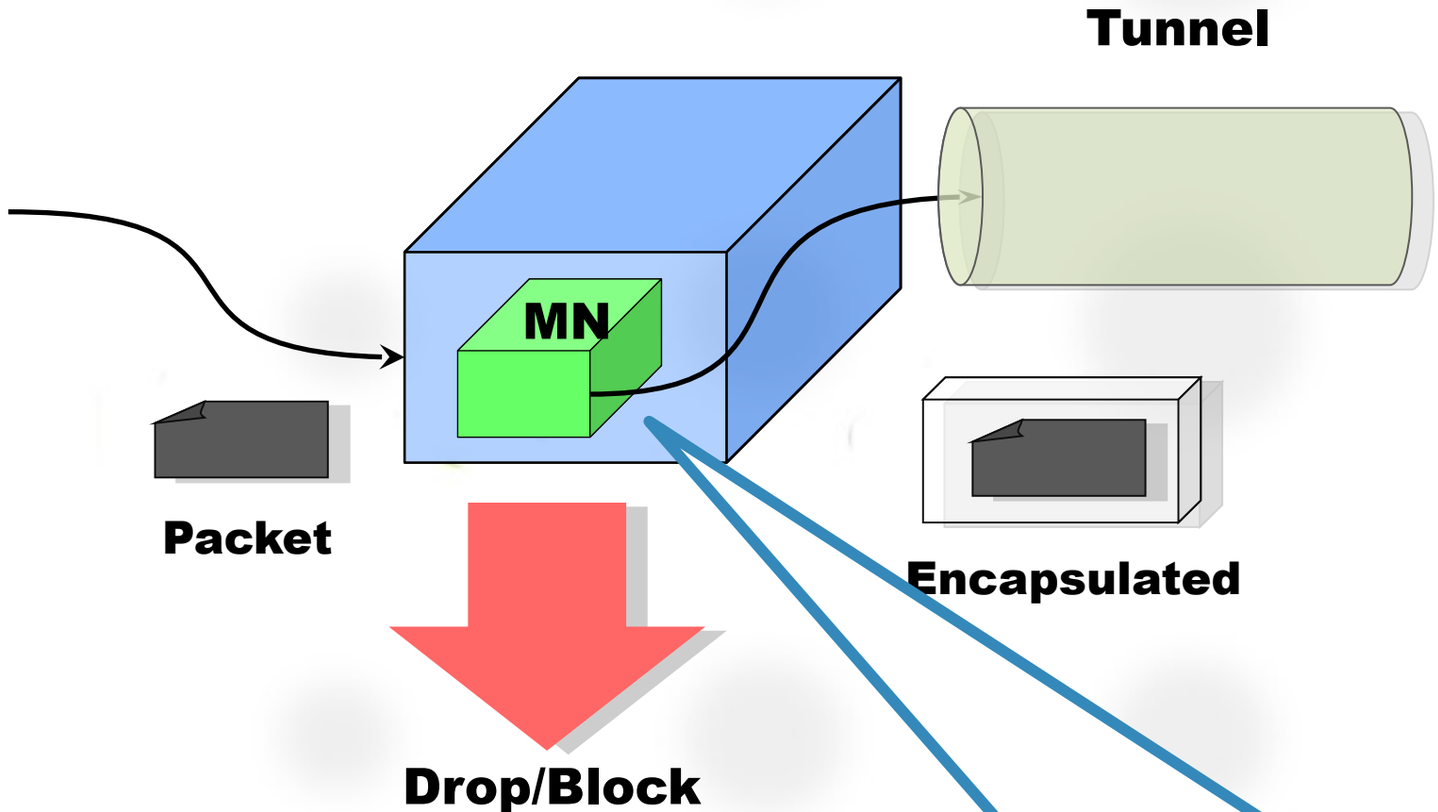
MidoNet SDN Solution



One flow rule reflecting the outcome of the virtual layer simulation AND the mapping of egress vport to peer host decides to drop or fwd

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MidoNet SDN Solution

- Distributed and scalable control plane
  - ➢Handle all control packets at local MidoNet agent adjacent to VM
- Scalable and fault tolerant central database
  - ➢Stores virtual network configuration
  - ➢Dynamic network state
    - ✧MAC learning, ARP cache, etc
  - ➢Cached at edges on demand
- All packet modifications at ingress
  - ➢One virtual hop
    - ✧No travel through middle boxes
  - ➢Drop at ingress

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MidoNet SDN Solution

- Scalable edge gateway interface to external networks
  - Multihomed BGP to ISP
- REST API and GUI
- Integration with popular open source cloud stacks
  - OpenStack
    - Removes SPOF of network node
    - Scalable and fault tolerant NAT for floating IP
    - Implements security groups efficiently
  - CloudStack and Eucalyptus

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Deep OpenStack Integration

- Quantum Plugin
  - L2 isolation, of course
- Also…
  - L3 isolation (without VM / appliance)
  - Security groups (stateful firewall)
  - Floating IP (NAT)
  - Load balancing (L4)

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Future Directions

- Scalable L7 virtual appliances
- MPLS VPN termination
  - Interconnect with carrier backbones
- multiple data center federation
  - Virtual L2 between sites
- LISP
  - Global IP mobility between sites

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Conclusions

- IaaS clouds require new networking
- Edge to edge overlays are the right approach
- Servers are good at packet processing
  - Can use them for edge gateways
- Multipath IP network fabric is cheap and easy to build

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