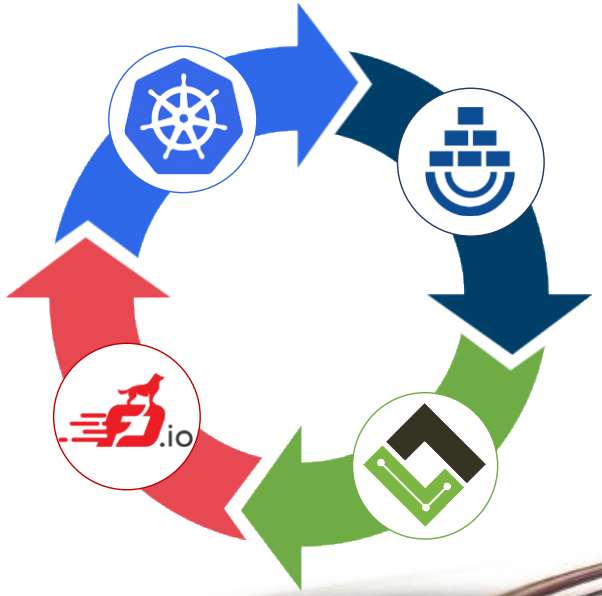
FD.io VPP & Ligato Use Cases

Contiv-VPP CNI plugin for Kubernetes
IPSEC VPN gateway



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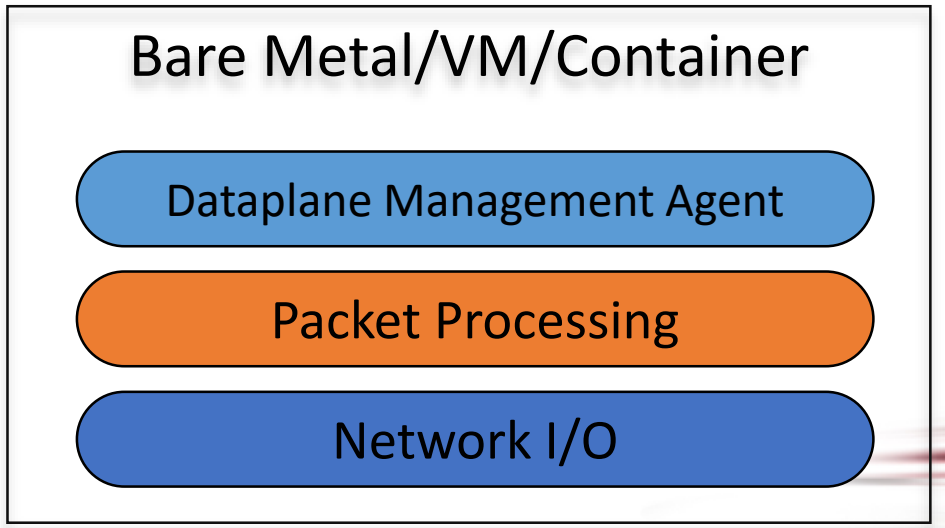
fd.io VPP – The Universal Dataplane

- Project at Linux Foundation
  - Multi-party
  - Multi-project
- Software Dataplane
  - High throughput
  - Low Latency
  - Feature Rich
  - Resource Efficient
  - Bare Metal/VM/Container
  - Multi-platform

- fd.io Scope:
  - **Network IO -** NIC/vNIC <-> cores/threads
  - **Packet Processing –** Classify/Transform/Prioritise/Forward/Terminate
  - **Dataplane Management Agents -** Control Plane



intel ARM Power

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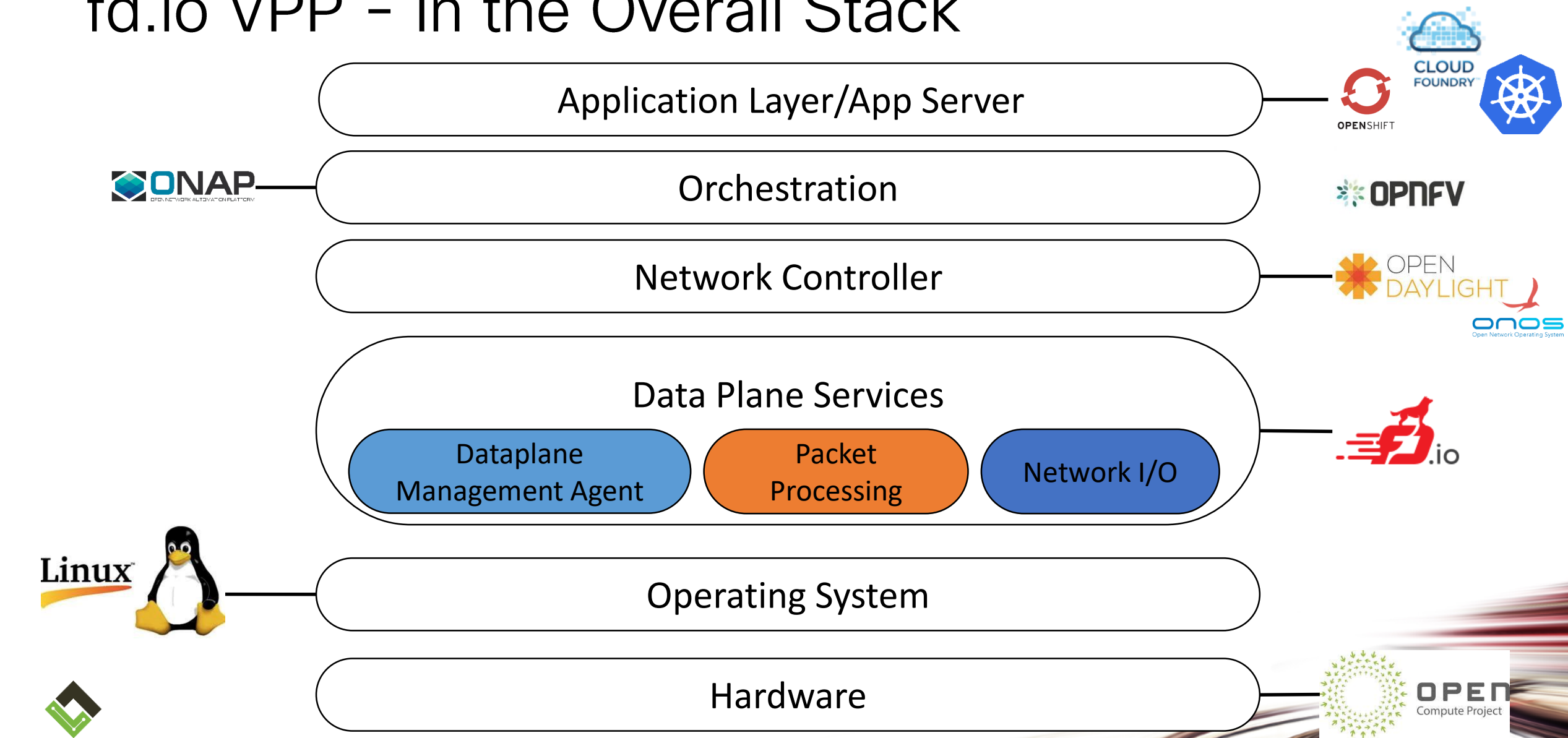
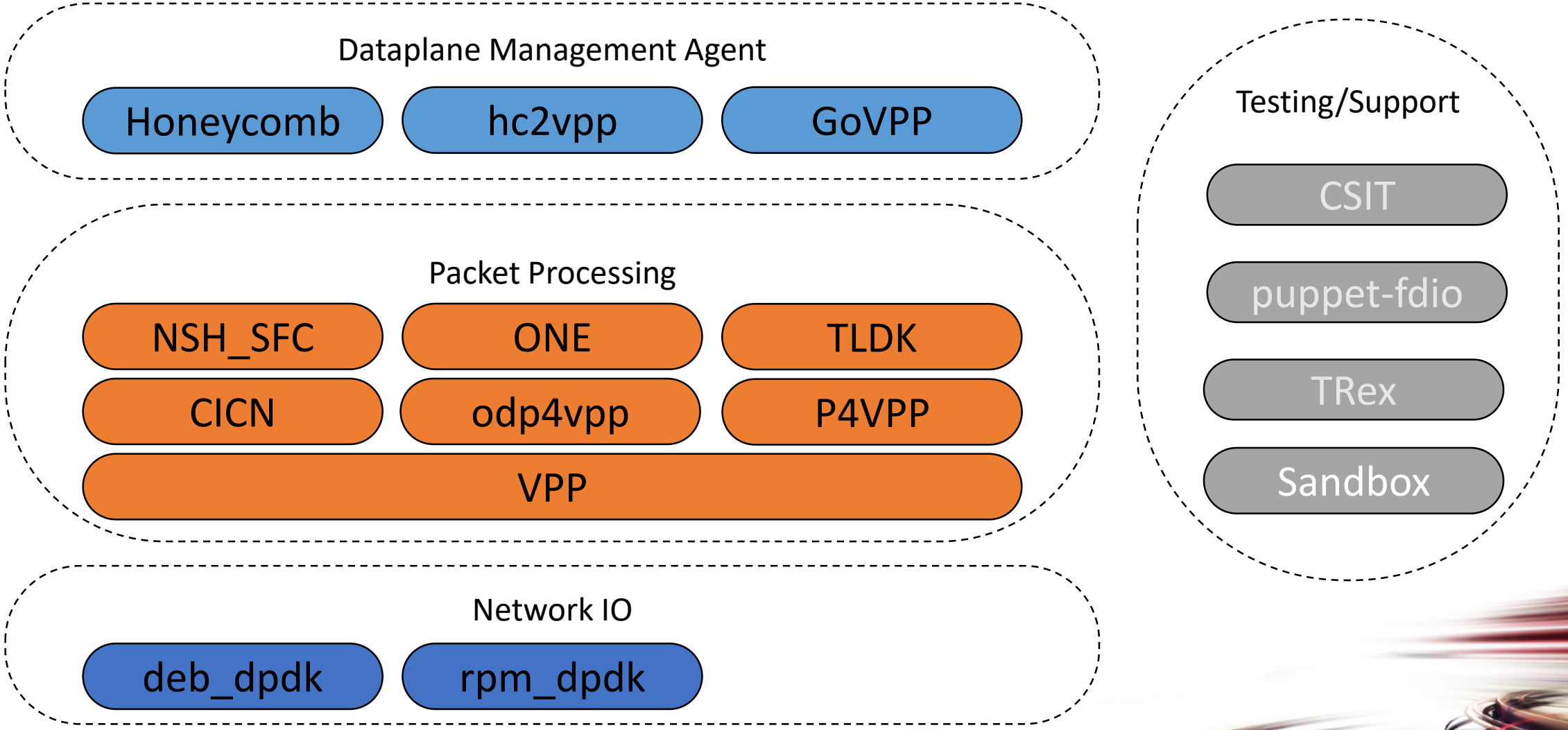
fd.io VPP – In the Overall Stack



fd.io VPP – Projects



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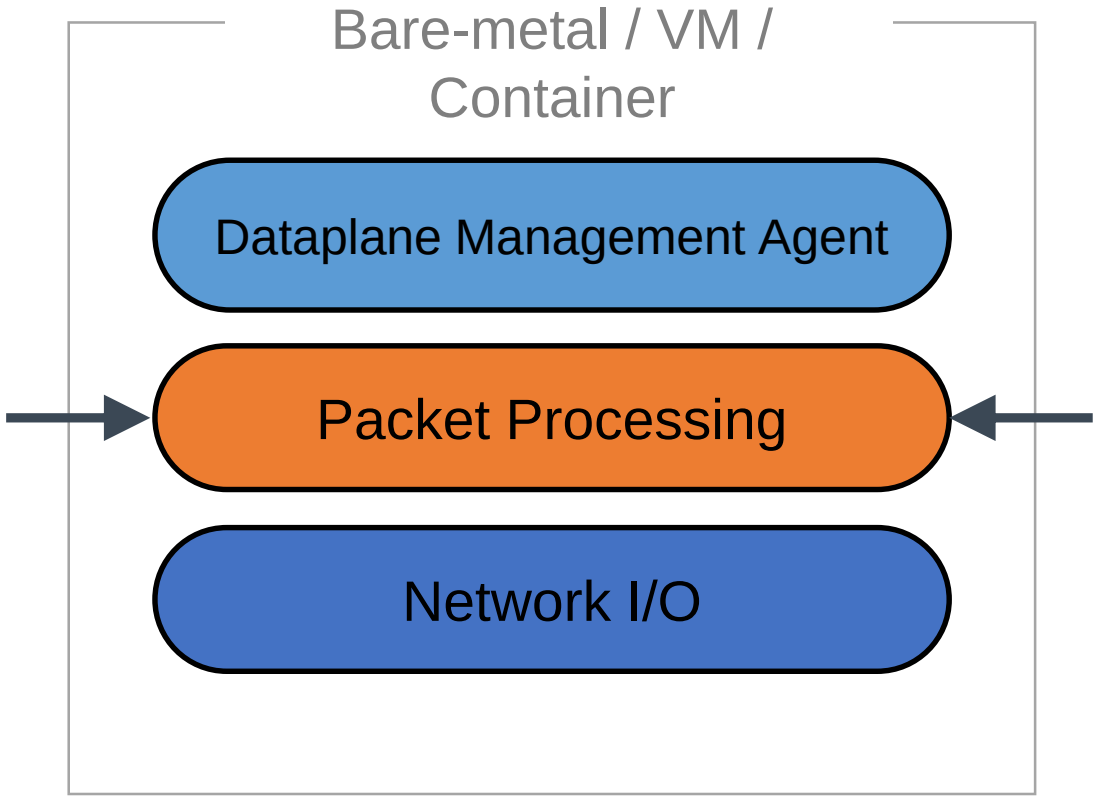
fd.io VPP – Vector Packet Processing

Compute Optimised SW Network Platform



Packet Processing Software Platform

- High performance
- Linux user space
- Runs on compute CPUs: intel ARM Power
  - And “knows” how to run them well !

Shipping at volume in server & embedded products

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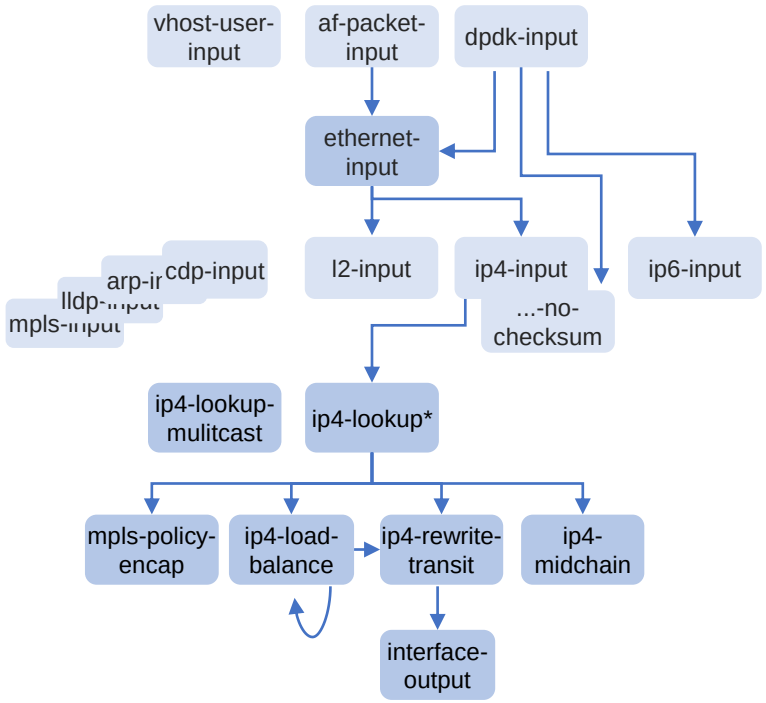
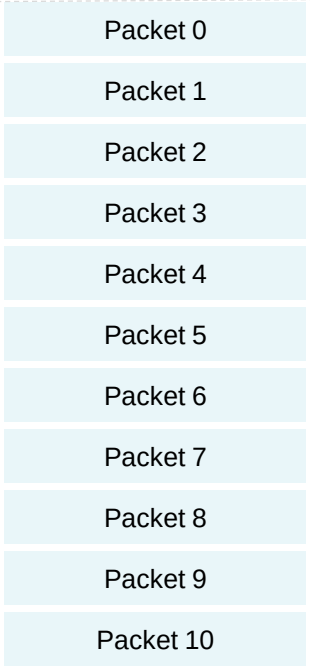
fd.io VPP – How does it work?

Compute Optimised S/W Network Platform

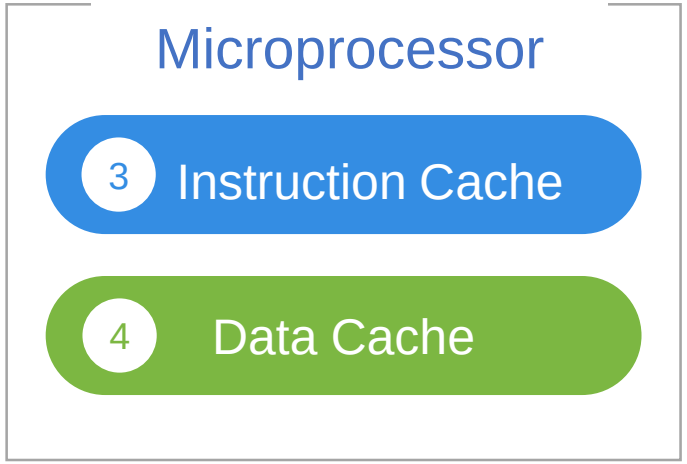
1 Packet processing is decomposed into a directed graph of nodes …



2 … packets move through graph nodes in vectors …



3 … graph nodes are optimised to fit inside the instruction cache …



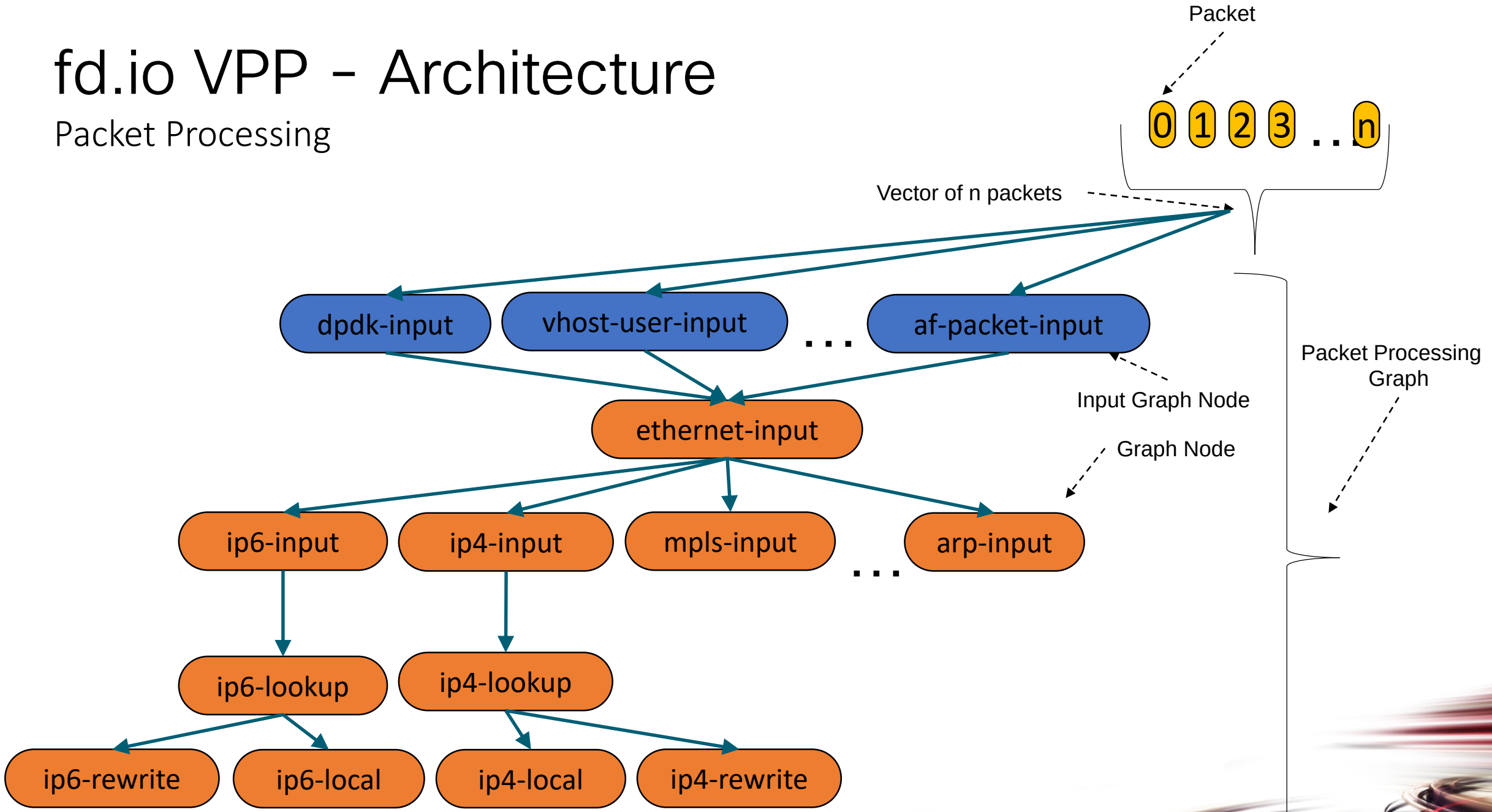
4 … packets are pre-fetched into the data cache.

* Each graph node implements a “micro-NF”, a “micro-NetworkFunction” processing packets.

Makes use of modern Intel® Xeon® Processor micro-architectures.
Instruction cache & data cache always hot ➔ Minimised memory latency and usage.

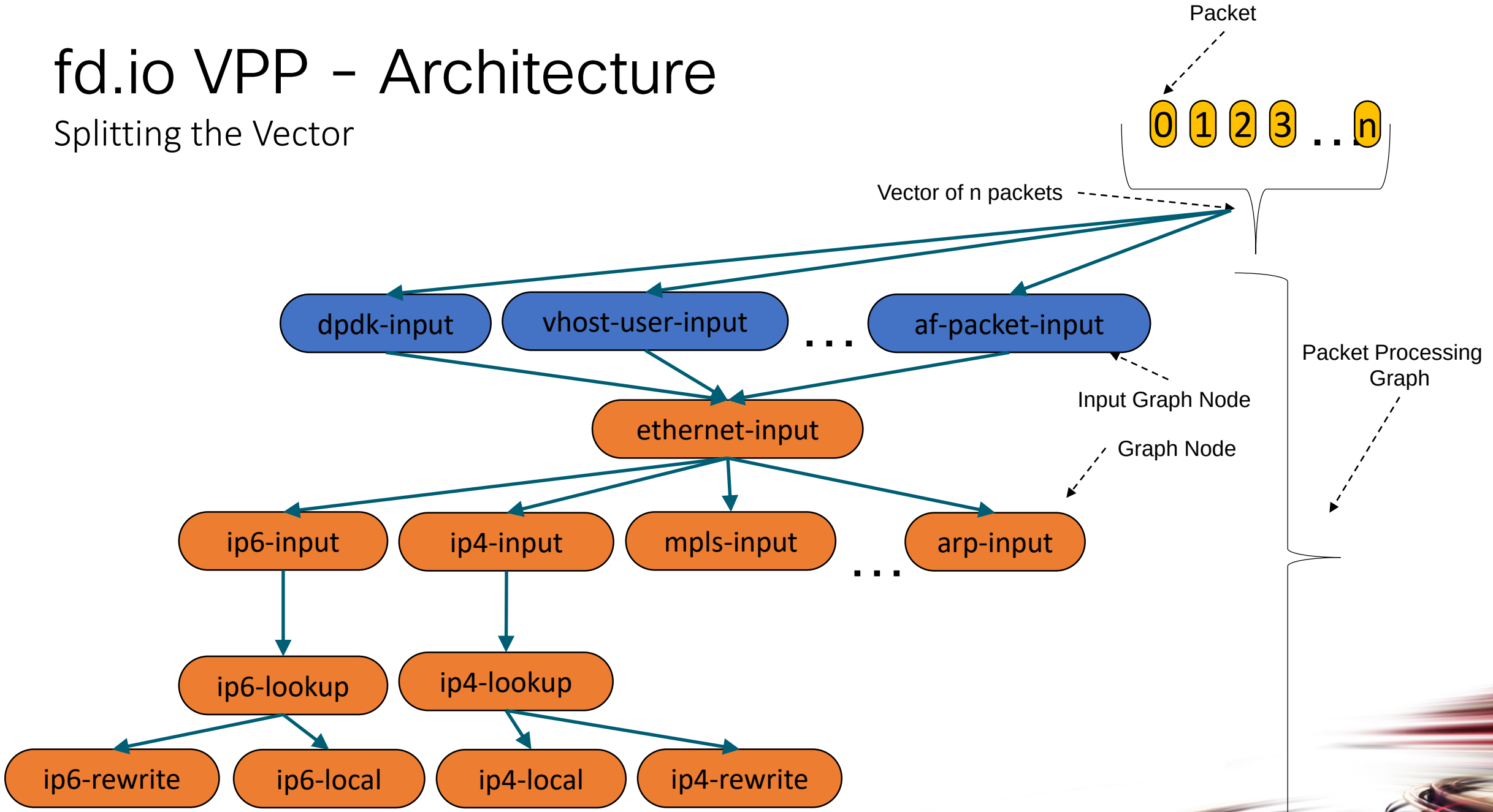
fd.io VPP – Architecture

Packet Processing



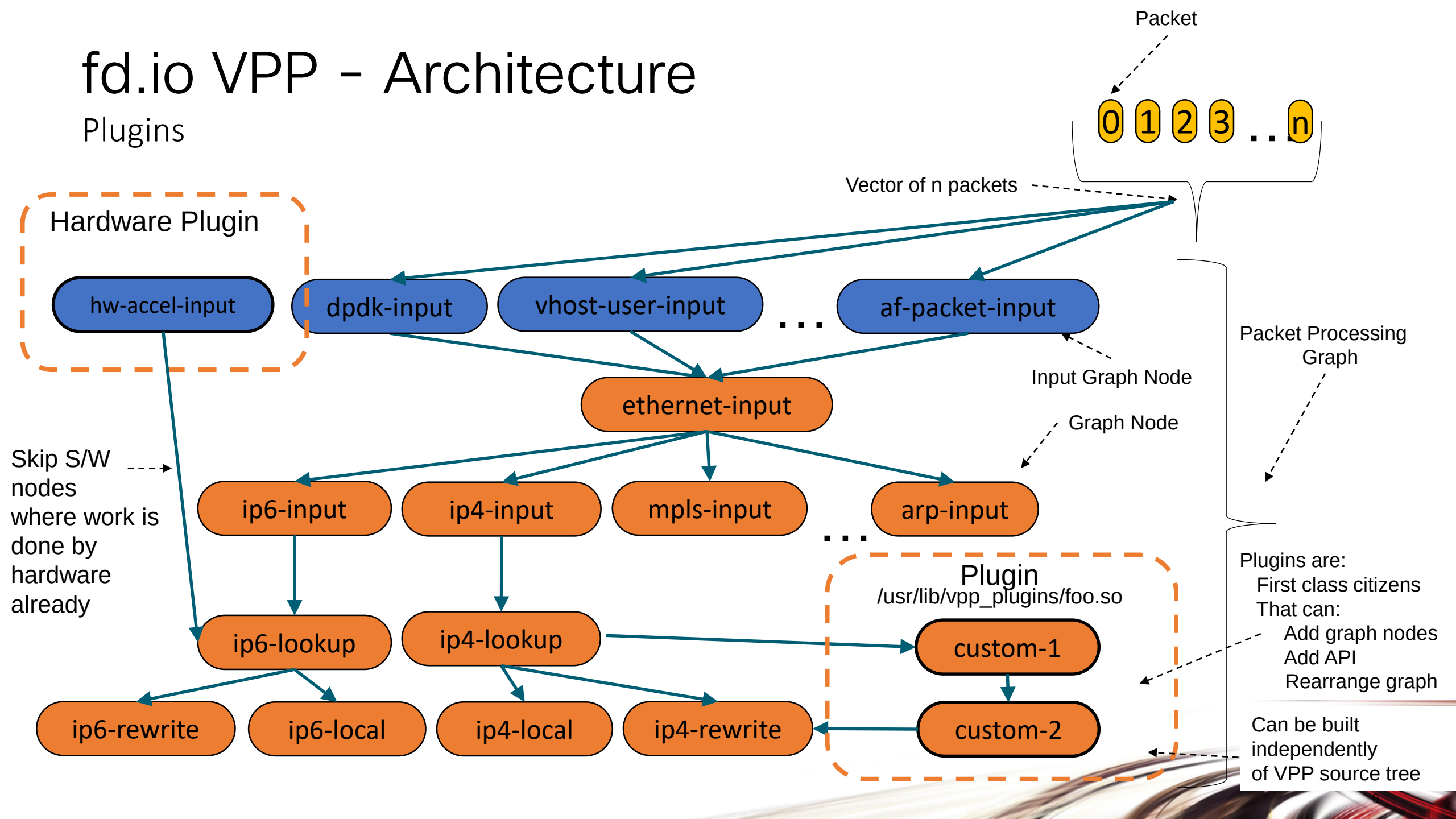
fd.io VPP – Architecture

Splitting the Vector



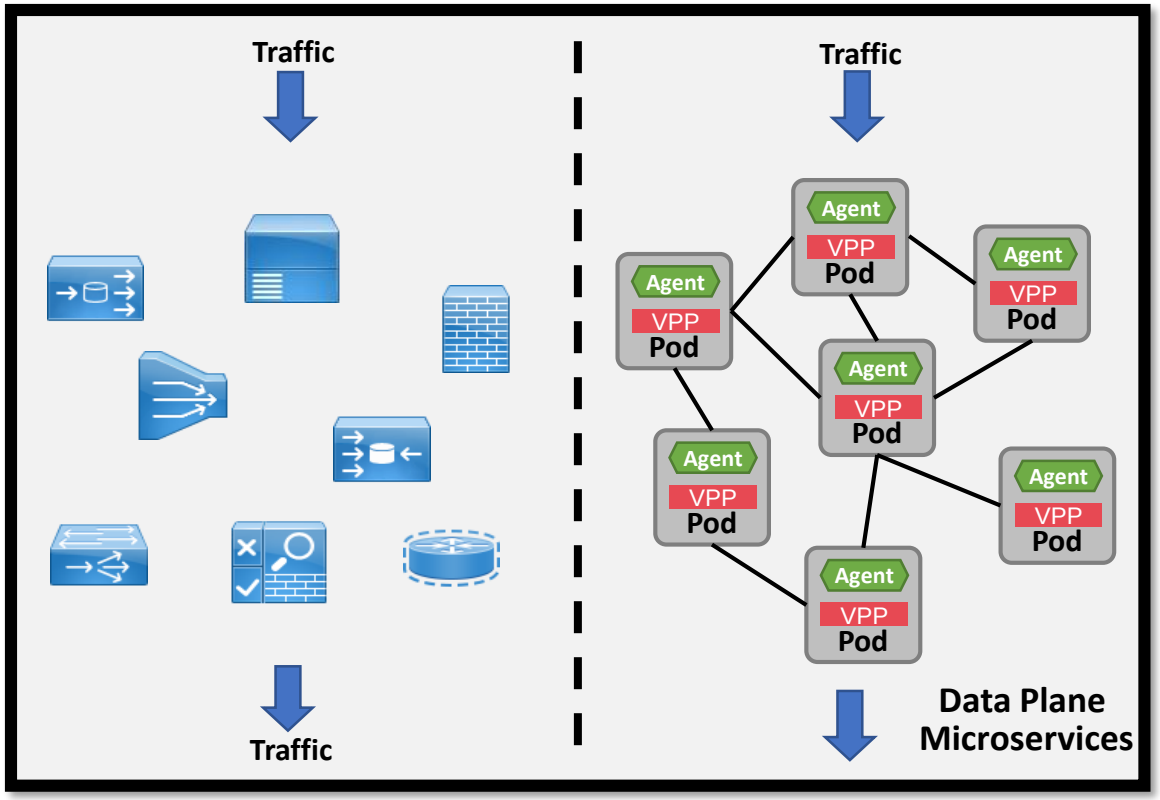
fd.io VPP – Architecture

Plugins



Cloud-Native Network Functions with VPP & Ligato

- **cncf.io**: "Cloud native computing uses an open source software stack to deploy **applications as microservices**, packaging each part into its **own container**, and dynamically **orchestrating** those containers to optimize resource utilization."
- **CNFs**: Splitting of network functions into collection (chain) of loosely coupled services, deployed as containers, interconnected with fast data plane links
- **VPP**: data plane part for building CNFs (memifs for interconnecting)
- **Ligato**: control plane part for building CNFs (VPP agent) and CNF chaining (SFC Controller)



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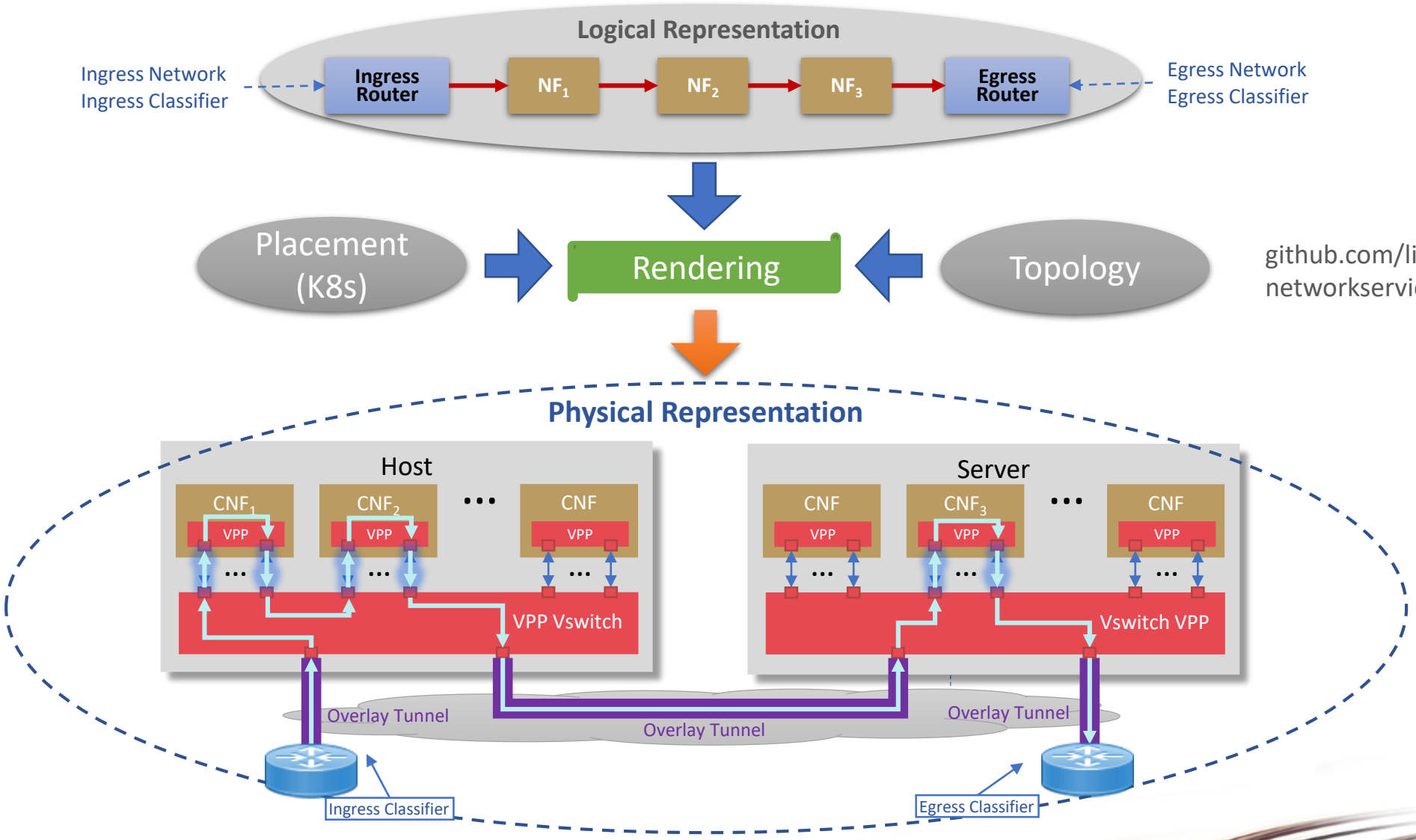
Service Function Chaining with CNFs & VPP



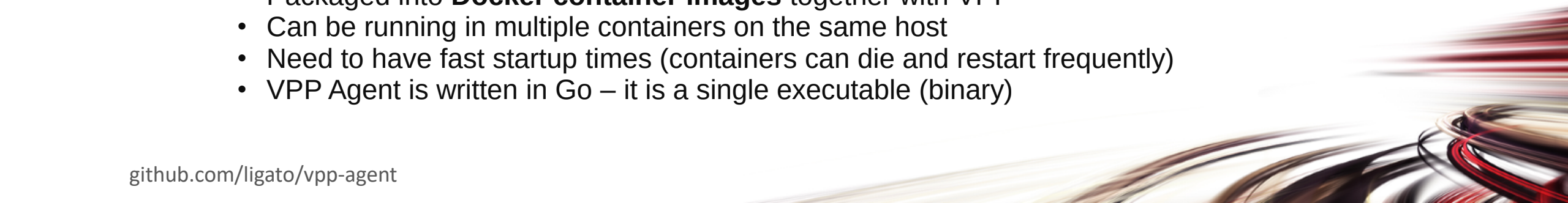
github.com/ligato/sfc-controller
networkservicemesh.io

Ligato VPP Agent

(Development Platform for VPP-based / Non-VPP-based CNFs)

VPP-based CNFs require a cloud-native management agent for VPP:

- NETCONF/RESTCONF + YANG does not fit to cloud-native very well
- **Protobuf API** is used instead; via any transport:
  - gRPC / REST (for RPC-based configuration / state data retrieval)
  - Key-value datastores: ETCD, Redis, Bolt DB, ... (asynchronous configuration)
  - Message brokers: Kafka, (RabbitMQ, NATS, ...)
- Needs to be pluggable into existing cloud-native infra (k8s, Docker)
  - Implemented in **Go** (as well as Docker & k8s)
  - The agent can be used as a library from other Go applications (Contiv-VPP)
- Needs to be compact and low footprint
  - Packaged into **Docker container images** together with VPP
  - Can be running in multiple containers on the same host
  - Need to have fast startup times (containers can die and restart frequently)
  - VPP Agent is written in Go – it is a single executable (binary)



github.com/ligato/vpp-agent

Ligato VPP Agent

(Development Platform for VPP-based / Non-VPP-based CNFs)

VPP:

wiki.fd.io/view/VPP

- Binary API – shared memory / unix domain socket

GoVPP:

wiki.fd.io/view/GoVPP

- Golang wrappers over binary APIs (generator)
- Go struct to binary API marashalling & unmarshalling, communication with VPP
- Still binary API
  - low-level (numeric references to interfaces, byte ordering issues, bit flags,, etc.)
  - API message ordering / dependency issues
  - API versioning issues (API needs to match with VPP version)

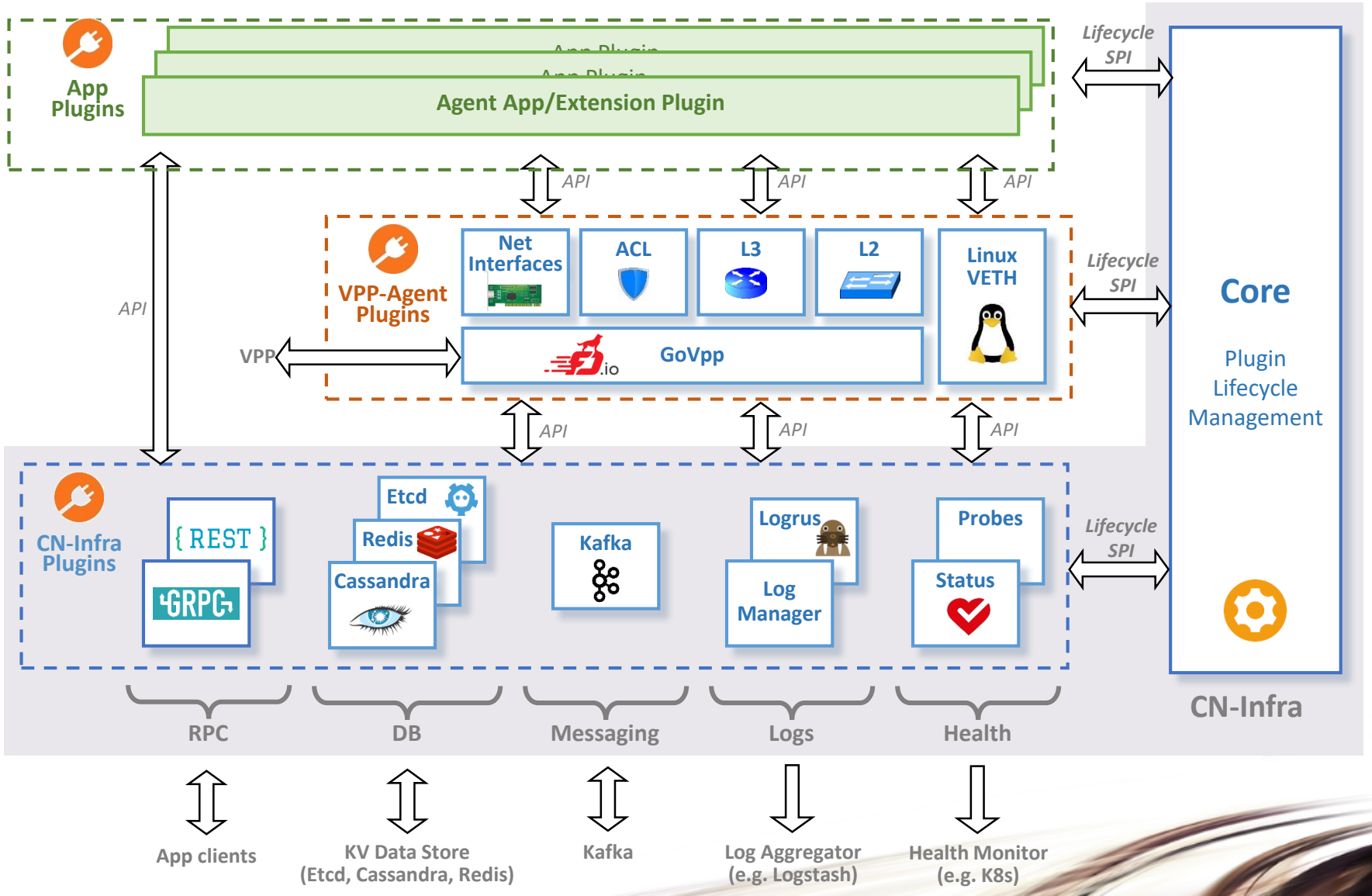
VPP Agent:

github.com/ligato/vpp-agent

- Provides protobuf-modelled NB API
  - more high-level, uses labels (names) for referencing
  - does not change frequently, allows backward-compatible API changes
  - various transports for the same API: RPC (gRPC, REST), key-value store (ETCD, Redis), …
- KVScheduler
  - transaction-based configuration processing using graph processing engine (addresses the ordering issue)
  - error state handling: handles restarts, retries on error, auto-healing (resync)
- Modular & extandable – VPP plugins, Linux plugin
- Packaged as a Docker container together with compatible VPP (no versioning issues)

Ligato VPP Agent

(Development Platform for VPP-based / Non-VPP-based CNFs)



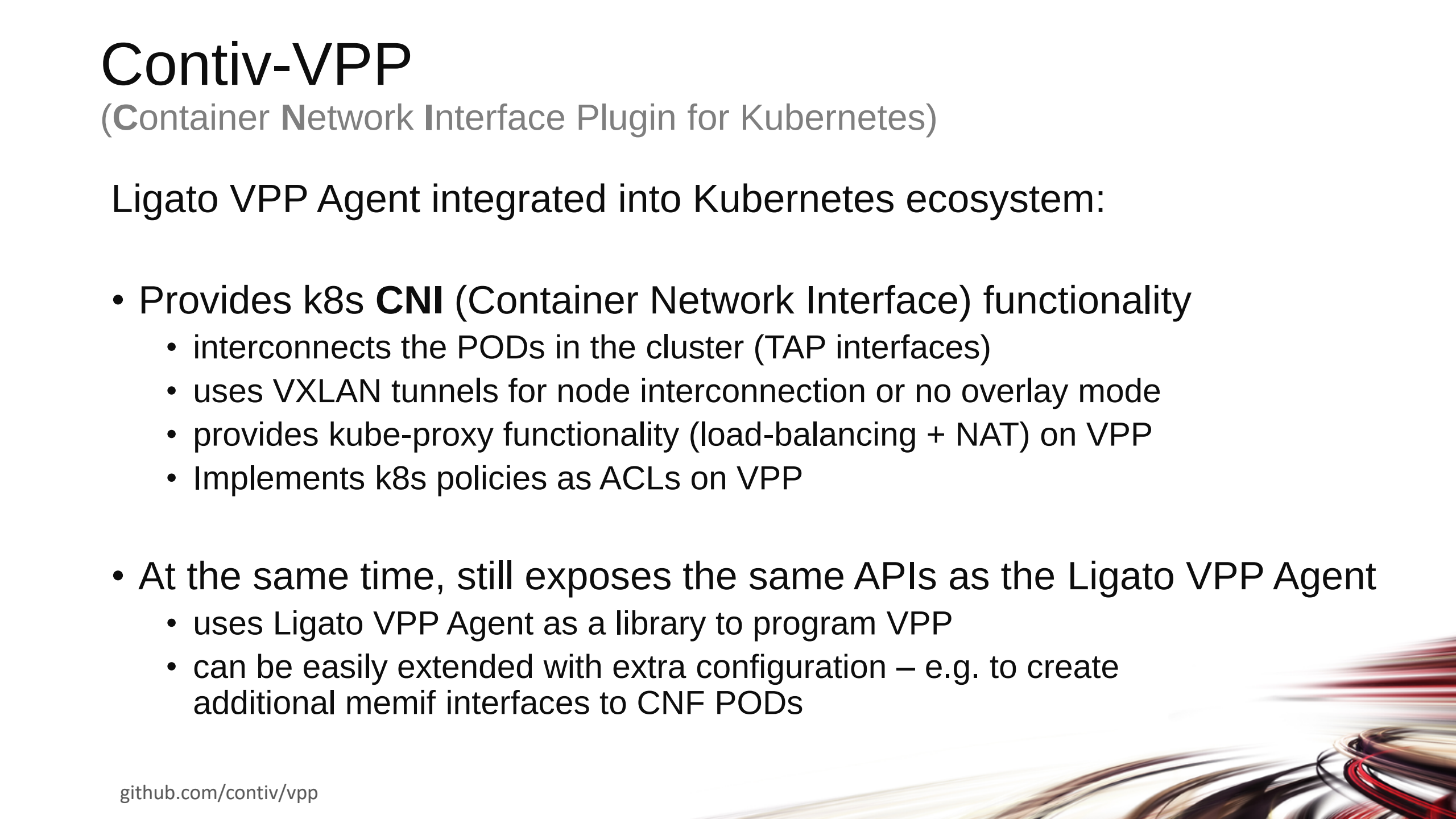
Contiv-VPP

(**C**ontainer **N**etwork **I**nterface Plugin for Kubernetes)

Ligato VPP Agent integrated into Kubernetes ecosystem:

- Provides k8s **CNI** (Container Network Interface) functionality
  - interconnects the PODs in the cluster (TAP interfaces)
  - uses VXLAN tunnels for node interconnection or no overlay mode
  - provides kube-proxy functionality (load-balancing + NAT) on VPP
  - Implements k8s policies as ACLs on VPP

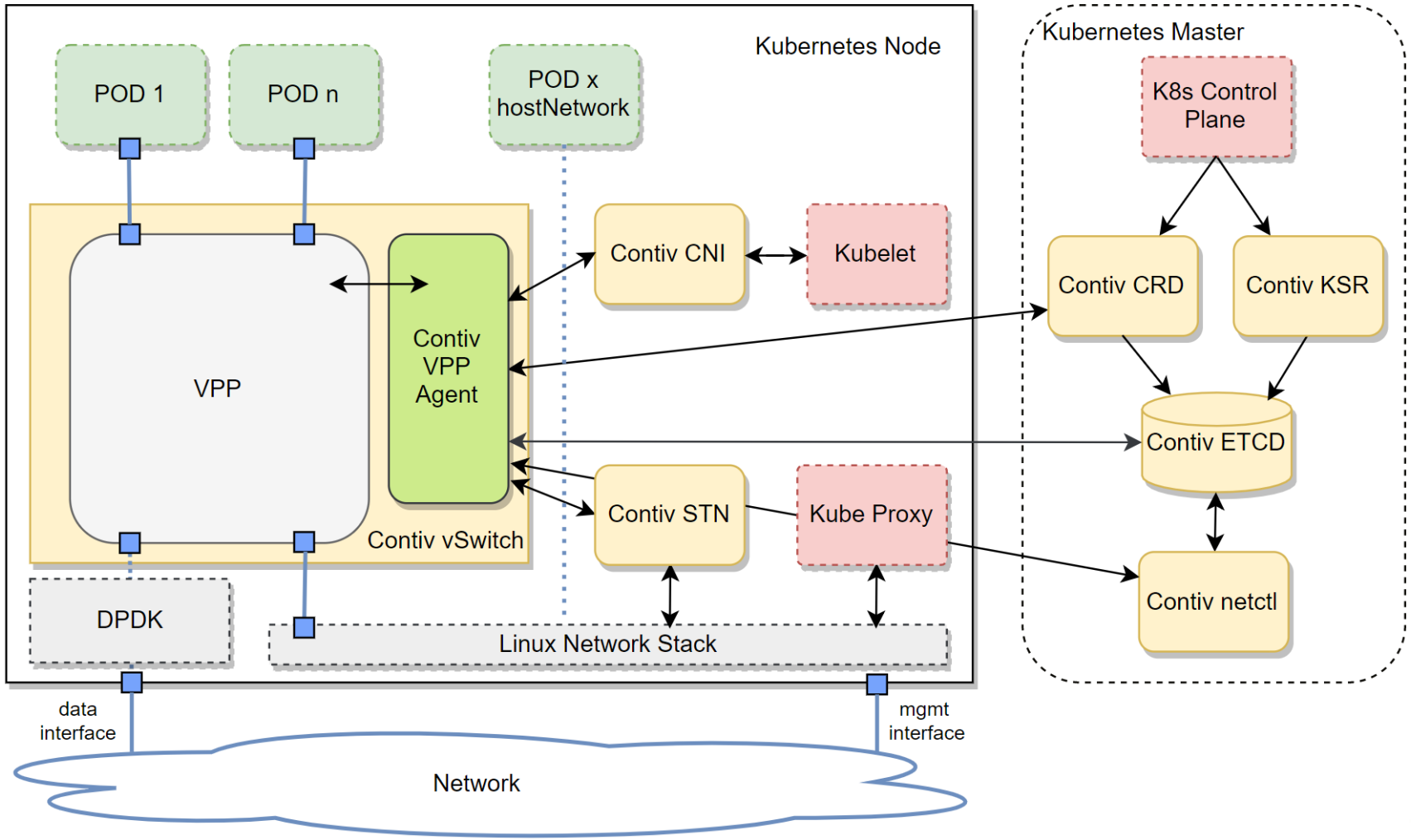
- At the same time, still exposes the same APIs as the Ligato VPP Agent
  - uses Ligato VPP Agent as a library to program VPP
  - can be easily extended with extra configuration – e.g. to create additional memif interfaces to CNF PODs



github.com/contiv/vpp

Contiv-VPP

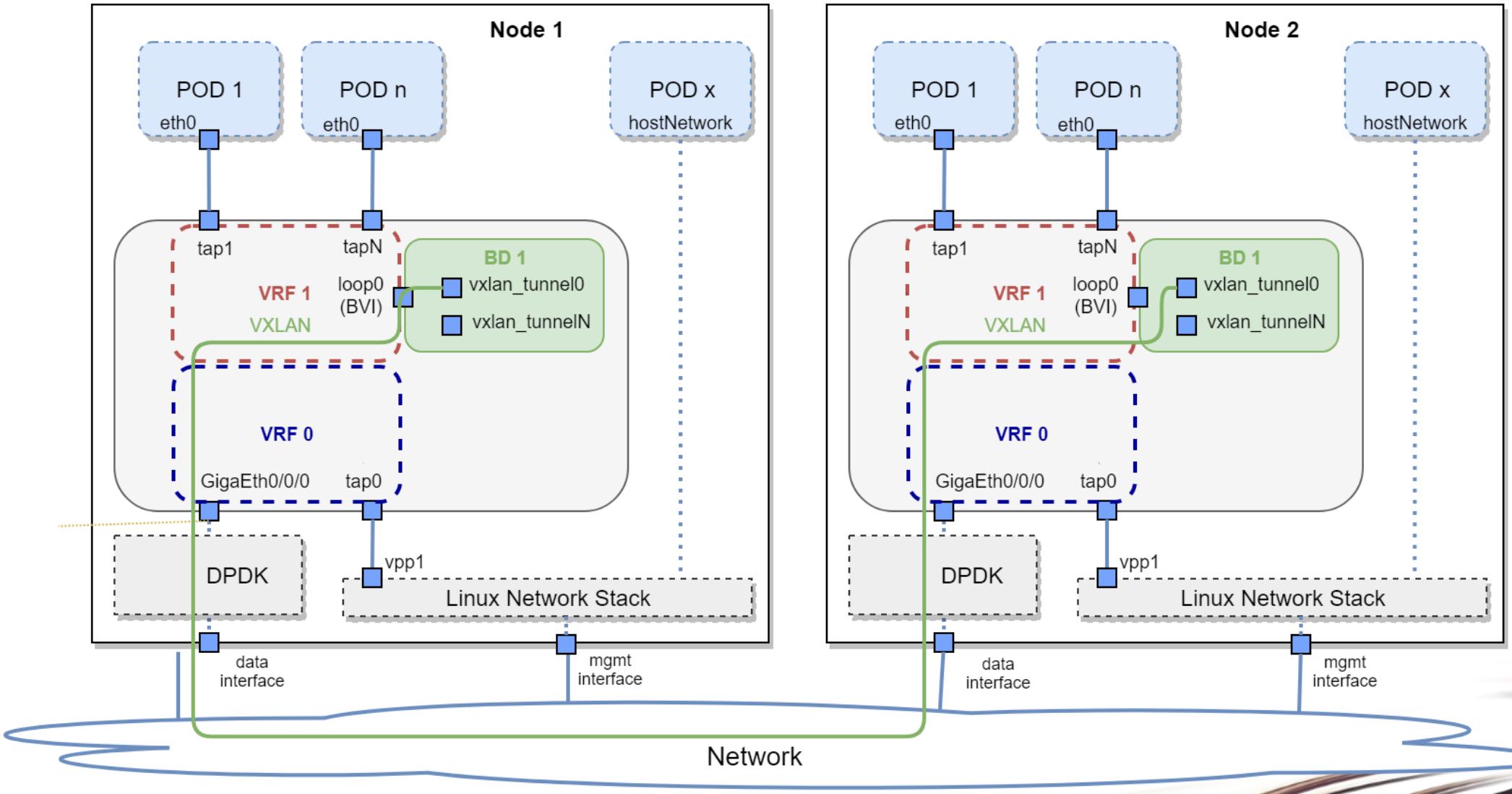
(**C**ontainer **N**etwork **I**nterface Plugin for Kubernetes)



github.com/contiv/vpp

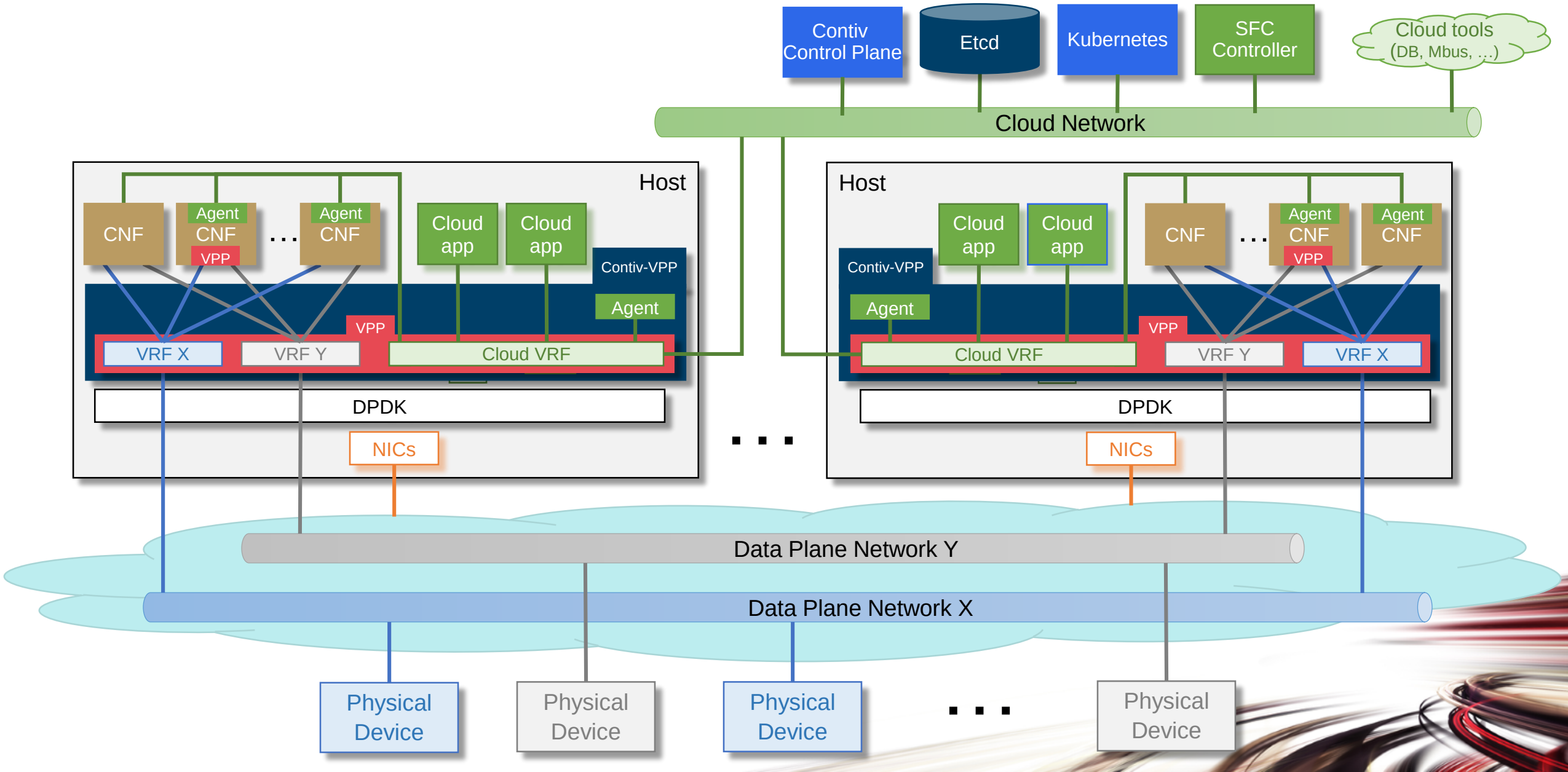
Contiv-VPP

(**C**ontainer **N**etwork **I**nterface Plugin for Kubernetes)

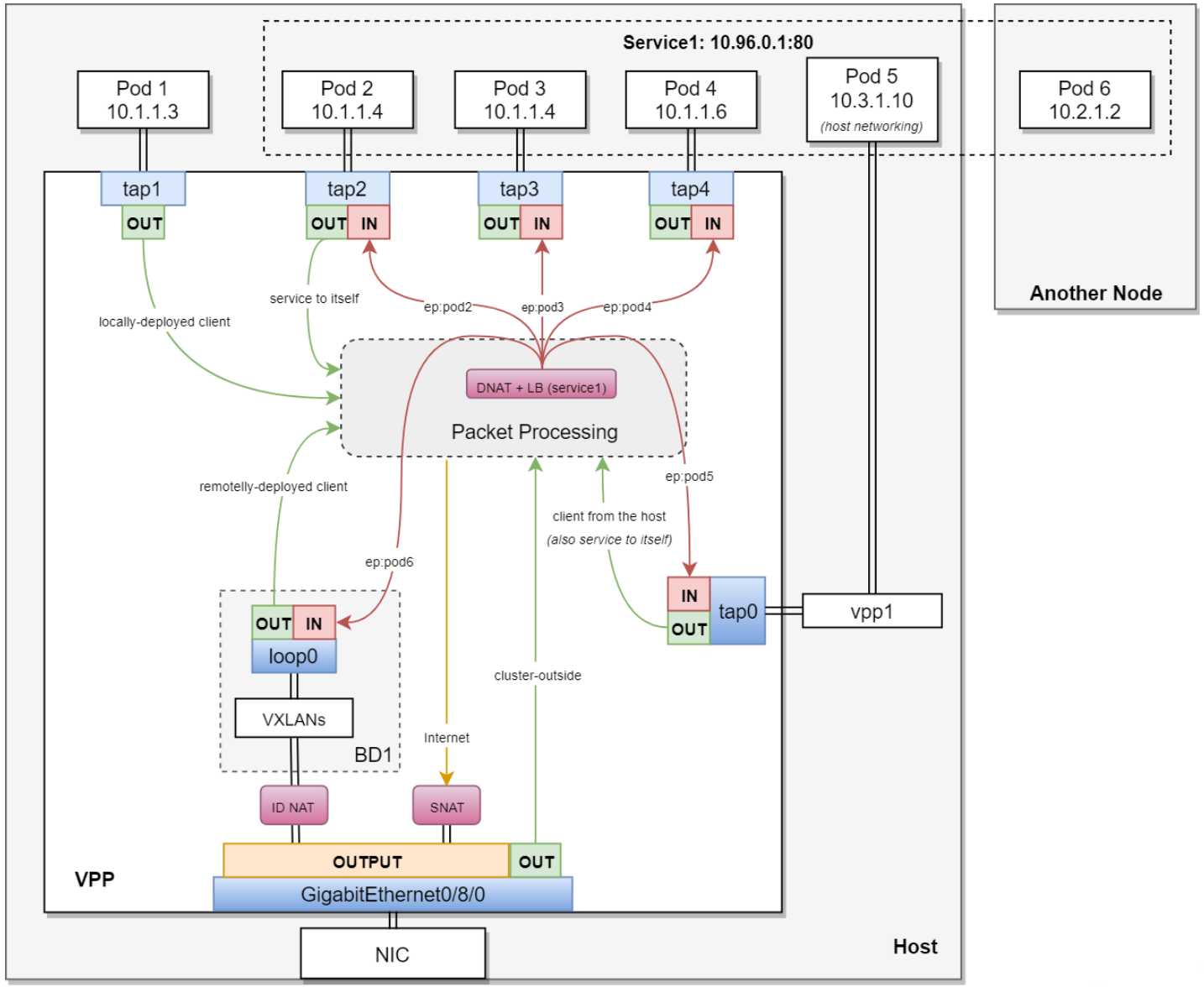


github.com/contiv/vpp

Contiv-VPP + CNFs



k8s Services & Load Balancing with Contiv-VPP



github.com/contiv/vpp

k8s Services & Load Balancing with Contiv-VPP

```
apiVersion: apps/v1beta2
kind: ReplicaSet
metadata:
  name: nginx
spec:
  replicas: 3
  selector:
    matchLabels:
      app: nginx
  template:
    metadata:
      labels:
        app: nginx
    spec:
      containers:
      - name: nginx
        image: nginx
        ports:
        - name: http
          containerPort: 80
```

```
apiVersion: v1
kind: Service
metadata:
  name: nginx
spec:
  type: LoadBalancer
  ports:
  - name: http
    port: 80
    protocol: TCP
    targetPort: 80
  selector:
    app: nginx
```

```
apiVersion: v1
kind: ConfigMap
metadata:
  namespace: metallb-system
  name: config
data:
  config: |
    address-pools:
    - name: my-ip-space
      protocol: layer2
      addresses:
      - 192.168.16.150-
192.168.16.250
```

MetalLB (https://metallb.universe.tf) used for external load balancing

```
vagrant@k8s-master:~$ kubectl get svc nginx
NAME      TYPE           CLUSTER-IP      EXTERNAL-IP      PORT(S)        AGE
nginx     LoadBalancer   10.107.167.81   192.168.16.150   80:32676/TCP   1m

vagrant@k8s-master:~$ kubectl get pods -o wide
NAME          READY     STATUS    RESTARTS   AGE       IP          NODE          NOMINATED NODE
nginx-bnh78   1/1       Running   0          1m        10.1.3.2    k8s-worker2   <none>
nginx-rqhrf   1/1       Running   0          1m        10.1.4.2    k8s-worker3   <none>
nginx-w57kx   1/1       Running   0          1m        10.1.2.2    k8s-worker1   <none>
```

k8s Services & Load Balancing with Contiv-VPP

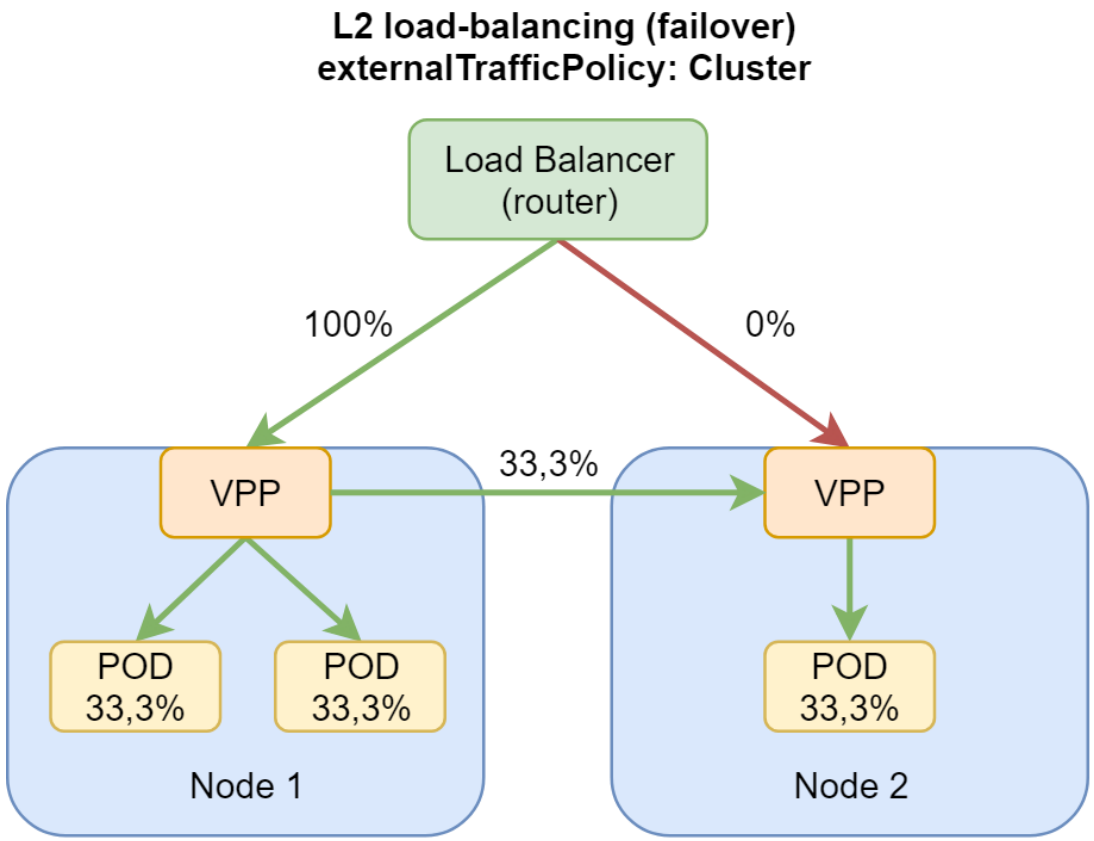
```
vagrant@k8s-worker1:~$ sudo vppctl

    _______    _        _   _____  ___
 __/ __/ _ \  (_)__    | | / / _ \/ _ \
 _/ _// // / / / _ \   | |/ / ___/ ___/
 /_/ /____(_)_/\___/   |___/_/  /_/

vpp# sh inter addr
GigabitEthernet0/8/0 (up):
  L3 192.168.16.2/24
local0 (dn):
loop0 (up):
  L3 10.1.2.1/24 ip4 table-id 1 fib-idx 1
loop1 (up):
  L2 bridge bd-id 1 idx 1 shg 1 bvi
  L3 192.168.30.2/24 ip4 table-id 1 fib-idx 1
tap0 (up):
  L3 172.30.2.1/24
tap1 (up):
  unnumbered, use loop0
  L3 10.1.2.1/24 ip4 table-id 1 fib-idx 1
vxlan_tunnel0 (up):
  L2 bridge bd-id 1 idx 1 shg 1
vxlan_tunnel1 (up):
  L2 bridge bd-id 1 idx 1 shg 1
vxlan_tunnel2 (up):
  L2 bridge bd-id 1 idx 1 shg 1
```

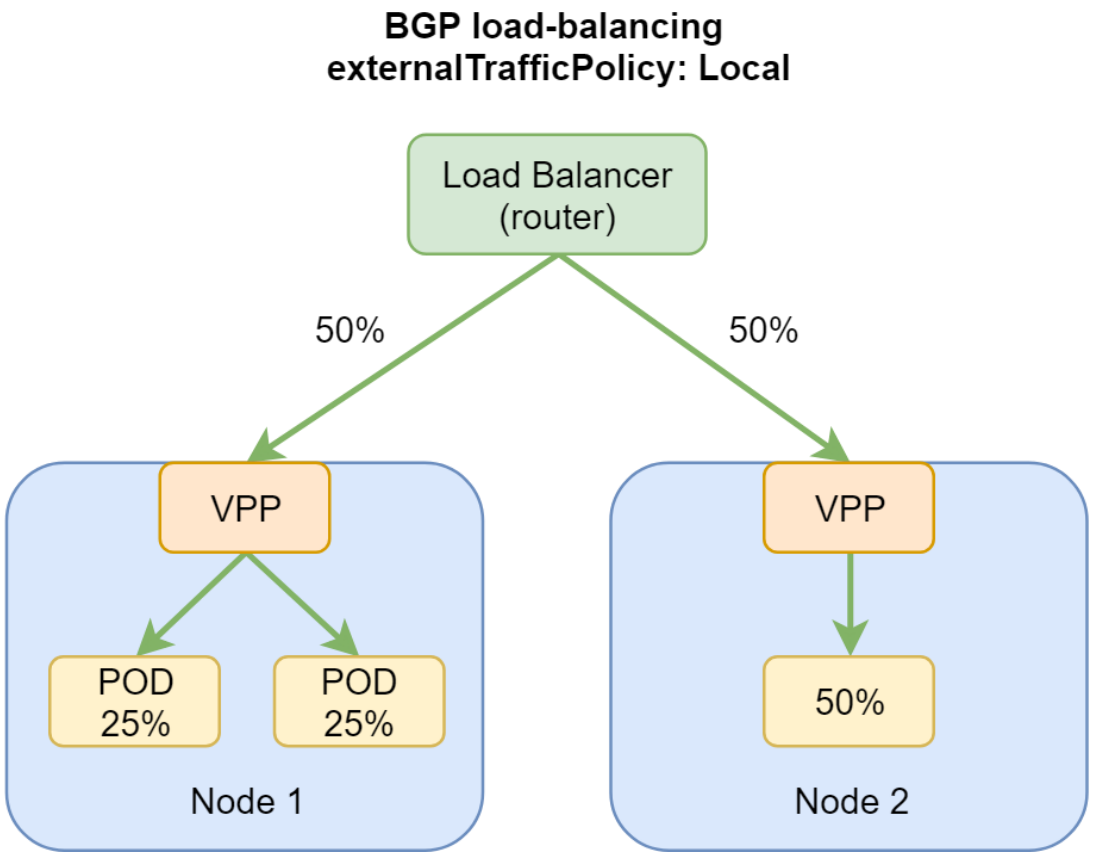
```
vagrant@k8s-worker1:~$ sudo vppctl

    _______    _        _   _____  ___
 __/ __/ _ \  (_)__    | | / / _ \/ _ \
 _/ _// // / / / _ \   | |/ / ___/ ___/
 /_/ /____(_)_/\___/   |___/_/  /_/

vpp# sh nat44 static mappings
tcp external 10.107.167.81:80 self-twice-nat out2in-only
  local 10.1.2.2:80 vrf 1 probability 1
  local 10.1.3.2:80 vrf 1 probability 1
  local 10.1.4.2:80 vrf 1 probability 1
 tcp external 192.168.16.150:80 twice-nat out2in-only
  local 10.1.2.2:80 vrf 1 probability 1
  local 10.1.3.2:80 vrf 1 probability 1
  local 10.1.4.2:80 vrf 1 probability 1
```

```
vagrant@k8s-worker1:~$ sudo vppctl

    _______    _        _   _____  ___
 __/ __/ _ \  (_)__    | | / / _ \/ _ \
 _/ _// // / / / _ \   | |/ / ___/ ___/
 /_/ /____(_)_/\___/   |___/_/  /_/

vpp# sh ip arp
Proxy arps enabled for:
Fib_index 0   192.168.16.150 - 192.168.16.150
```

github.com/contiv/vpp

k8s Services & Load Balancing with Contiv-VPP





github.com/contiv/vpp

IPSEC in fd.io VPP

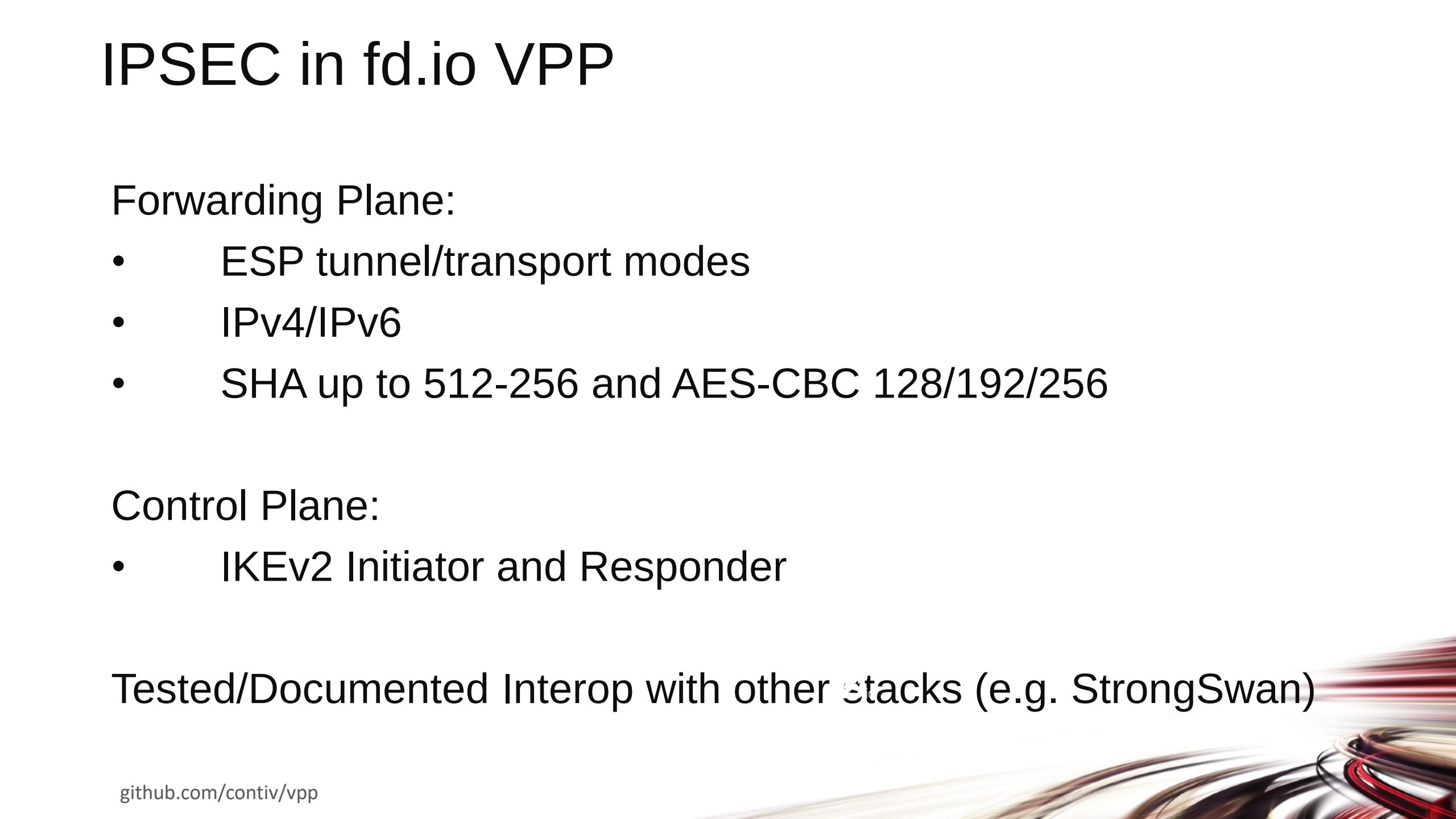
Forwarding Plane:

- ESP tunnel/transport modes
- IPv4/IPv6
- SHA up to 512-256 and AES-CBC 128/192/256

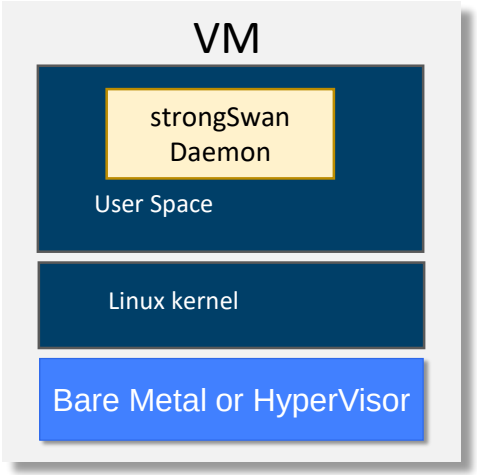
Control Plane:

- IKEv2 Initiator and Responder

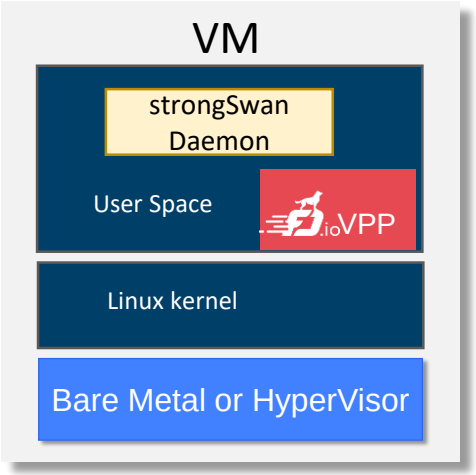
Tested/Documented Interop with other stacks (e.g. StrongSwan)



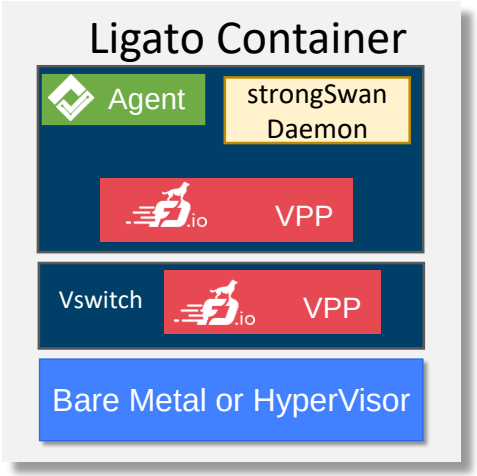
Migration from VM/StrongSwan to Contiv/Ligato VNFs



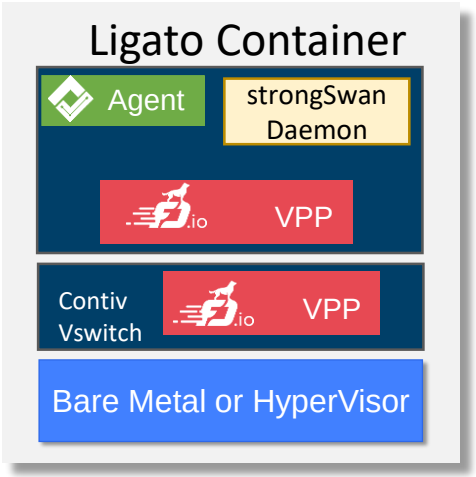
- Server running a VM with StrongSwan and Linux kernel



- Server running StrongSwan with a plugin to VPP for higher IPSEC pps throughput

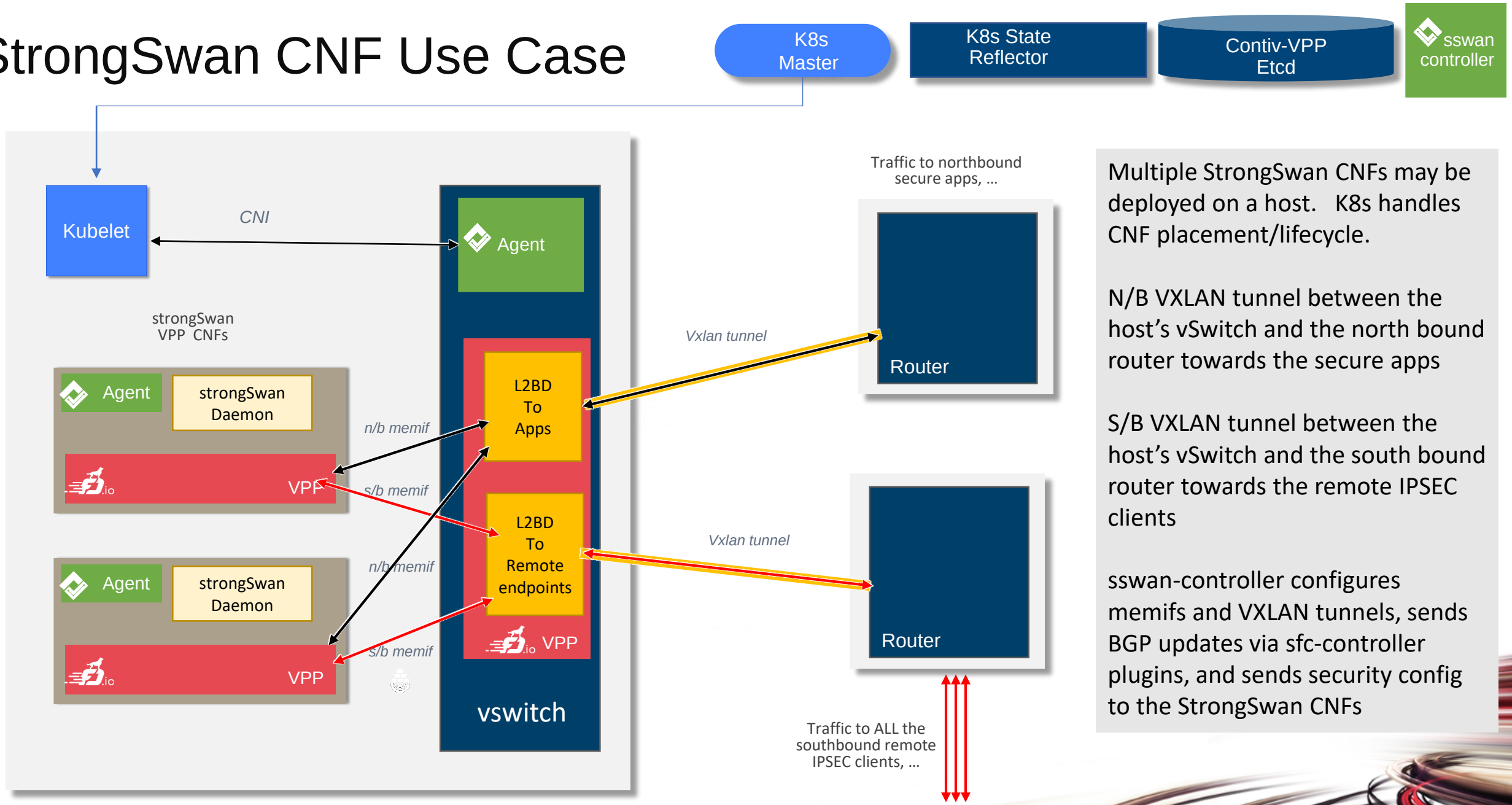


- Ligato CNF running StrongSwan, a Ligato agent, and a VPP for IPSEC data plane - with a memIf to the Ligato vSwitch
- Kubernetes is optional



- Full K8s/Contiv-vpp integration with ligato CNF, dynamic re-wiring of CNFs using sfc-controller based on k8s placement policies

StrongSwan CNF Use Case



Multiple StrongSwan CNFs may be deployed on a host. K8s handles CNF placement/lifecycle.

N/B VXLAN tunnel between the host's vSwitch and the north bound router towards the secure apps

S/B VXLAN tunnel between the host's vSwitch and the south bound router towards the remote IPSEC clients

sswan-controller configures memifs and VXLAN tunnels, sends BGP updates via sfc-controller plugins, and sends security config to the StrongSwan CNFs

Backup

LIGATO

Network Micro-Service Use Case:

Service Function Chaining with Cloud-Native NFs