

# Software Router and Network Function Virtualization

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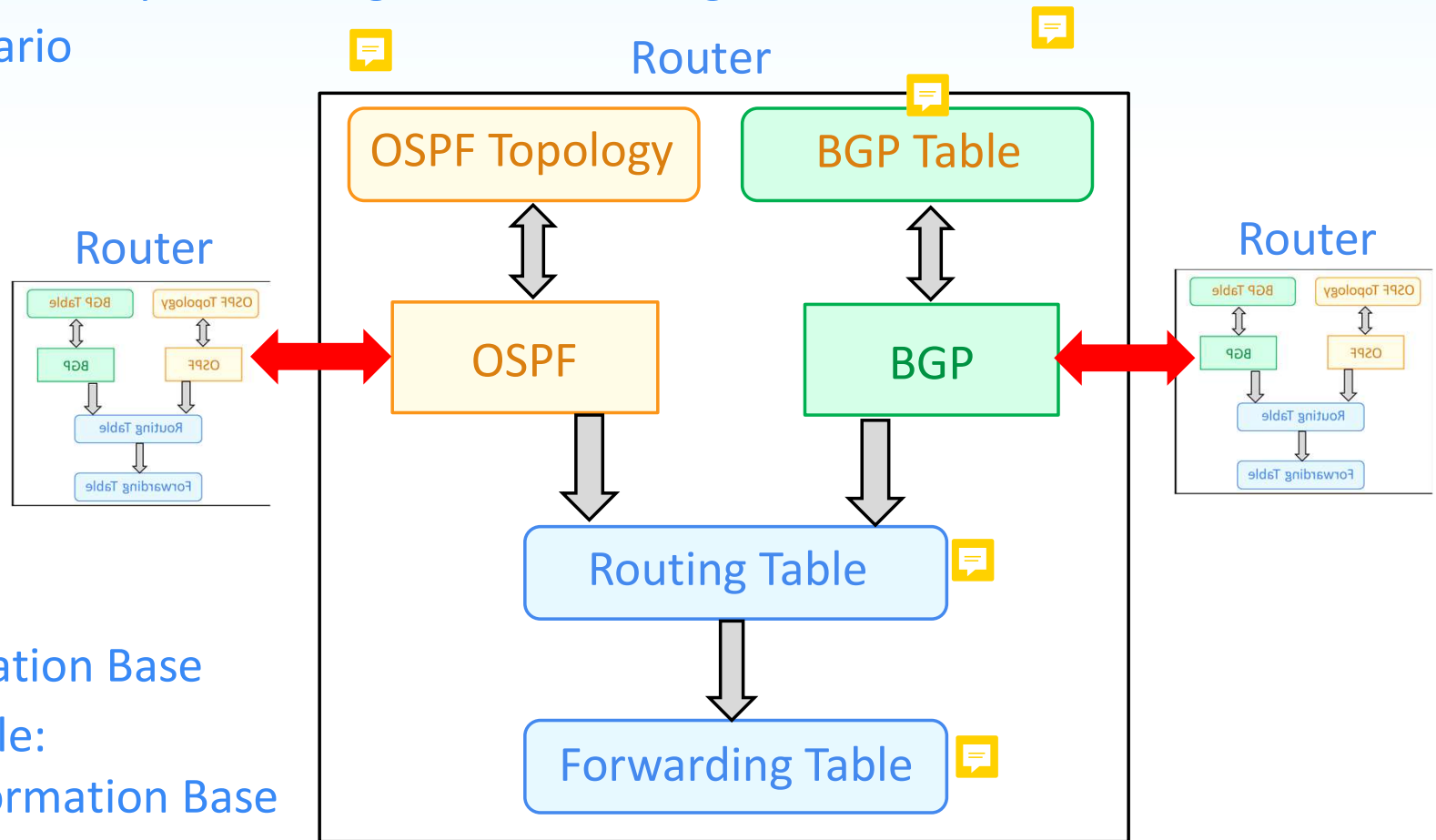
References: <https://www.comparitech.com/blog/vpn-privacy/ipsec-vs-ssl-vpn/>



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# Routing, Forwarding and Routing Protocols

- Main functions of IP layer: Routing and Forwarding
- Operation Scenario




- Routing Table:  
Routing Information Base
- Forwarding Table:  
Forwarding Information Base

# Routing Information Base (RIB),

- **Routing Information Base (RIB)**, also known as **Routing Table**
  - a **data table** stored in a **router** or a network host
  - **lists the routes** to particular network destinations, and in some cases, metrics (distances) associated with those routes.
- Primary goal of routing protocols is to construct routing tables.
  - Static routes: entries made in a routing table manually, fixed, not dynamic
- In general, not used directly for packet forwarding
- **Forwarding Information Base (FIB)**: a simpler forwarding table generated from RIBs
  - Contains only the routes chosen by routing algorithms as **preferred routes** for packet forwarding.
  - In a compressed or pre-compiled format **optimized for storage and lookup**.
- ✓ **Separation** of control plane function (routing table) from forwarding plane function (forwarding table) ⇒ uninterrupted high-performance forwarding.

# Virtual Network Interface (VIF) – Virtual Loopback Interface

- An abstract virtualized representation of a **computer network interface** that may or may not correspond directly to a network interface controller.
- **Virtual Loopback Interface**
  - a VIF through which network applications can communicate when executing on the same machine.
    - Implemented entirely within network software stack
- Any traffic sent to a loopback IP address is immediately passed back up the network software stack (as if it had been received from another device.)
- Loopback address:
  - IPv4 reserves entire address block 127.0.0.0/8 for loopback purpose
    - Standard IPv4 loopback address: 127.0.0.1. 
  - IPv6 standard assigns only a single address for loopback: ::1/128
- Commonly mapped to the hostnames, localhost or *loopback*.

# Virtual Network Interface (VIF) – Management interface

- **Management interface**

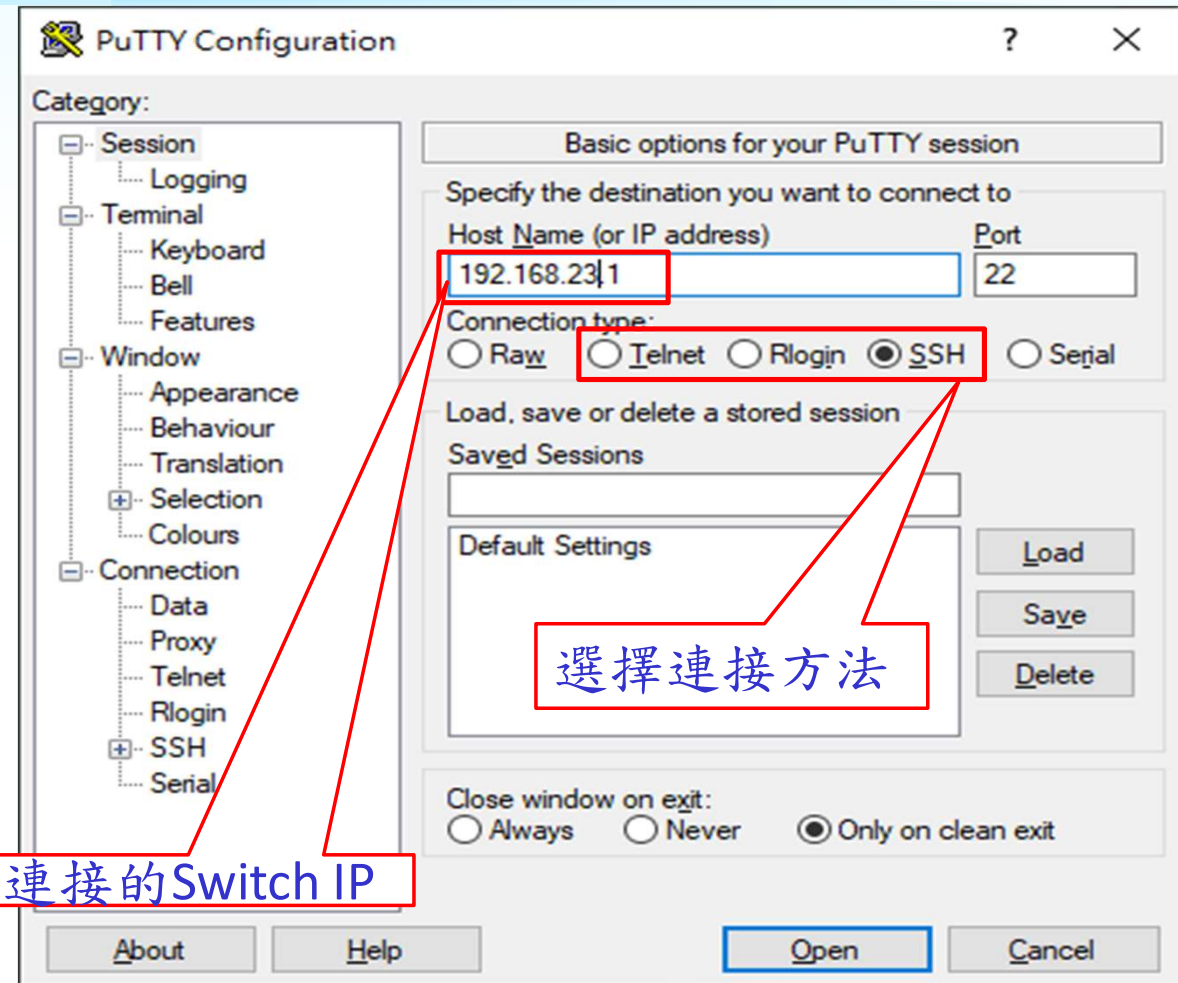
Often called "loopback" interface in computer networks




- a virtual interface used for management purposes.
  - Not used to talk with itself and
- Assigned an address that
  - can be accessed over a network
  - but not associated with any of the physical interfaces on the device.
- will not go down when a physical port fails.

# Virtual Teletype Terminal (VTY)

- Virtual Teletype Terminal (VTY)  
a command line interface (CLI)  
created in a router and  
used to facilitate a connection  
to the daemon
  - Via Telnet, SSH, ...



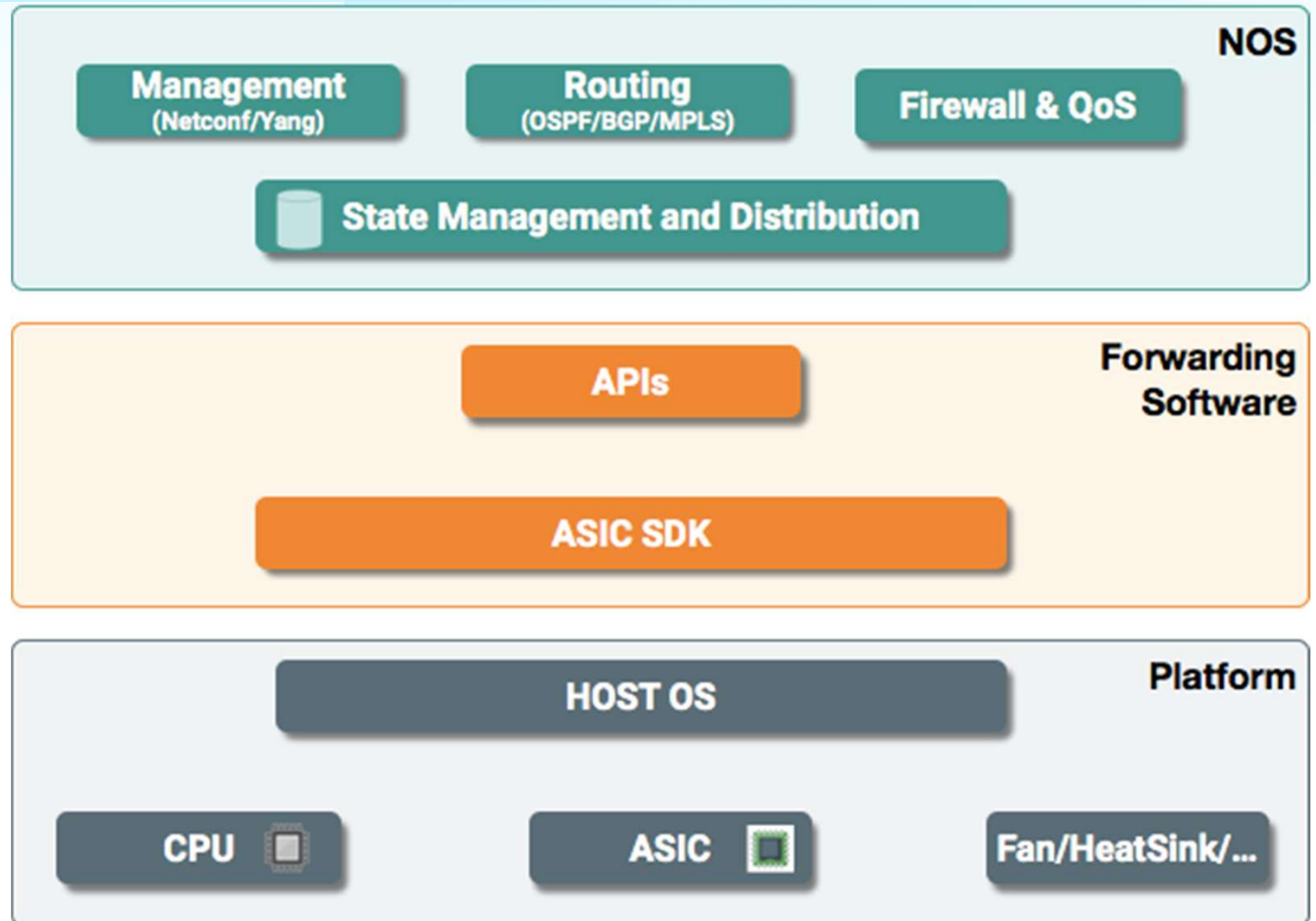
# Virtual Routing and Forwarding (VRF)

- A technology that enables IP based routers to create and operate **multiple instances of a routing table** simultaneously. 
- A VRF works like a typical router with its unique routing table, table entries and routing protocols, and it
  - Operates independently of the core router and other VRF created instances
- VRFs are the layer 3 equivalent of a VLAN.
  - Can use the same or overlapping IP addresses without confliction

# High-level View of a Typical Router

NOS: Network OS

- **High-level view** of key elements of a typical router.
- **Commercial Routers:** Commonly with vendor NOS integrated on 3rd party ODMs with little to **no customization**.

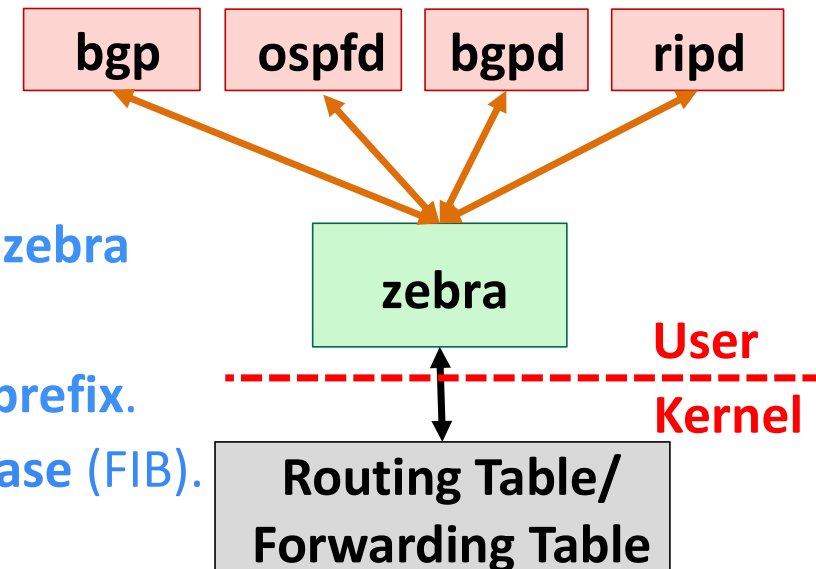


✓ Source: Juniper Forums



# Disaggregation (1<sup>st</sup> Look): Quagga – Routing Software

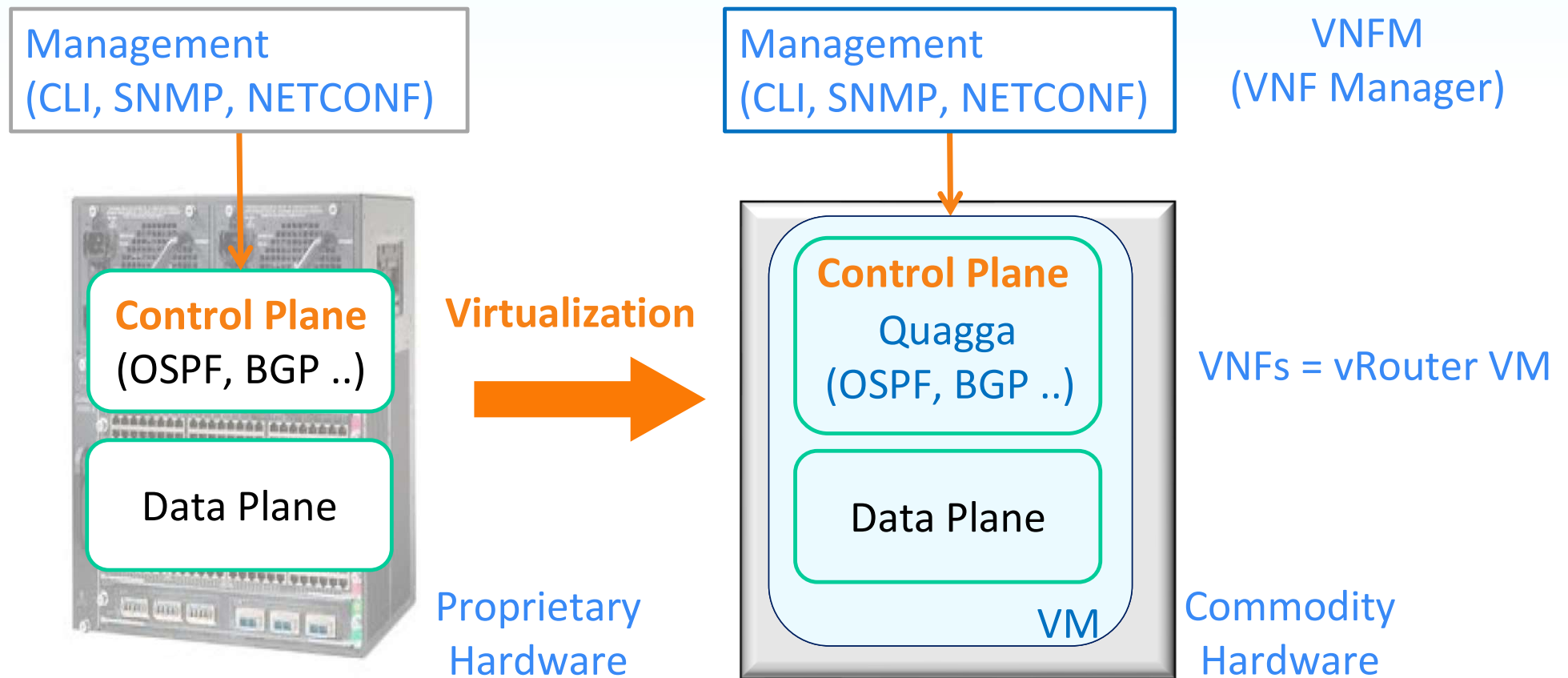
- **Quagga** is a routing software suite for Unix platforms, FreeBSD, Linux, and etc.
  - A fork of **GNU Zebra** project
  - Providing implementations of OSPFv2, OSPFv3, RIP v1 and v2, RIPng and BGP-4
- **Quagga** consists of
  - a **core daemon zebra** and
  - Separate daemons for **routing protocols**
- **Routing protocols** communicate their best routes to **zebra**
- **zebra**
  - Computes **best route** across protocols for each **IP prefix**.
    - Best routes make up **Forwarding Information Base (FIB)**.
  - Feeds FIB to Kernel
    - Using netlink interface on Linux, and route sockets on FreeBSD.
- ✓ Quagga running on a Unix platform with commodity hardware – A Disaggregation!



<https://quagga.net/> 10

# Disaggregation: Virtual Router – Naïve VNF Approach

- You might have thought about VNF like this...



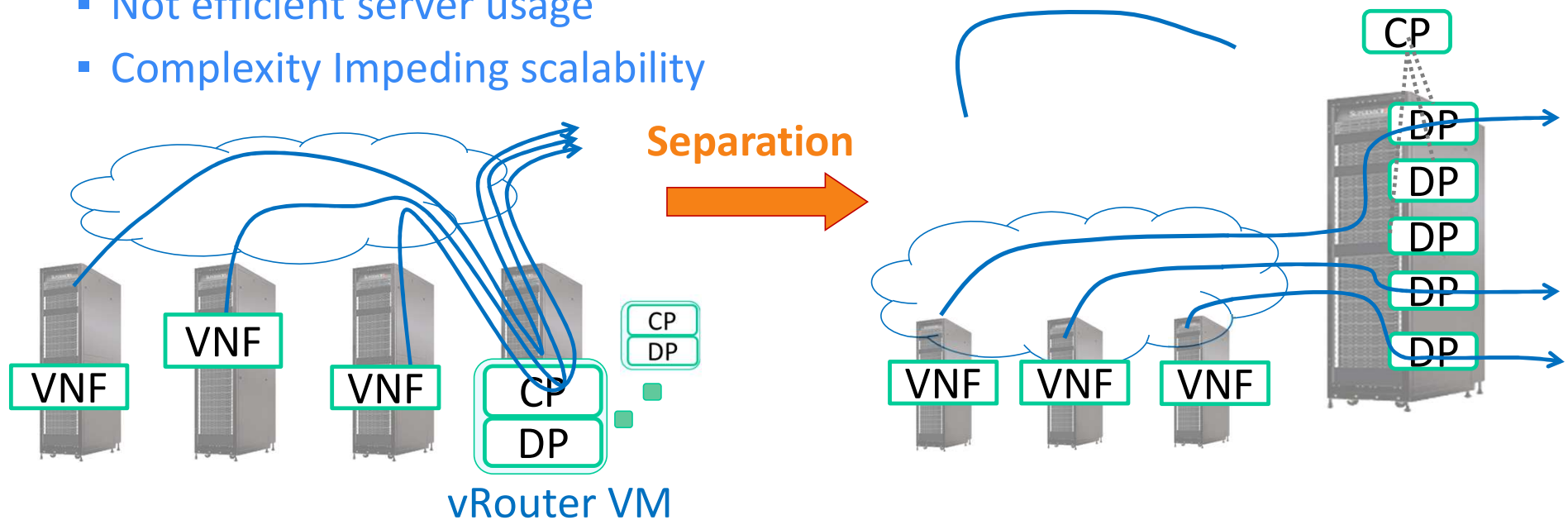
# Control Plane and Data Plane Separation (CUPS)

- Problem of Naïve VNF Approach

- Hair pinning
  - Traffic bottleneck
- Integrated control and data plane
  - Not efficient server usage
  - Complexity Impeding scalability

- Control Plane and Data Plane Separation (CUPS):

- May scale-out Data Planes on demand
- Disaggregation of CP and DP



# Disaggregation (Further Look): FIB Pushing

- Zebra supports a 'FIB push' interface (FPI)
  - FPI allows an external component to learn the forwarding information
- Forwarding Plane Manager (FPM):
  - Receives FIB
  - Decode FIB into routes
  - Programs forwarding plane (directly or indirectly)

## ➤ FIB Pushing:

- FPM establishes a TCP connection with Zebra
- Zebra pushes FIB to FPM

