Challenges in Distributed SDN

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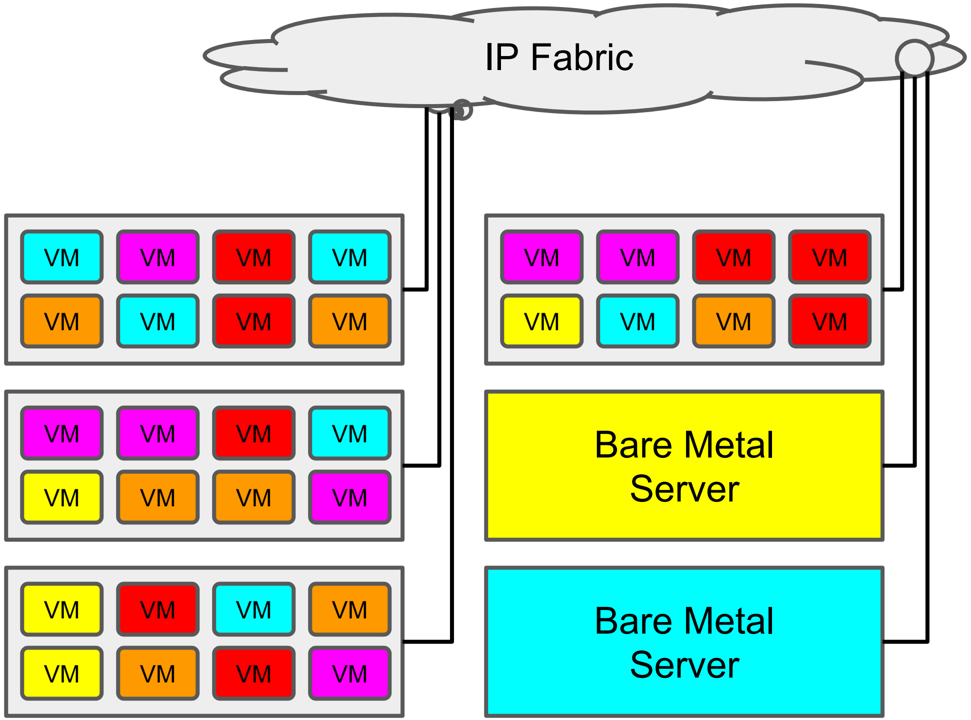
MidoNet transform this...



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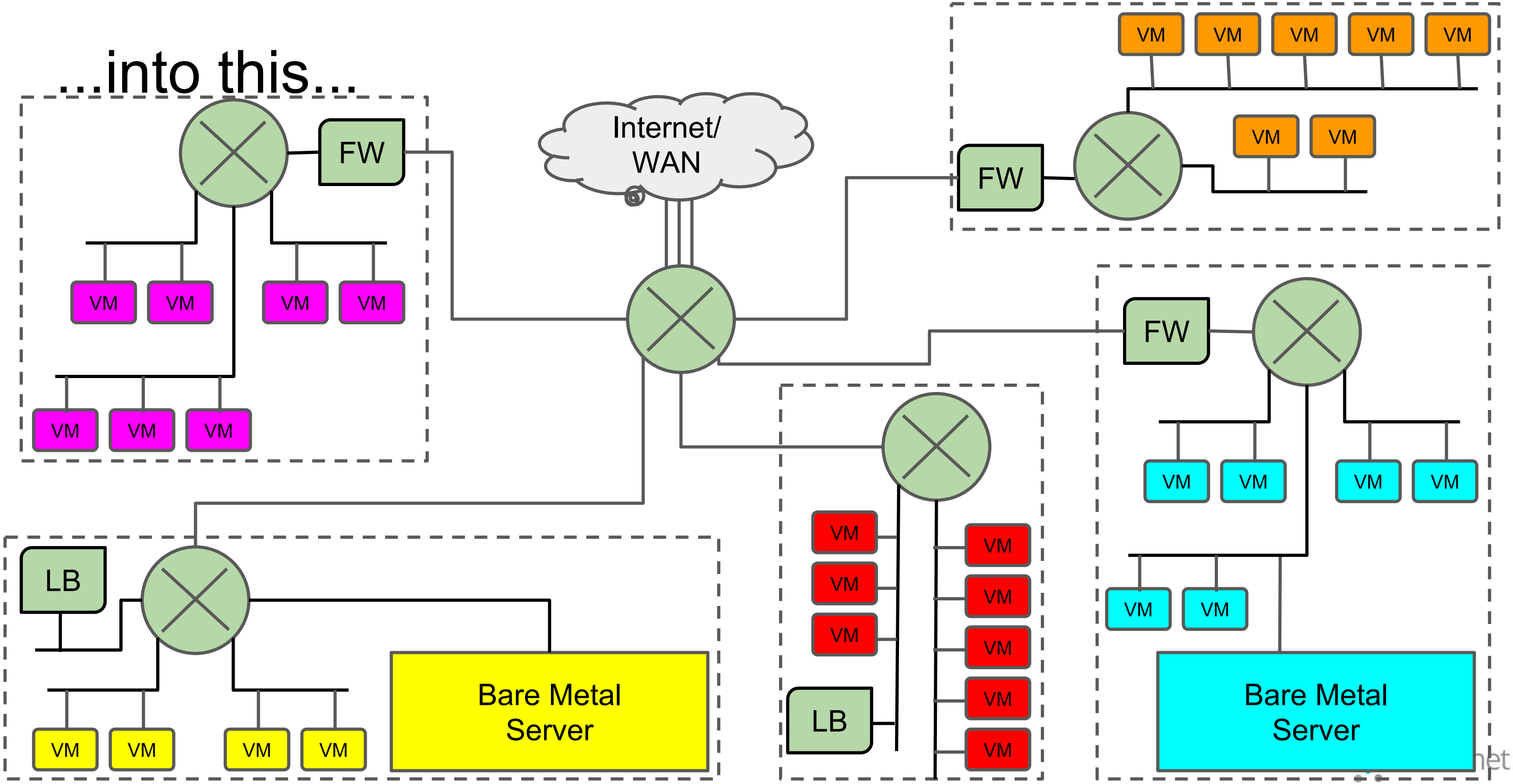
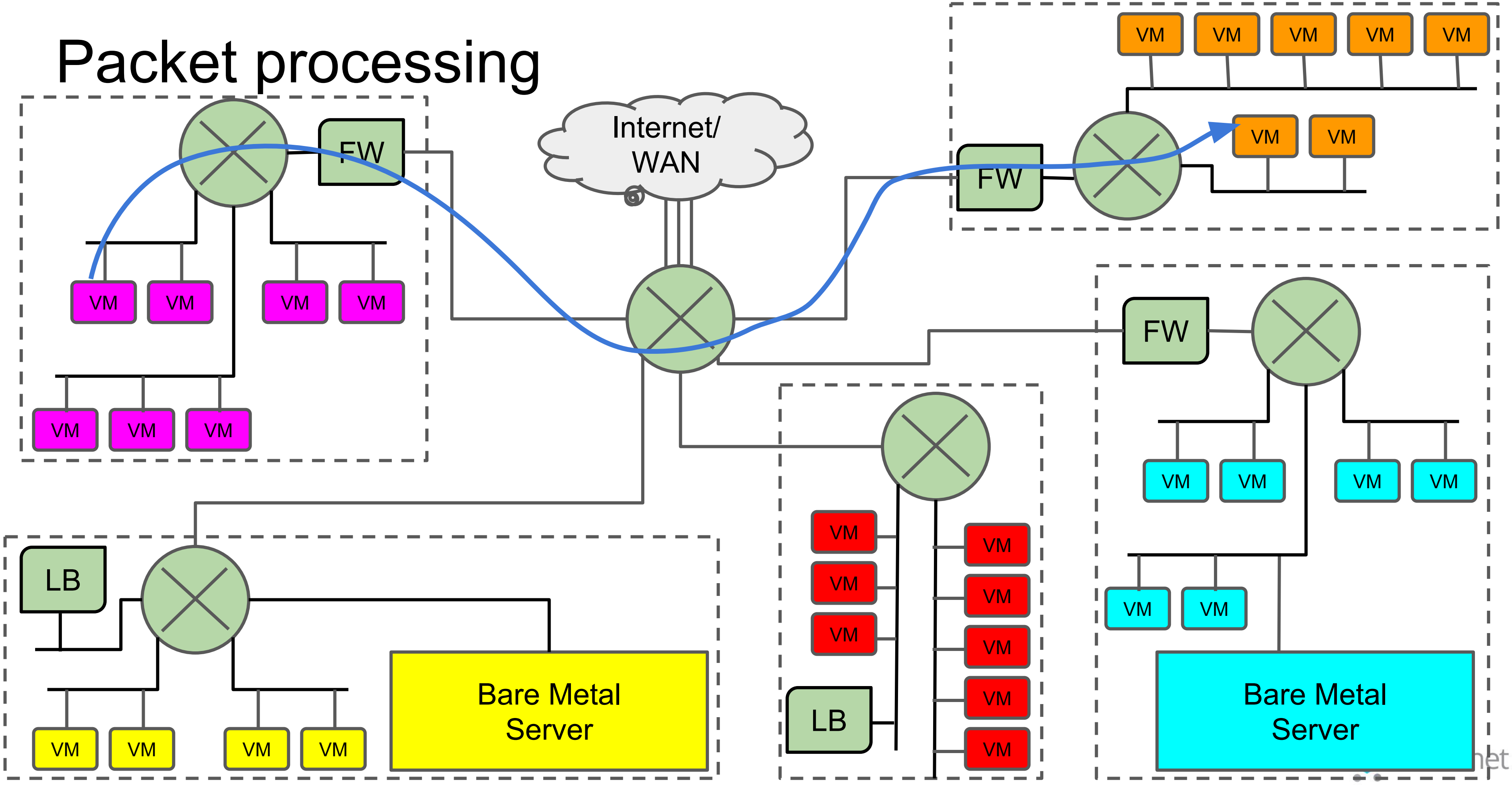
...into this...

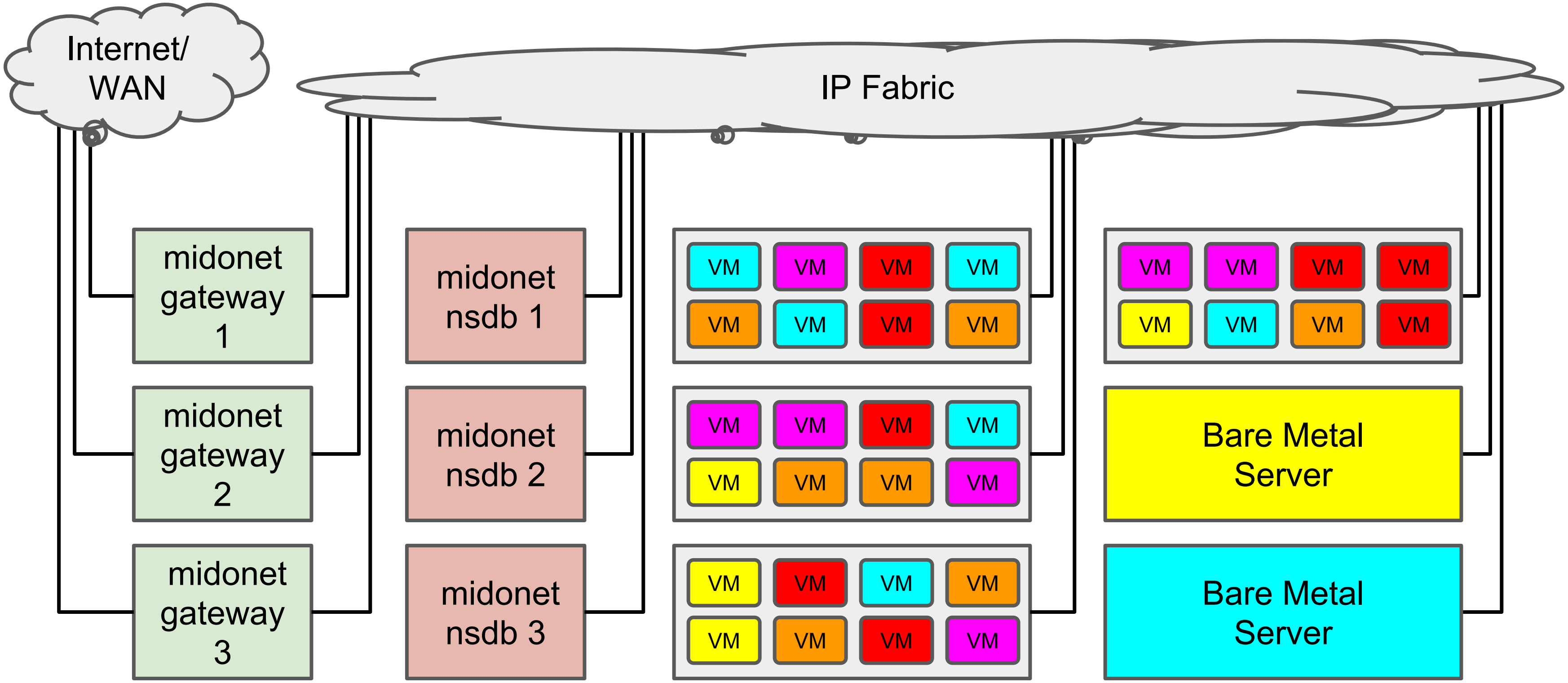


Internet/
WAN
FW
FW
FW
LB
LB
VM
Bare Metal
Server
Bare Metal
Server

Packet processing



Physical view



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MidoNet

- Fully distributed architecture
- All traffic processed at the edges, i.e., where it ingresses the physical network
  - virtual devices become distributed
  - a packet can traverse a particular virtual device at any host in the cloud
  - distributed virtual bridges, routers, NATs, FWs, LBs, etc.
- No SPOF
- No middle boxes
- Horizontally scalable L2 and L3 Gateways

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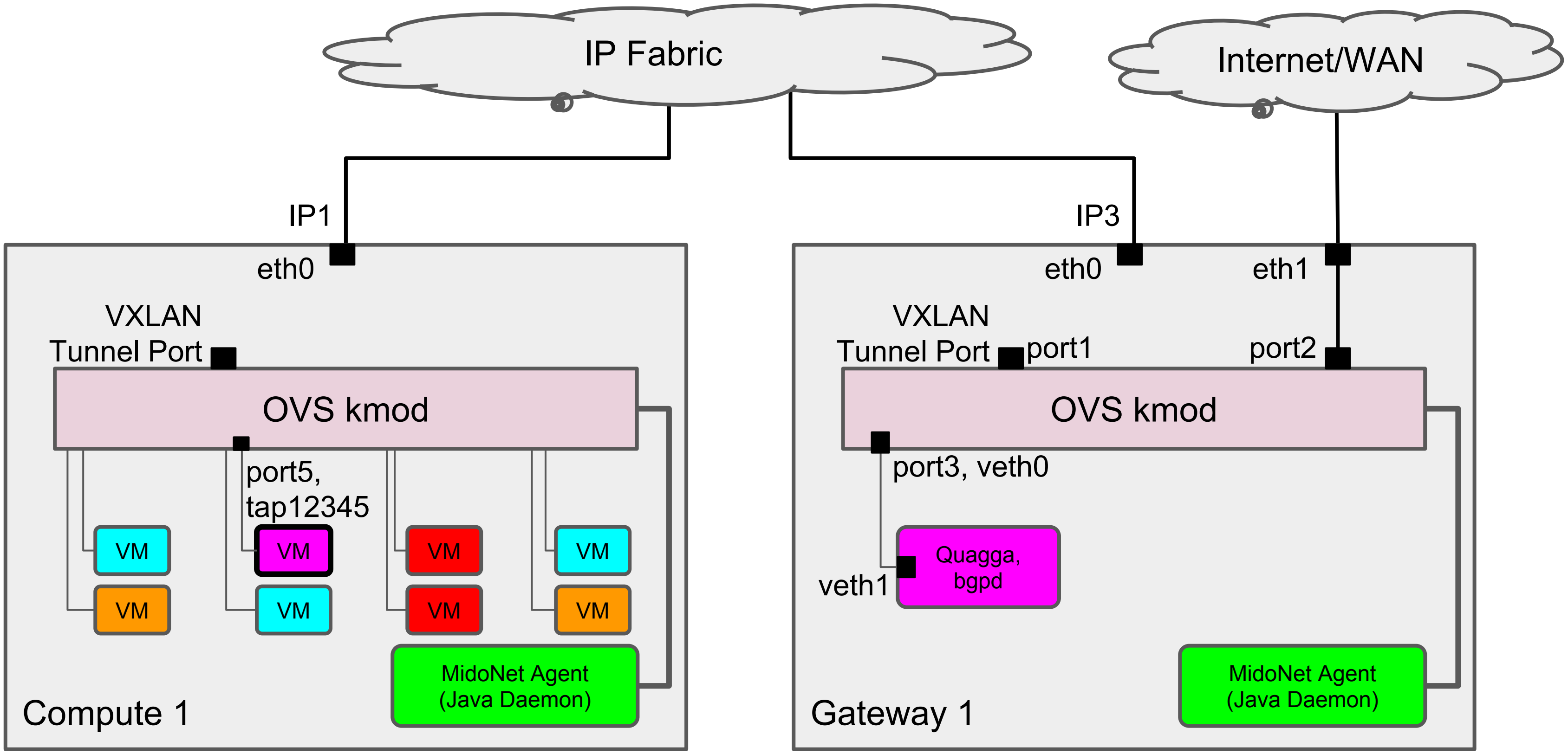
MidoNet Hosts



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Flow computation and tunneling

- Flows are computed at the ingress host
  - by simulating a packet's path through the virtual topology
  - without fetching any information off-box (~99% of the time)
- Just-in-time flow computation
- If the egress port is on a different host, then the packet is tunneled
  - the tunnel key encodes the egress port
  - no computation is needed at the egress

Virtual Devices

Device state

- ZooKeeper serves the virtual network topology
  - reliable subscription to topology changes
- Agents fetch, cache, and “watch” virtual devices on-demand to process packets
- Packets naturally traverse the same virtual device at *different* hosts
- This affects device state:
  - a virtual bridge learns a MAC-port mapping a host and needs to read it in other hosts
  - a virtual router emits an ARP request out of one host and receives the reply on another host
- Store device state tables (ARP, MAC-learning, routes) in ZooKeeper
  - interested agents subscribe to tables to get updates
  - the owner of an entry manages its lifecycle
  - use ZK Ephemeral nodes so entries go away if a host fails

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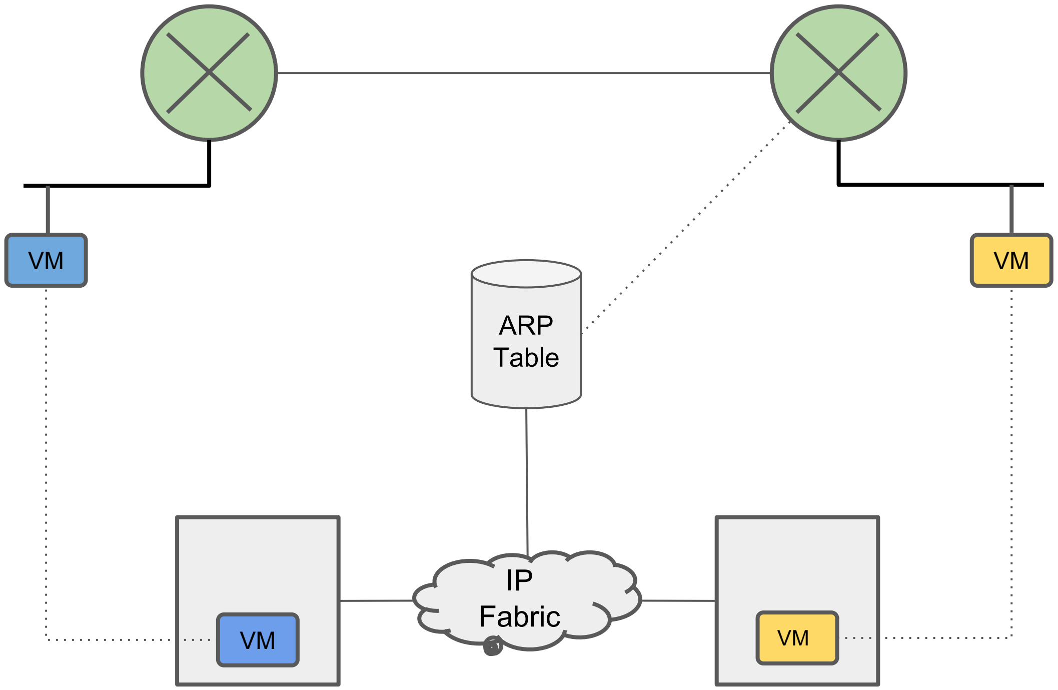
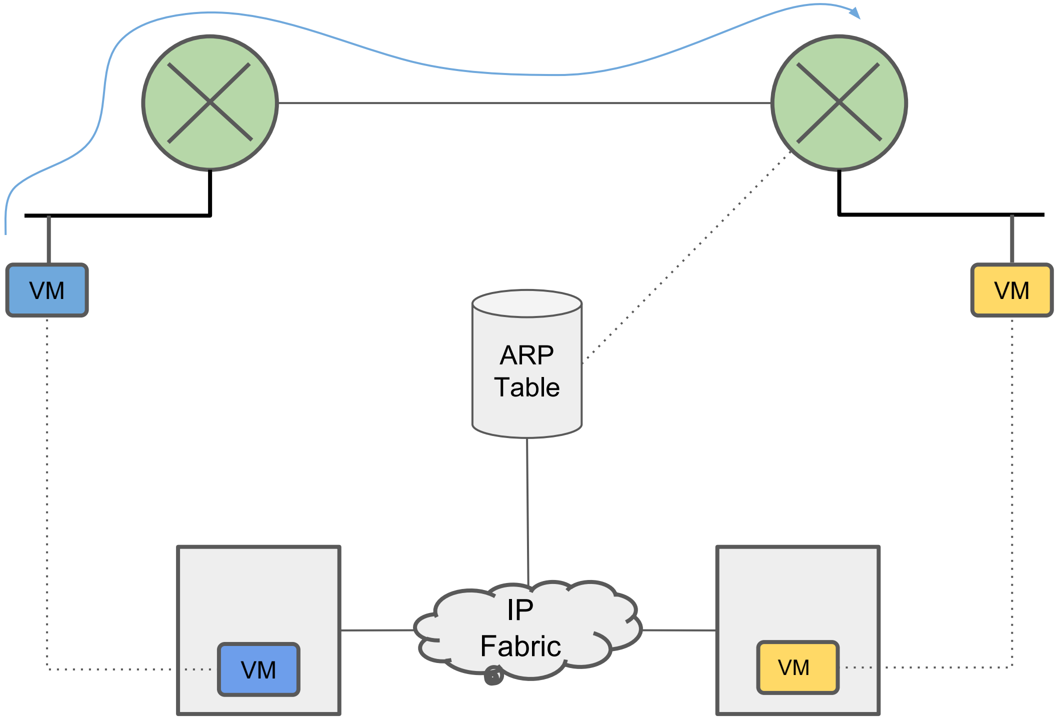
ARP Table



ARP Table



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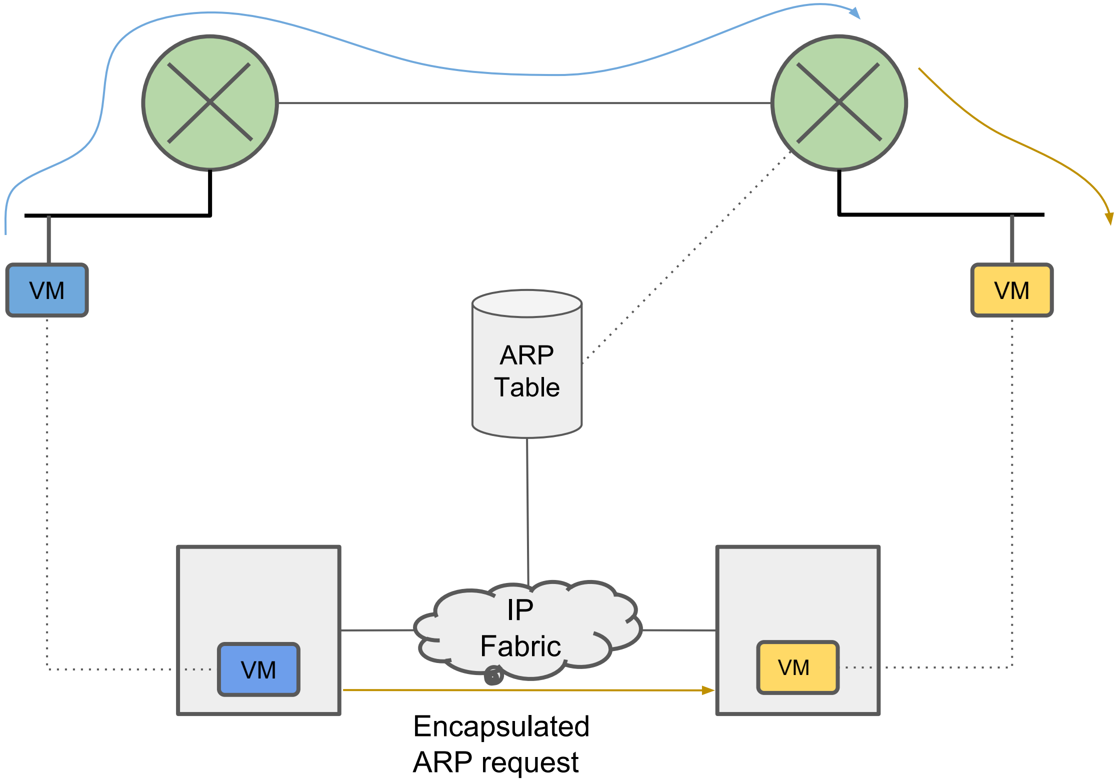
ARP Table



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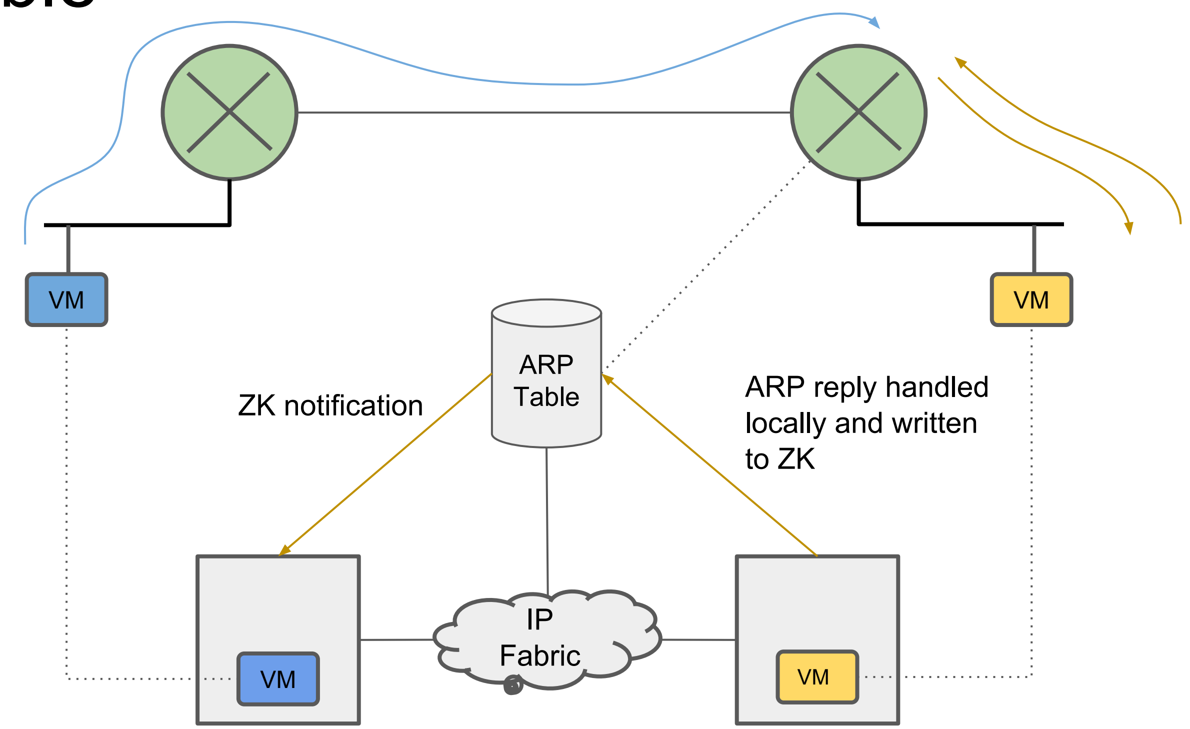
ARP Table



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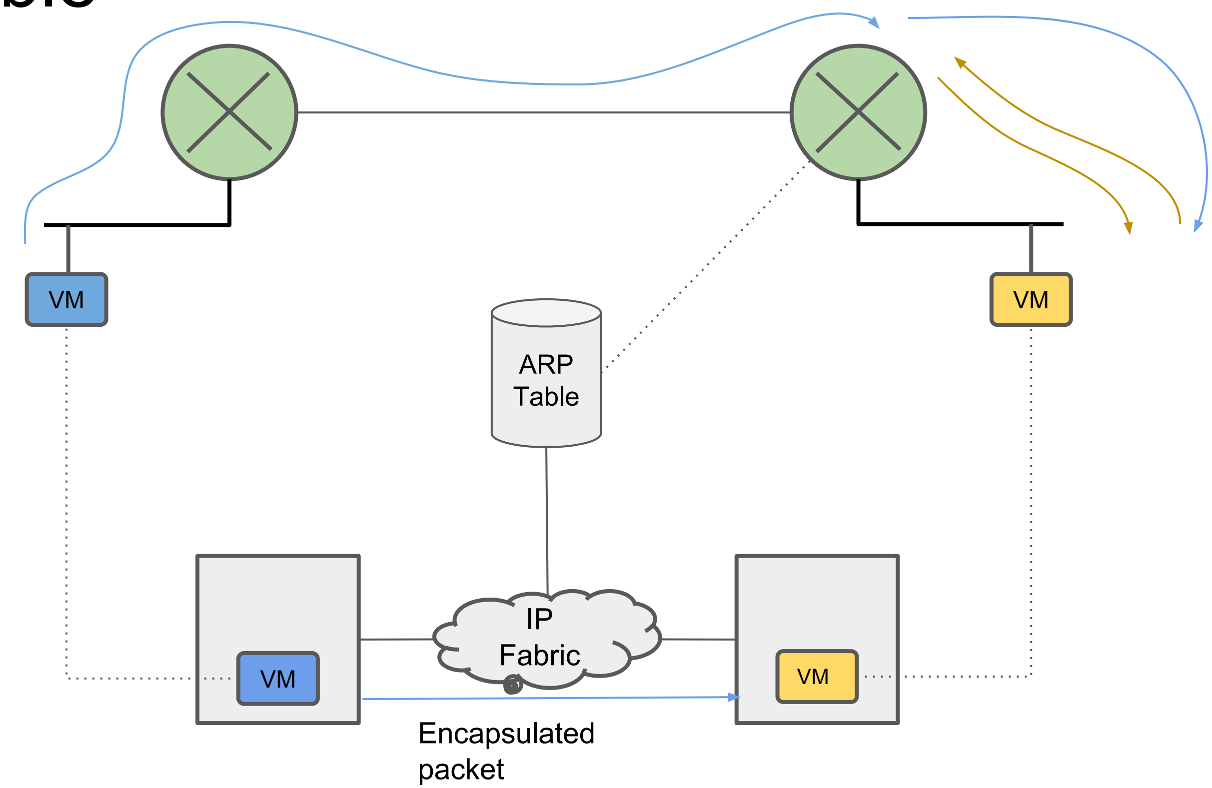
ARP Table



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Flow State

Flow state

- Per-flow L4 state, e.g. connection tracking or NAT
- Forward and return flows are typically handled by different hosts
  - thus, they need to share state

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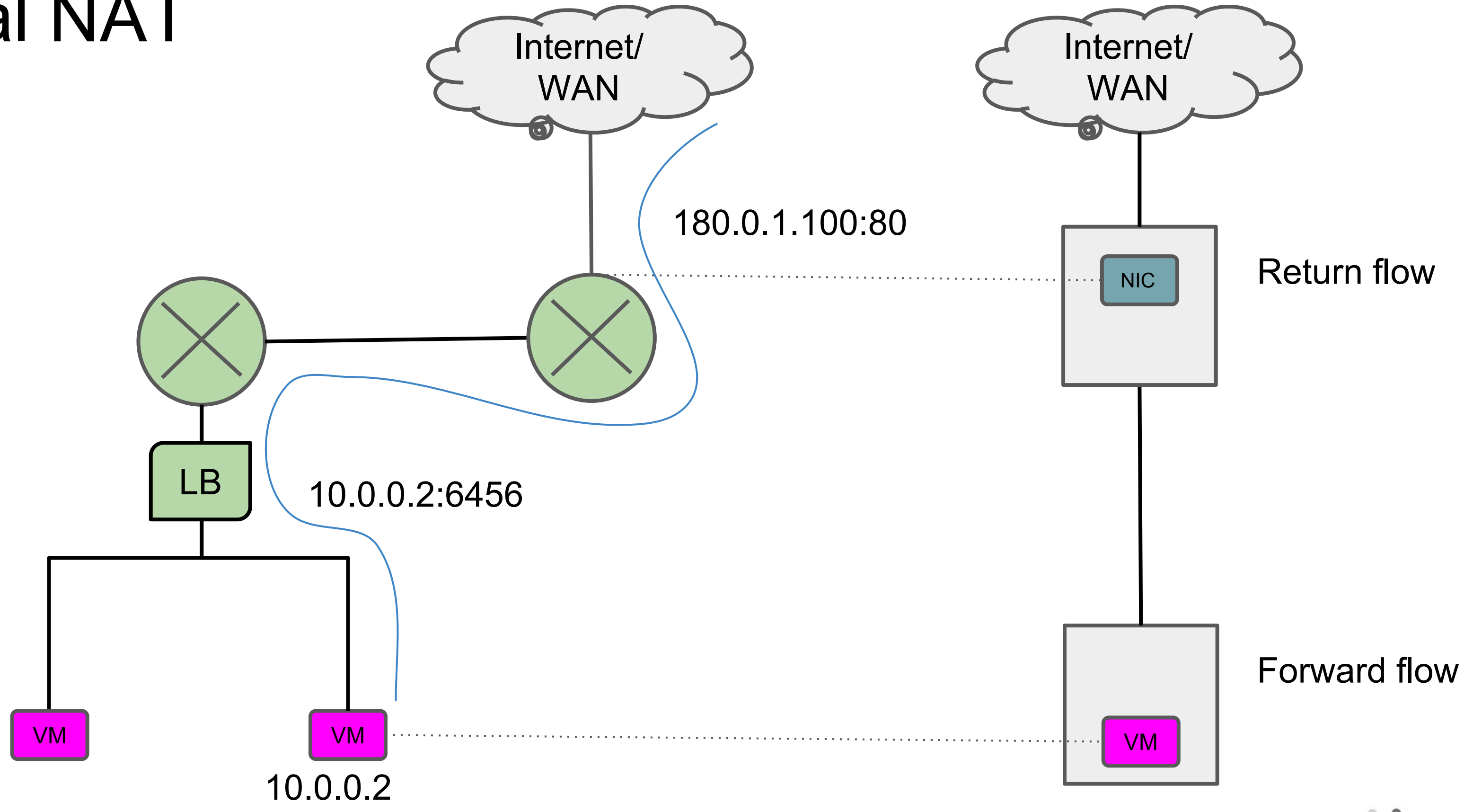
Virtual NAT



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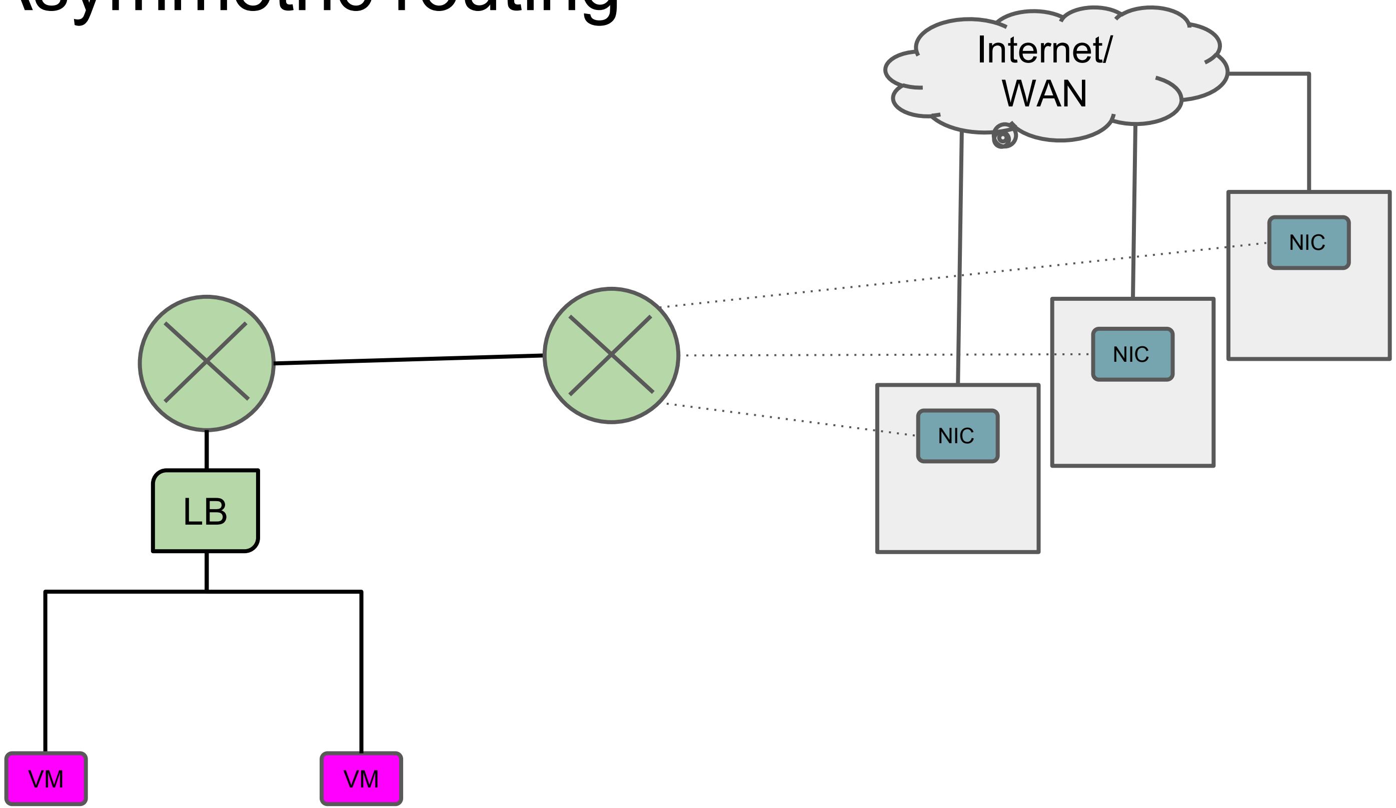
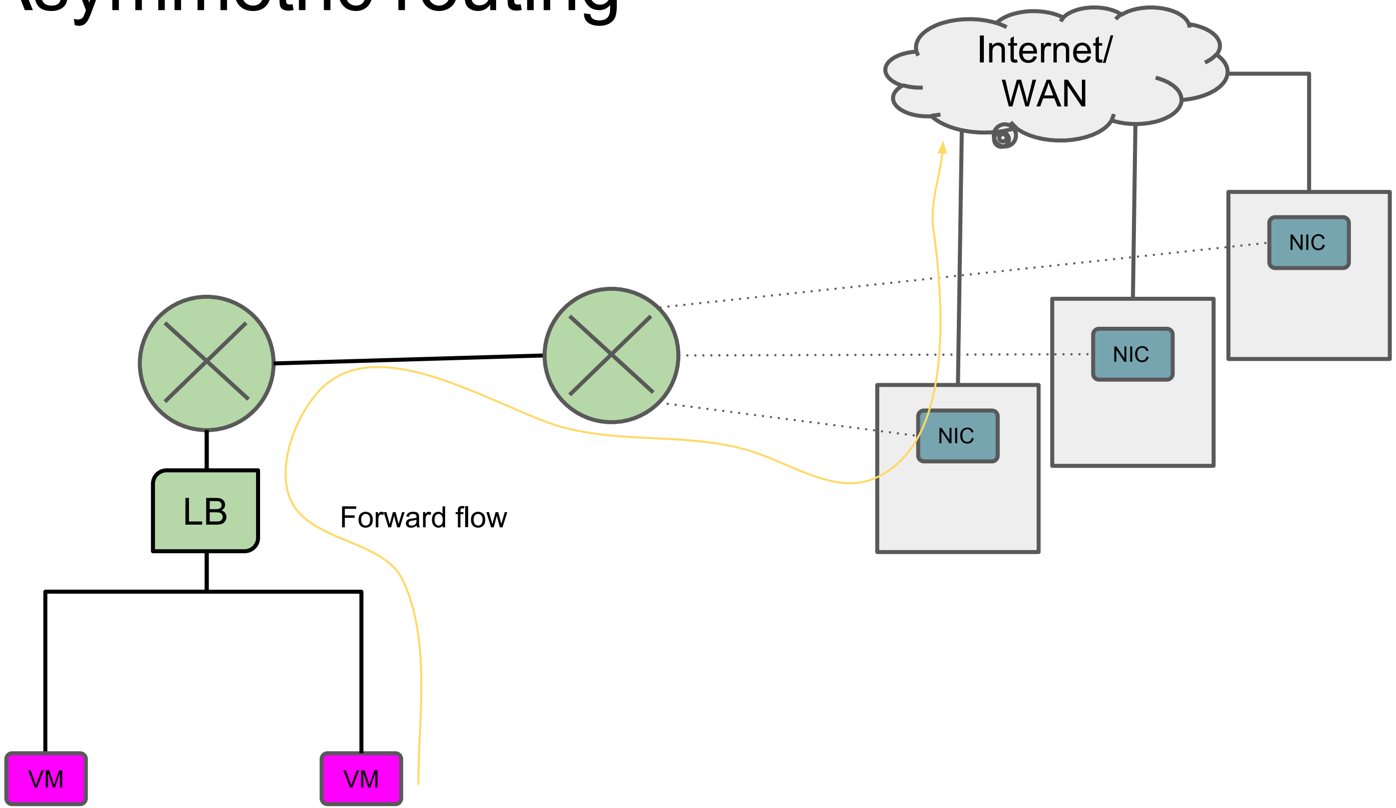
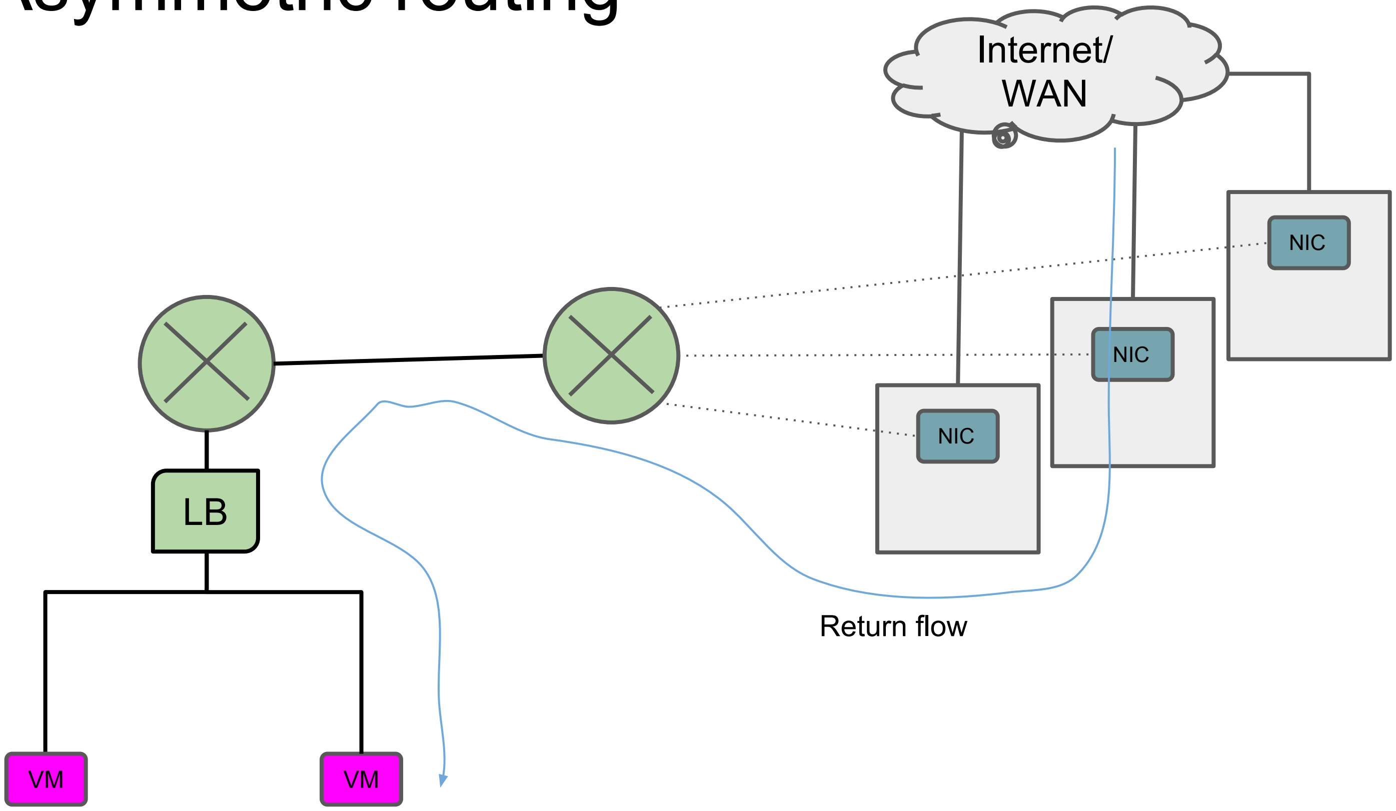
Asymmetric routing



Asymmetric routing



Asymmetric routing



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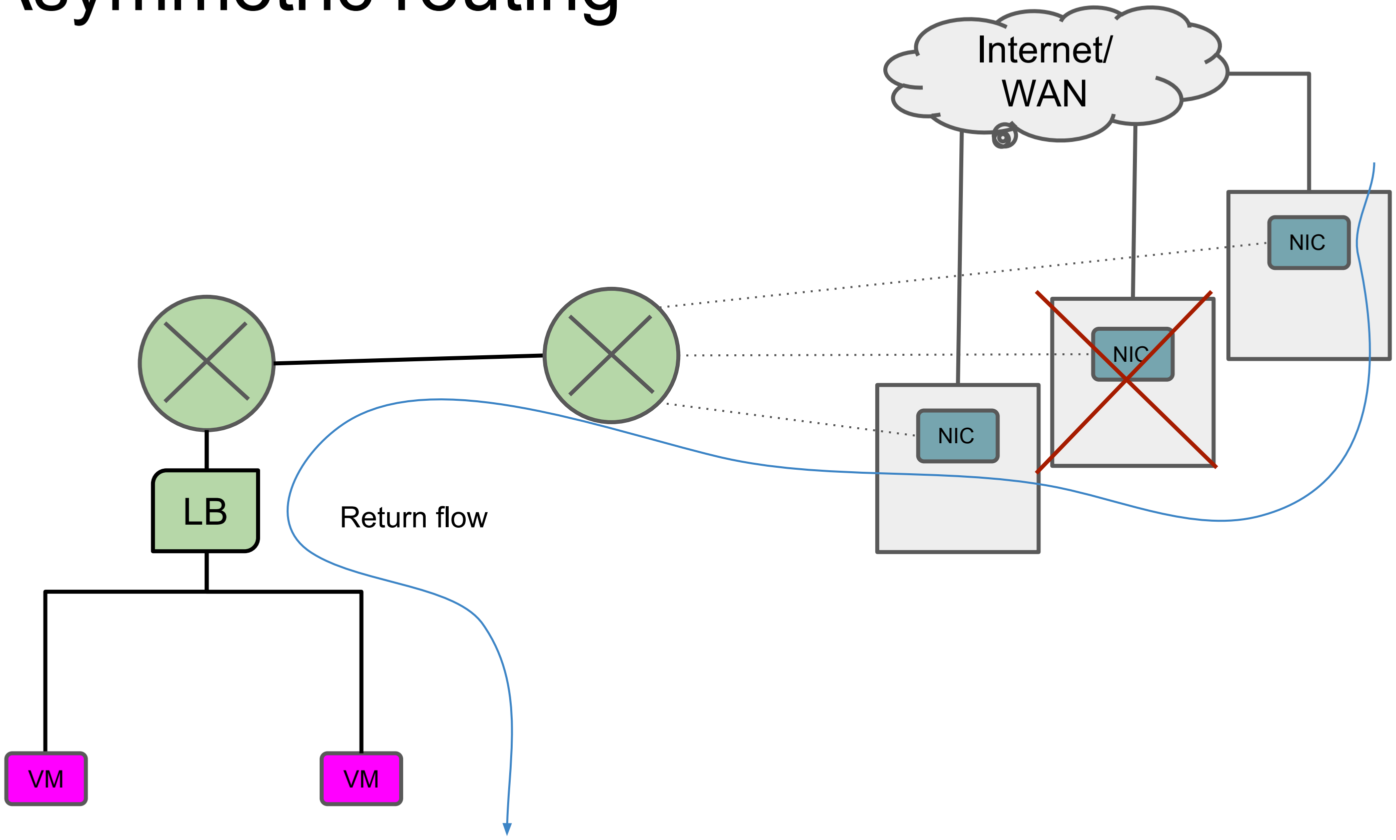
Asymmetric routing



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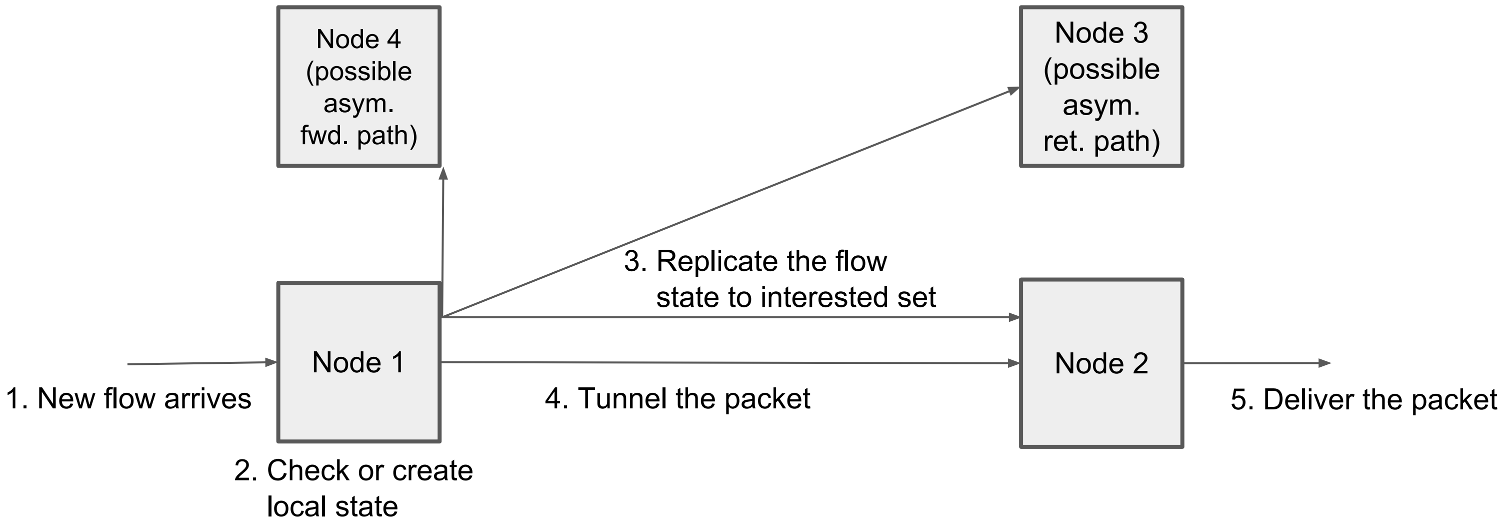
Flow state

- Connection tracking
  - Key: 5 tuple + ingress device UUID
  - Value: NA
  - Forward state not needed
  - One flow state entry per flow
- NAT
  - Key: 5 tuple + device UUID under which NAT was performed
  - Value: (IP, port) binding
  - Possibly multiple flow state entries per flow
- Key must always be derivable from the packet

Sharing state - Peer-to-peer handoff



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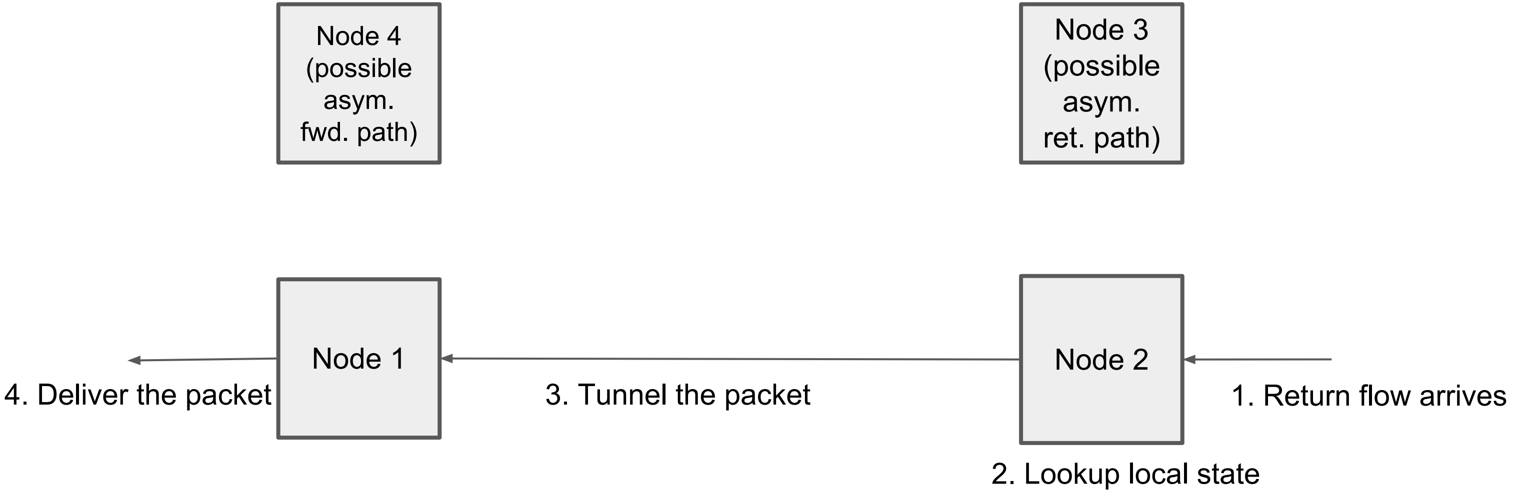
Sharing state - Peer-to-peer handoff



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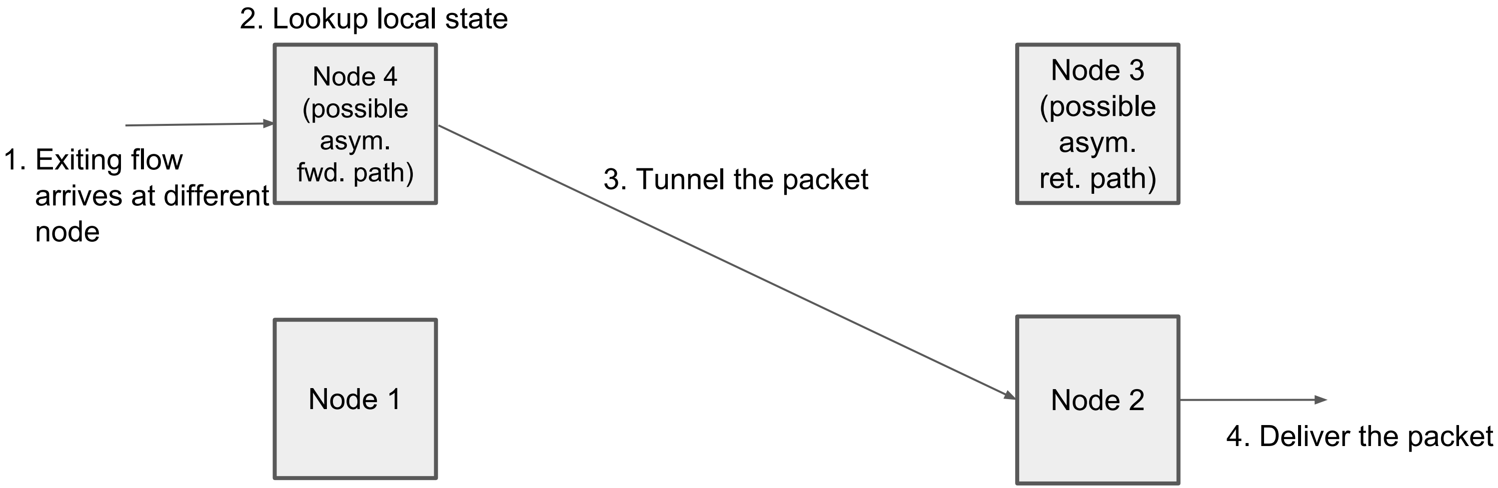
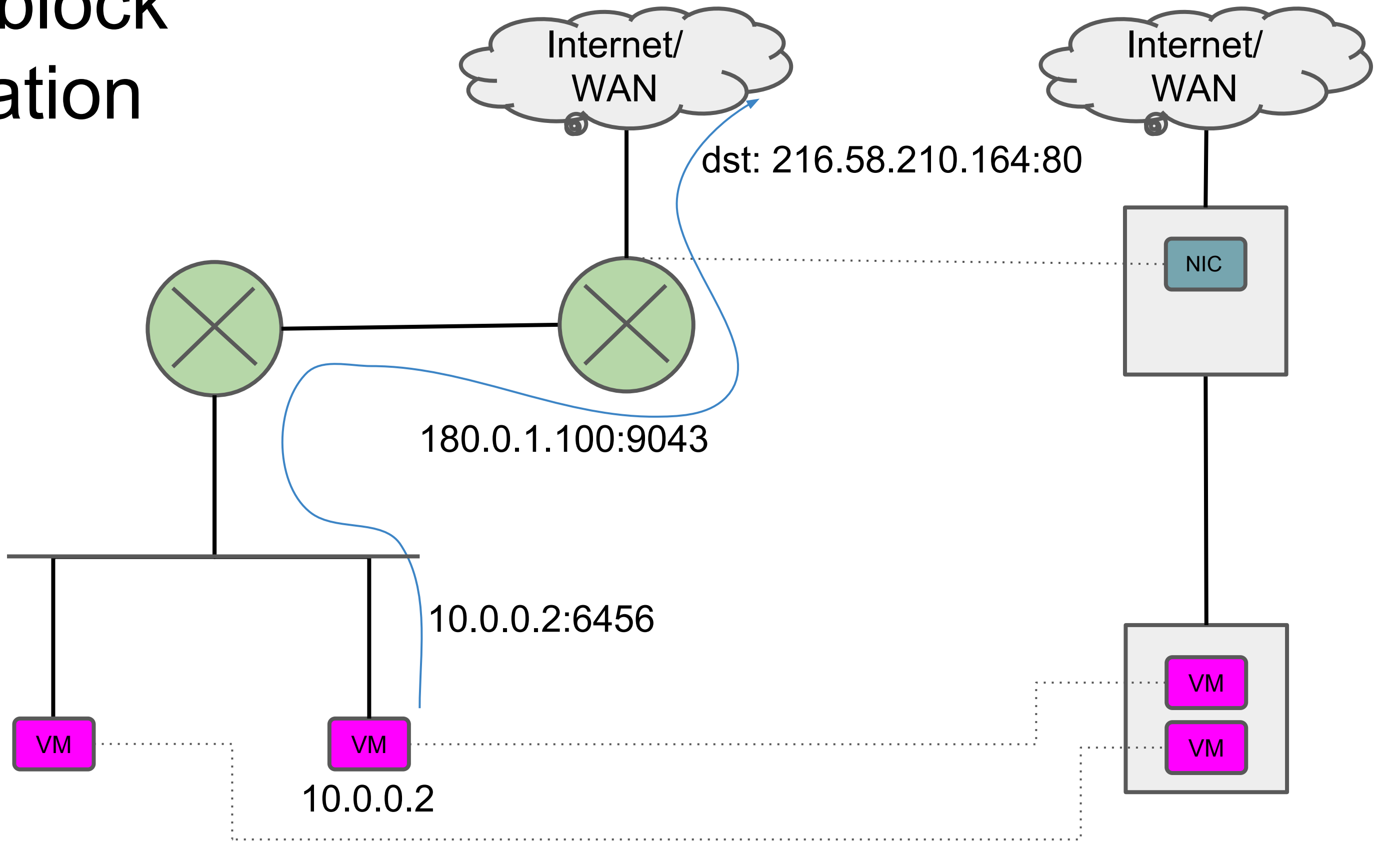
Sharing state - Peer-to-peer handoff



Sharing state - Peer-to-peer handoff

- No added latency
- Fire-and-forget or reliable?
- How often to retry?
- Delay tunneling the packets until the flow state has propagated or accept the risk of the return flow being computed without the flow state?

SNAT block reservation



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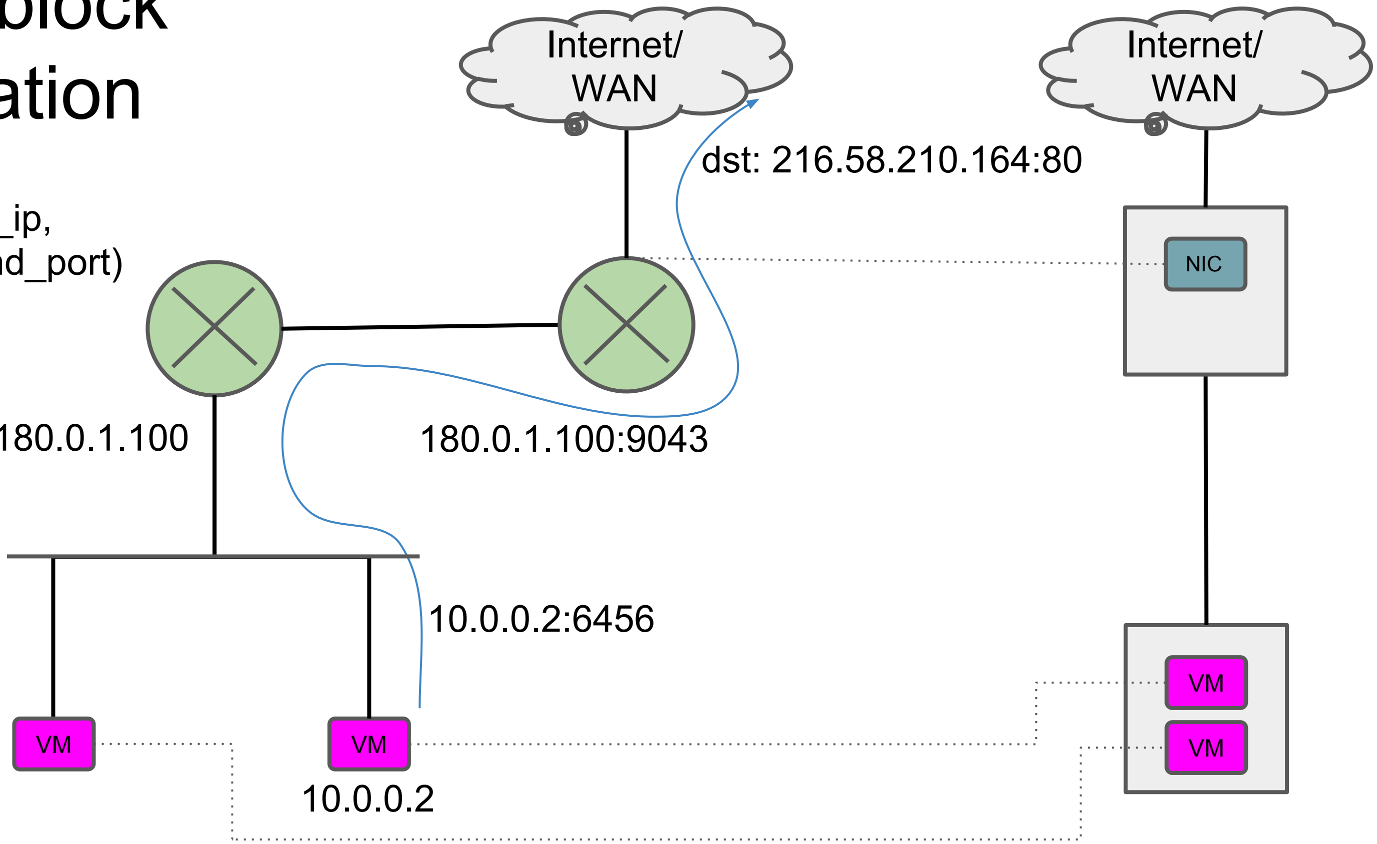
SNAT block reservation

NAT Target:
(start_ip..end_ip,
start_port..end_port)

e.g.

180.0.1.100..180.0.1.100
5000..65535



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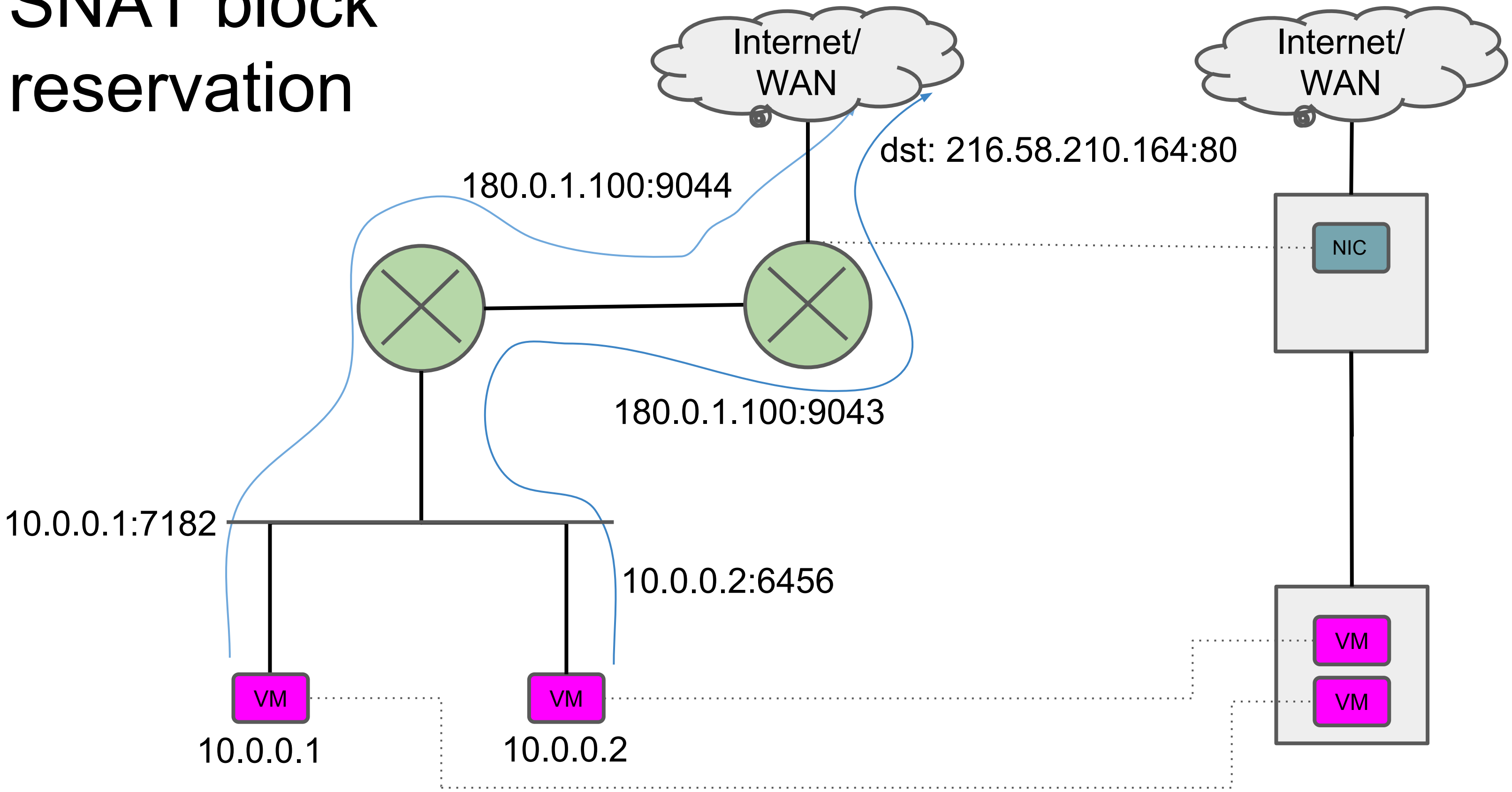
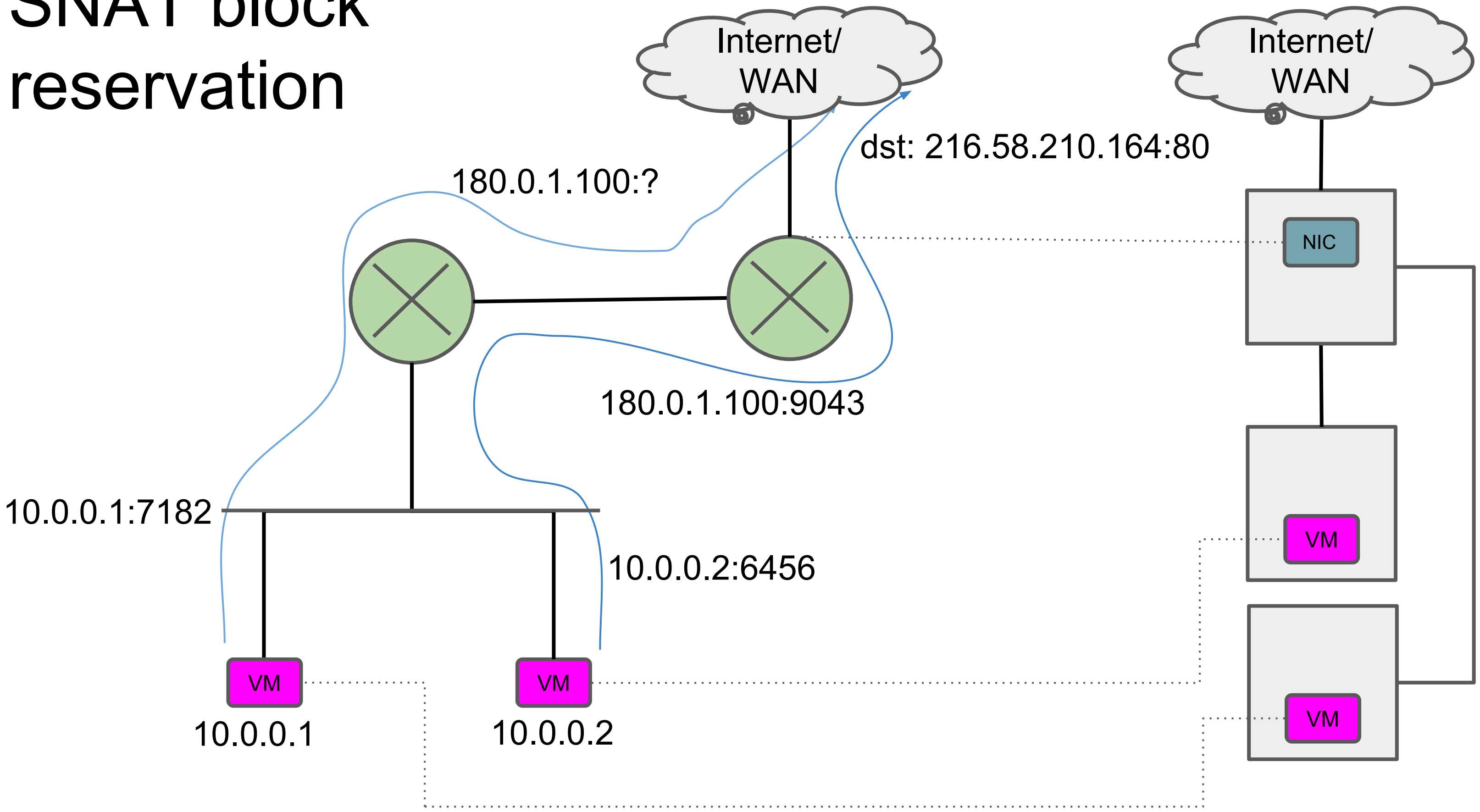


SNAT block reservation



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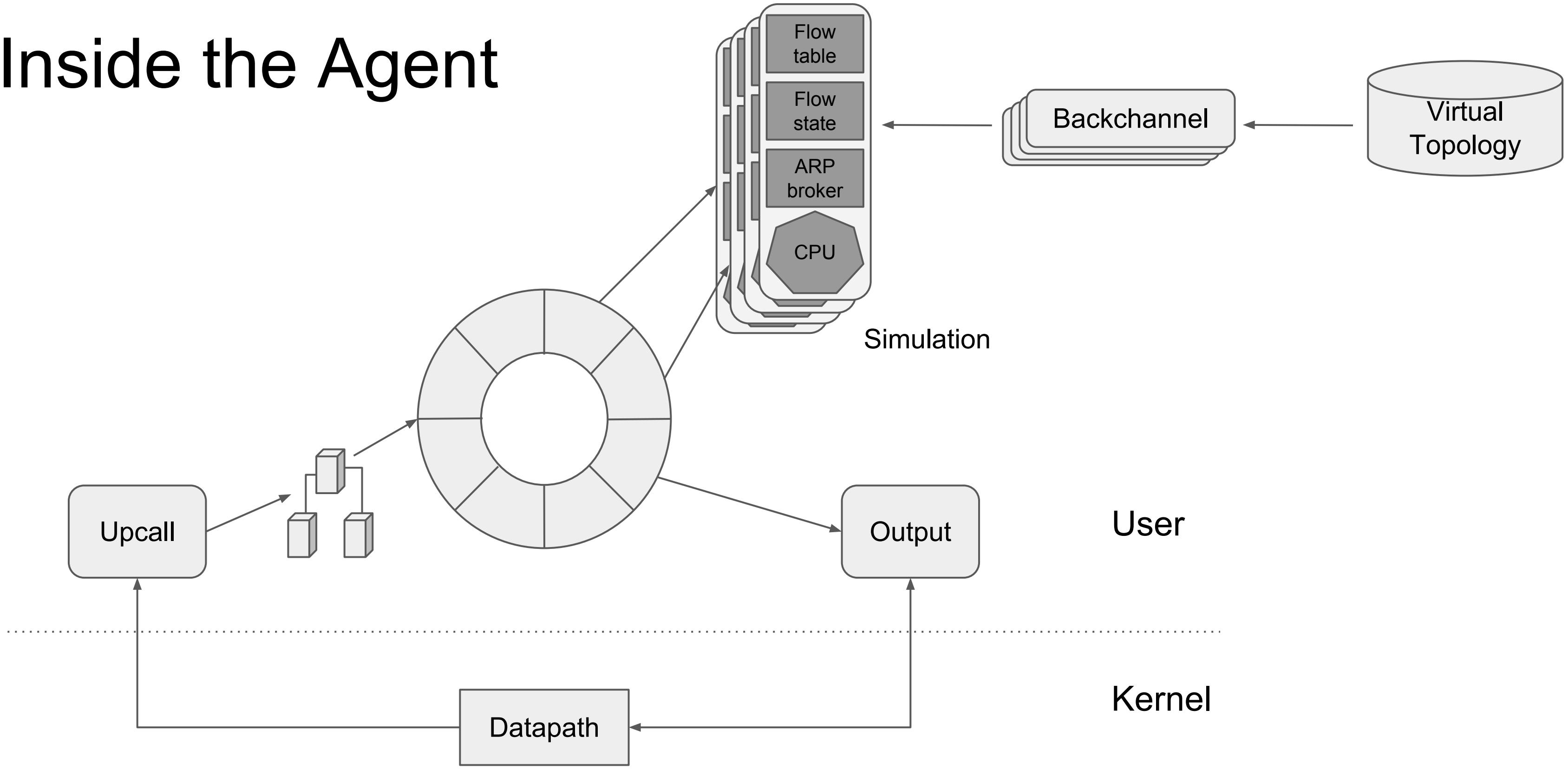
SNAT block reservation

- Performed through ZooKeeper
- /nat/{device_id}/{ip}/{block_idx}
- 64 ports per block, 1024 total blocks
- LRU based allocation
- Blocks are referenced by flow state

Thank you!
Q&A

Low-level

Inside the Agent



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Performance

- Sharding
  - Share nothing model
  - Each simulation thread is responsible for a subset of the installed flows
  - Each simulation thread is responsible for a subset of the flow state
  - Each thread ARPs individually
  - Communication by message passing through “backchannels”
- Run to completion model
  - When a piece of the virtual topology is needed, simulations are parked
- Lock-free algorithms where sharding is not possible