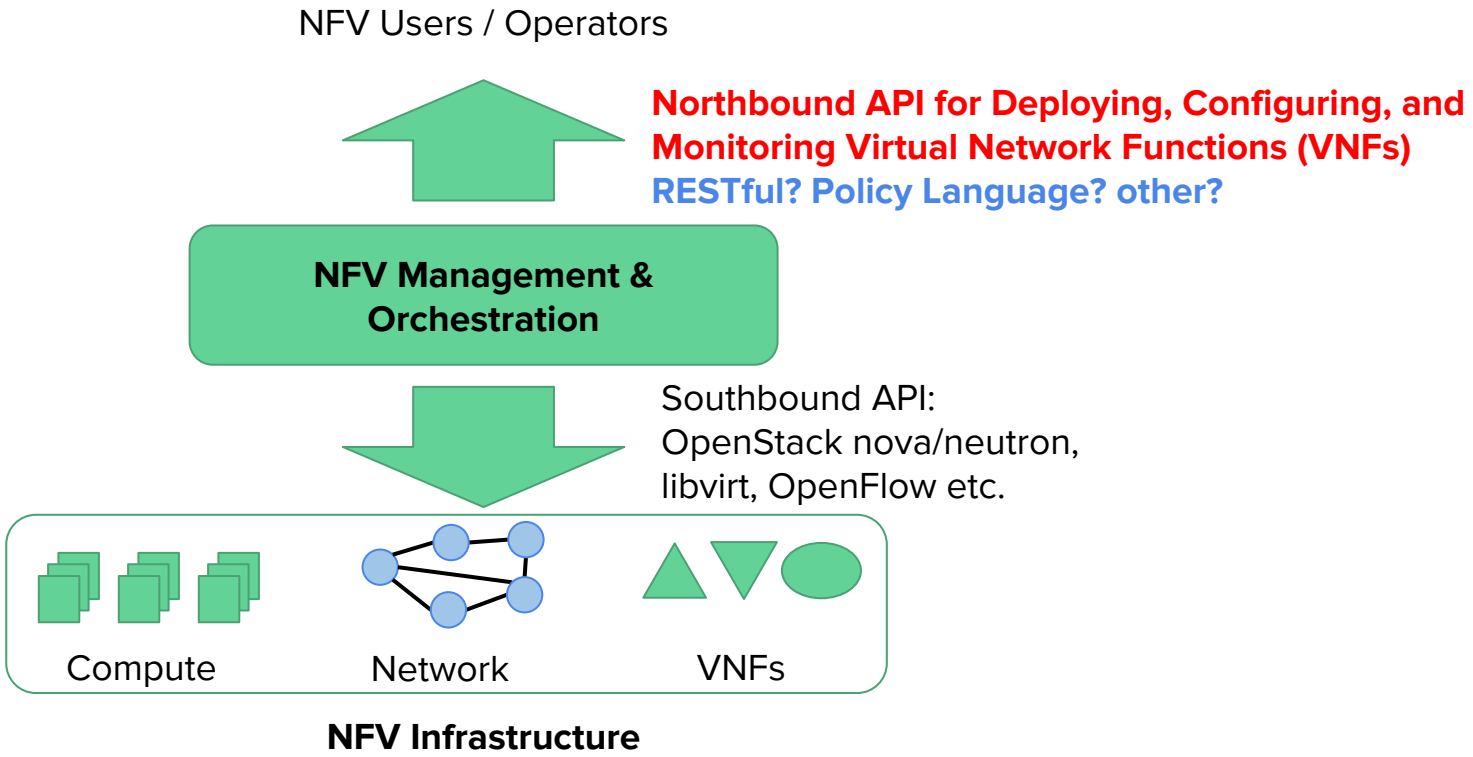
nf.io: A File System Abstraction for NFV Orchestration

Md. Faizul Bari, Shihabur R. Chowdhury, Reaz Ahmed, and Raouf Boutaba
David R. Cheriton School of Computer Science
University of Waterloo

Outline

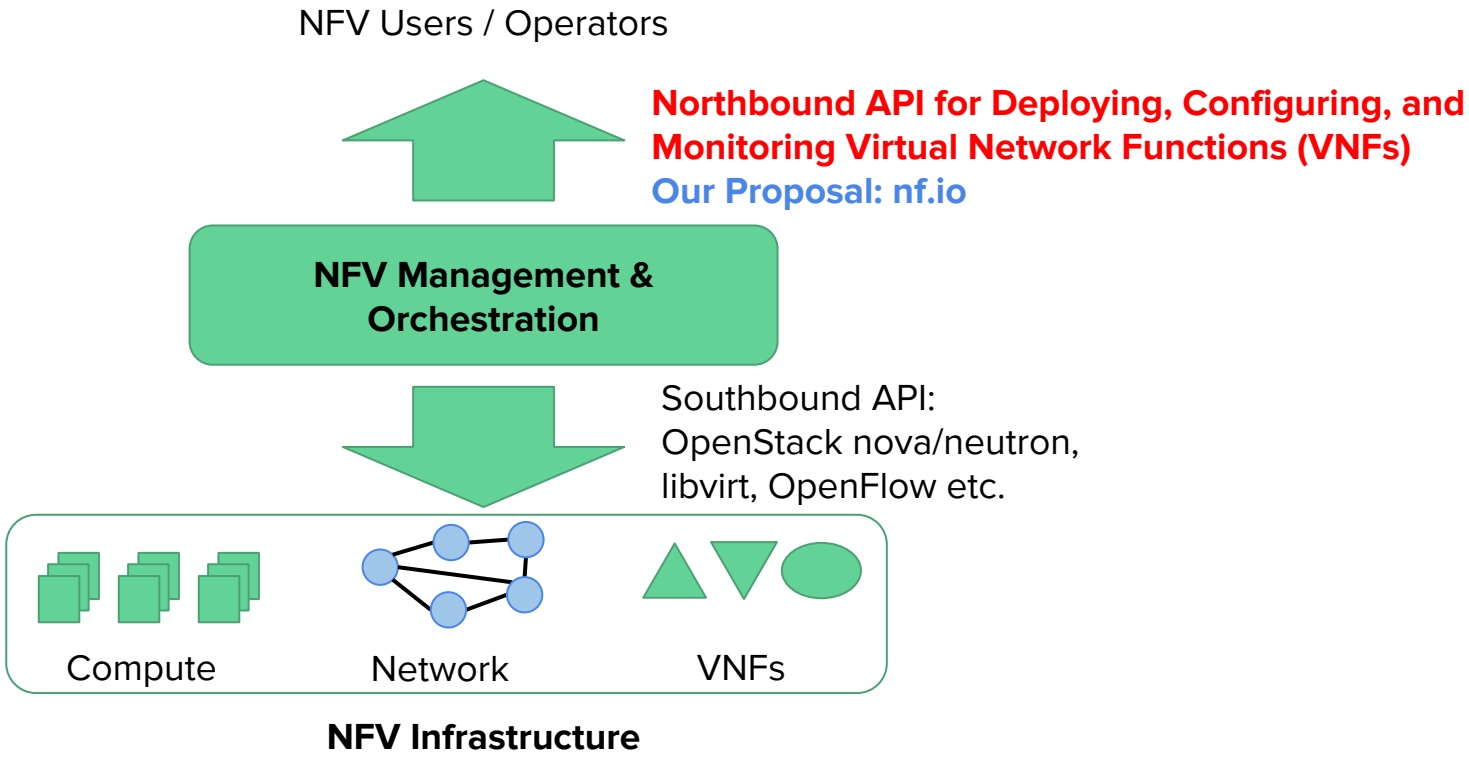
- What is nf.io?
- Related works
- Why File System abstraction?
- The nf.io File System Abstraction
- Sample Use cases
- System Architecture
- Prototype Implementation
- Work in Progress
- Conclusion

What is nf.io?



** Simplified view of ETSI Reference NFV Architecture*

What is nf.io?



** Simplified view of ETSI Reference NFV Architecture*

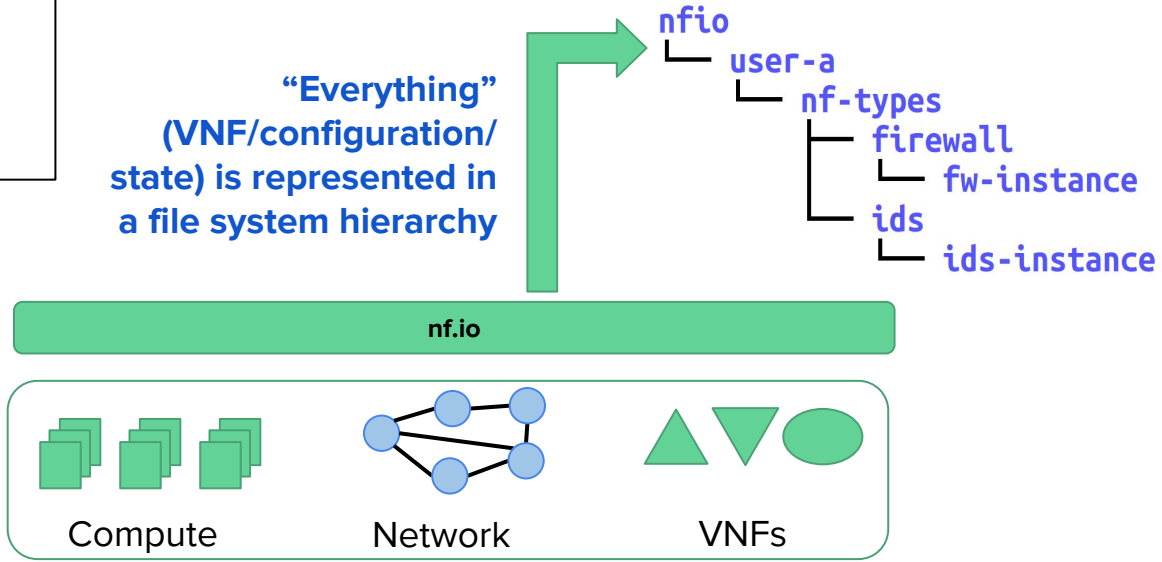
What is nf.io?

nfio: A Northbound Interface for NFV Management & Orchestration

What is nf.io?

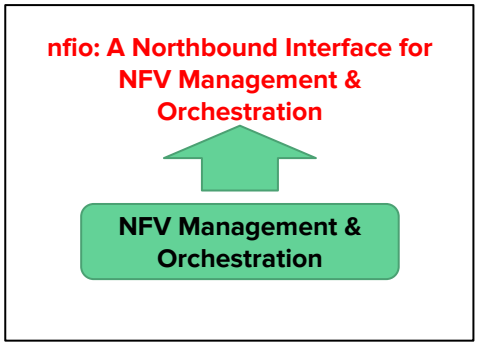
nfio: A Northbound Interface for NFV Management & Orchestration

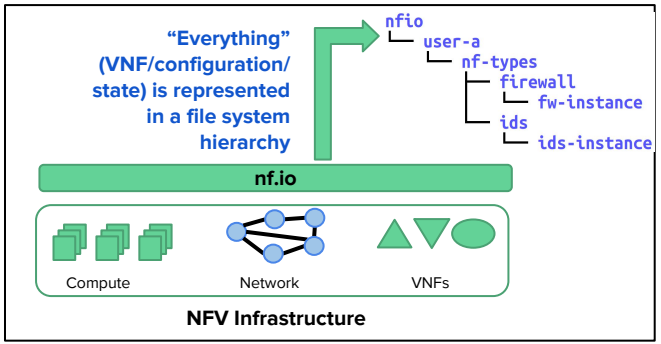
NFV Management & Orchestration

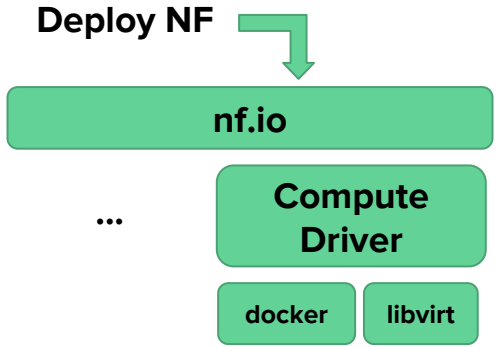


NFV Infrastructure

What is nf.io?

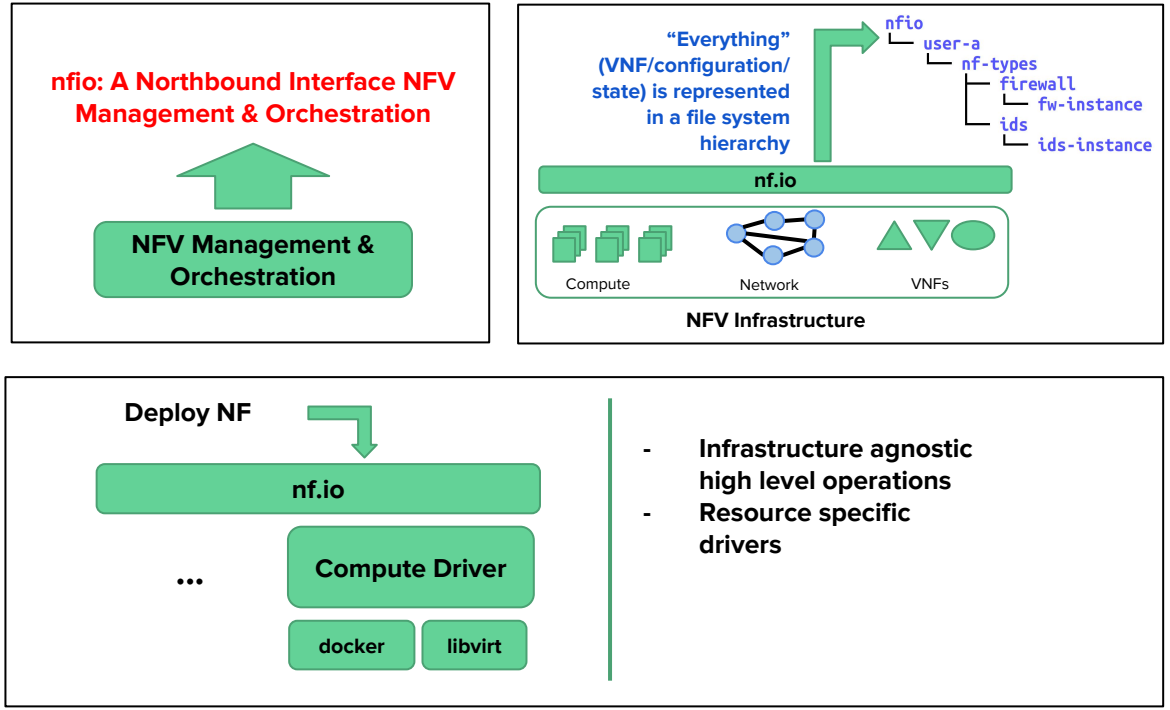






- Infrastructure agnostic high level operations
- Resource specific drivers

What is nf.io?


nfio: A Northbound Interface NFV Management & Orchestration
NFV Management & Orchestration
"Everything" (VNF/configuration/ state) is represented in a file system hierarchy
nfio
user-a
nf-types
firewall
fw-instance
ids
ids-instance
nf.io
Compute
Network
VNFs
NFV Infrastructure
Deploy NF
nf.io
...
Compute Driver
docker
libvirt
- Infrastructure agnostic high level operations
- Resource specific drivers

Related Work

- NFV Orchestration
  - Stratos, OpenNF [SIGCOMM ‘14]
  - E2 [SOSP ‘15]
  - OPNFV
- File System Abstraction
  - Linux sysfs, procfs, cgroup
  - yanc [HotNets ‘13]
- Cloud Orchestrator
  - OpenStack, CloudStack, SaltStack

Why File System Abstraction?

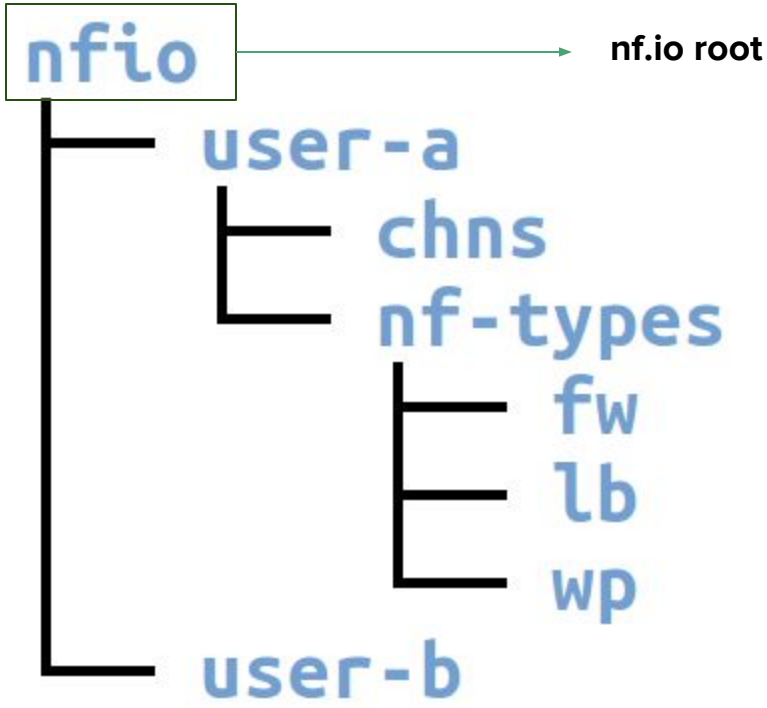
- Familiar tools to manage file systems
  - mkdir, cp, move, rm, rsync, etc.
  - grep, sed, awk, tail, etc.
    - e.g., instantiate a new VNF
      - mkdir -p /vnfs/user-a/chain-b/ids
- Rich set of file system management operations offered by configuration management tools such as Chef, Puppet, Salt etc.

Why File System Abstraction?

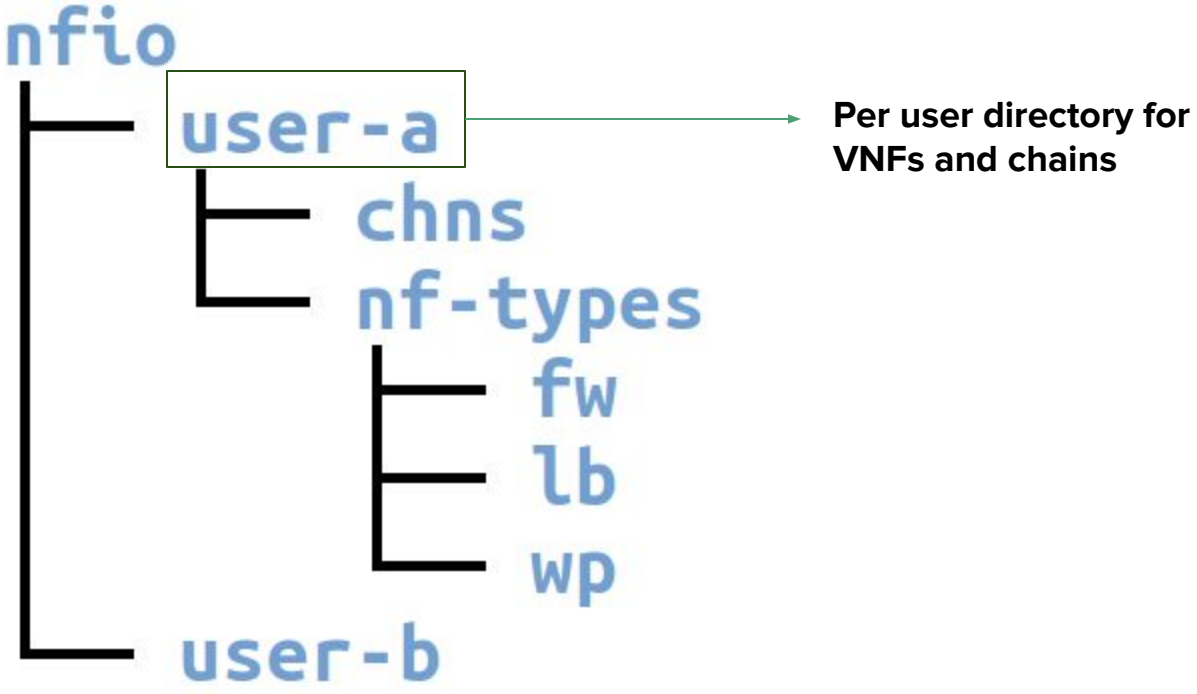
- Familiar tools to manage file systems
  - mkdir, cp, move, rm, rsync, etc.
  - grep, sed, awk, tail, etc.
    - e.g., instantiate a new VNF
      - mkdir -p /vnfs/user-a/chain-b/ids
- Rich set of file system management operations offered by configuration management tools such as Chef, Puppet, Salt etc.

Rich toolset around File Systems can be leveraged if we can translate NFV operations to File System Operations

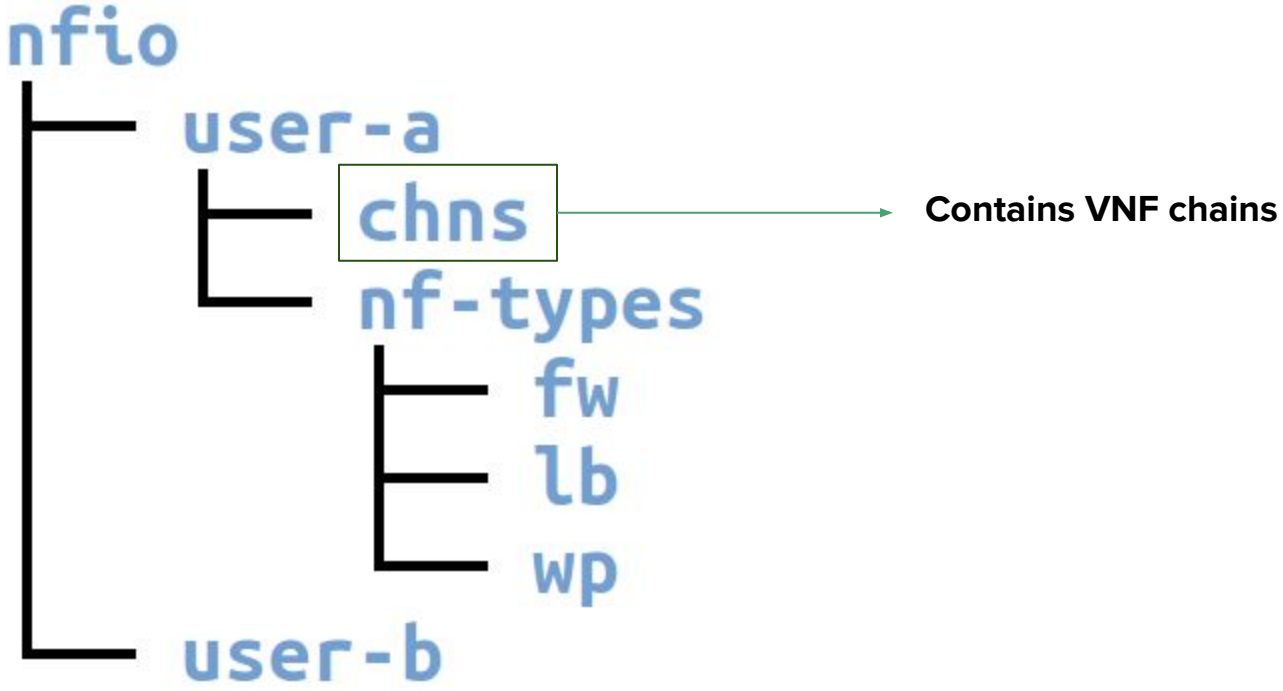
nf.io: File System Abstraction: High level



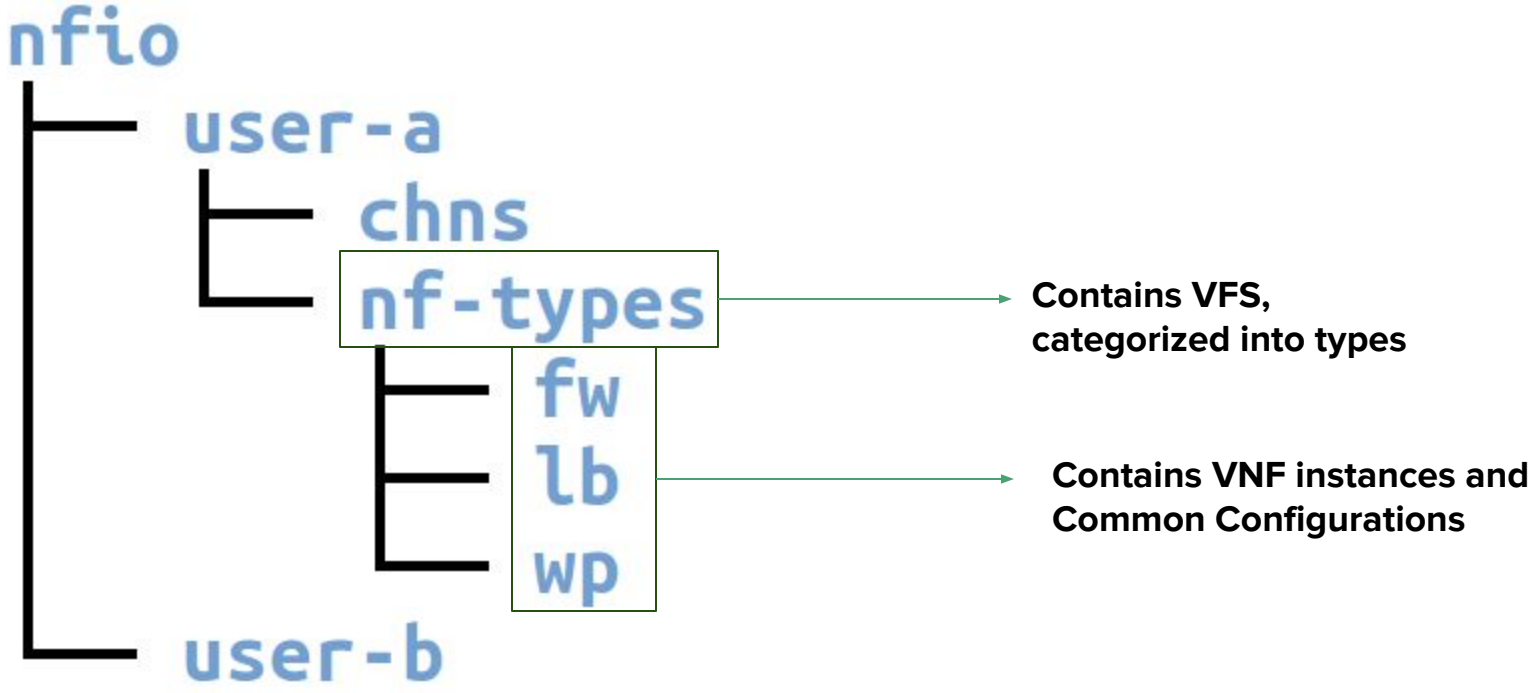
nf.io: File System Abstraction: High level



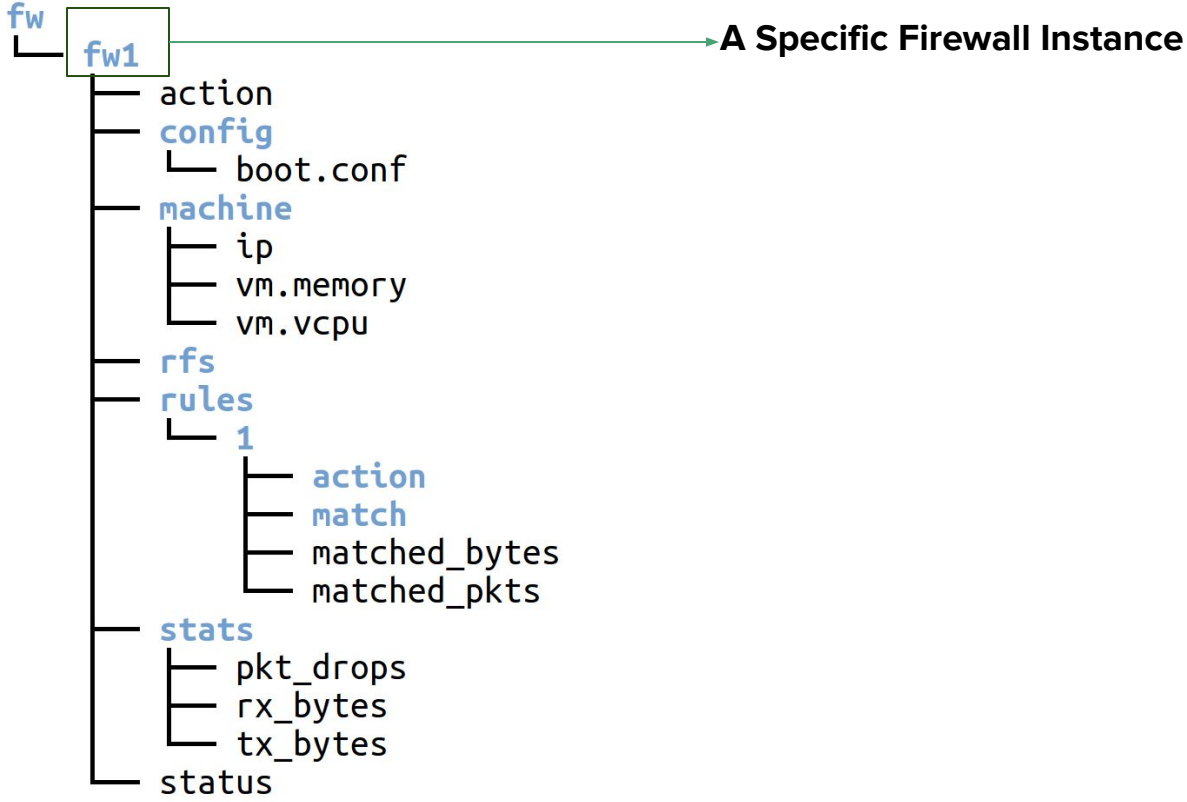
nf.io: File System Abstraction: High level



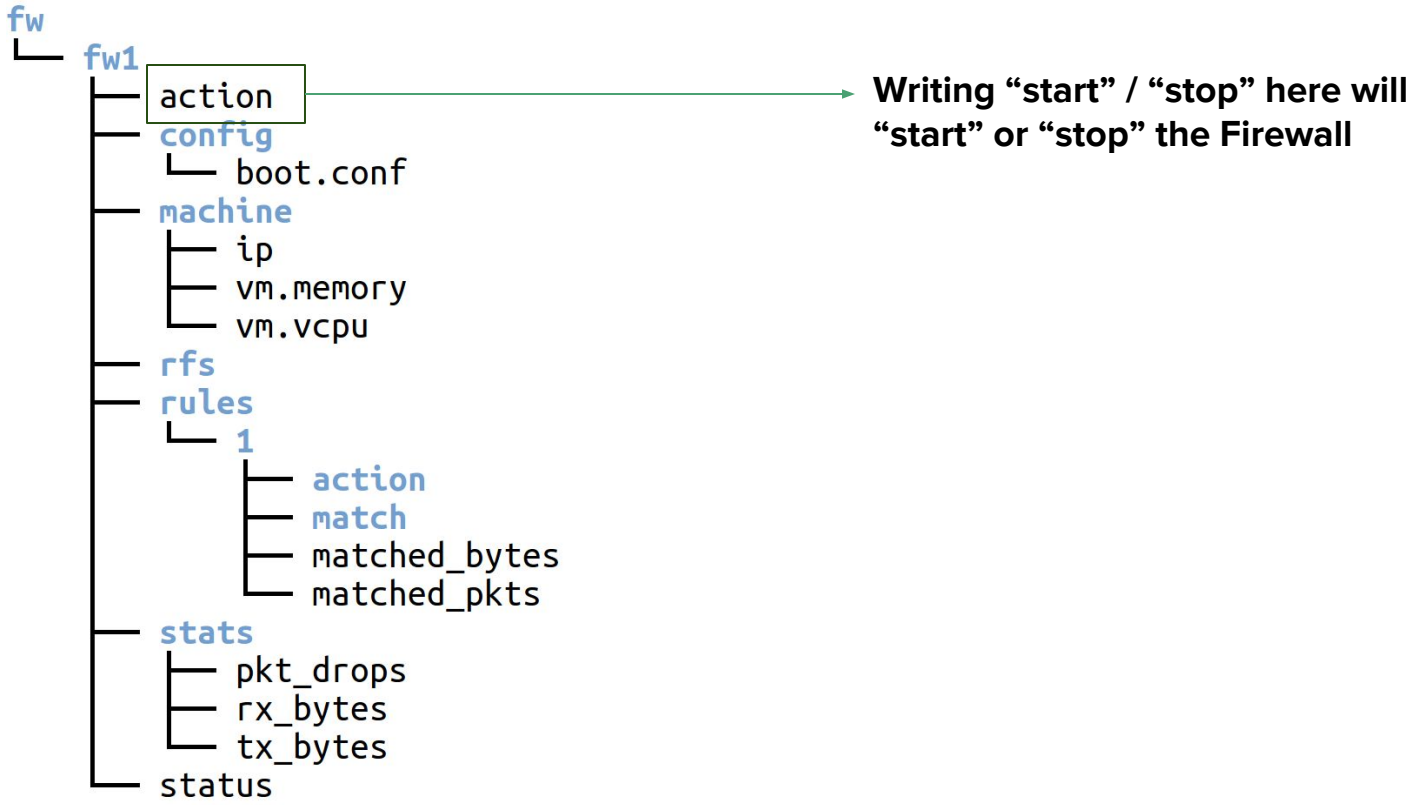
nf.io: File System Abstraction: High level



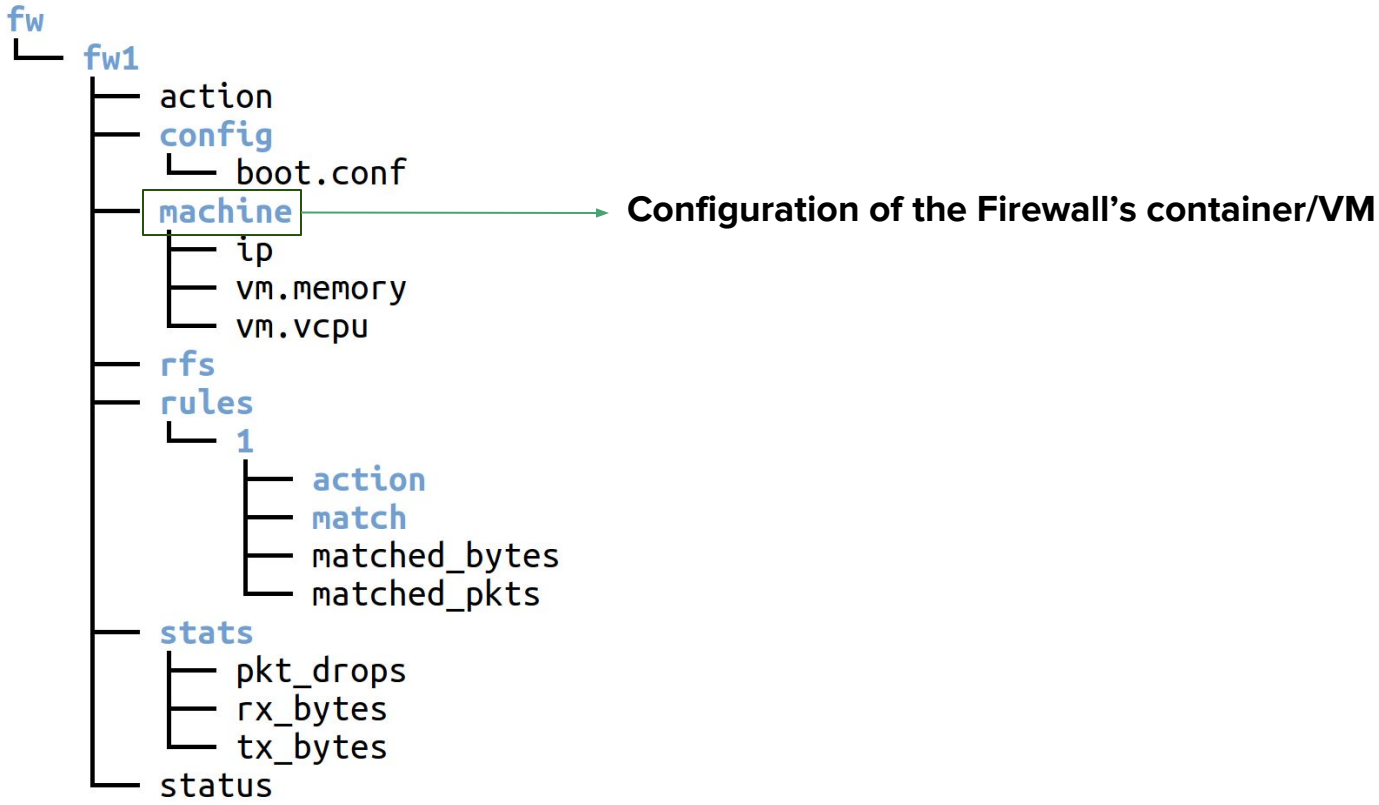
nf.io File System Abstraction: A Sample VNF



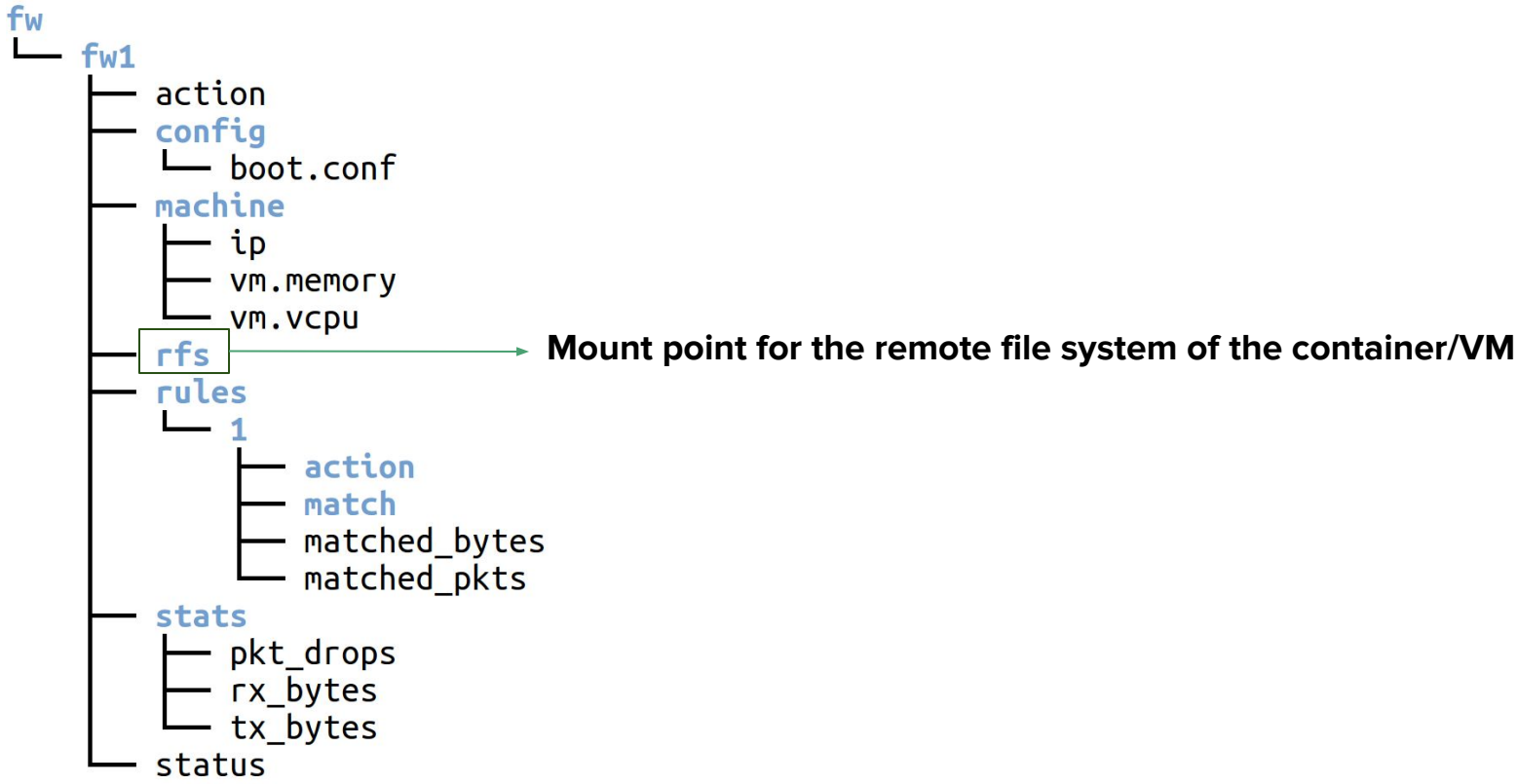
nf.io File System Abstraction: A Sample VNF



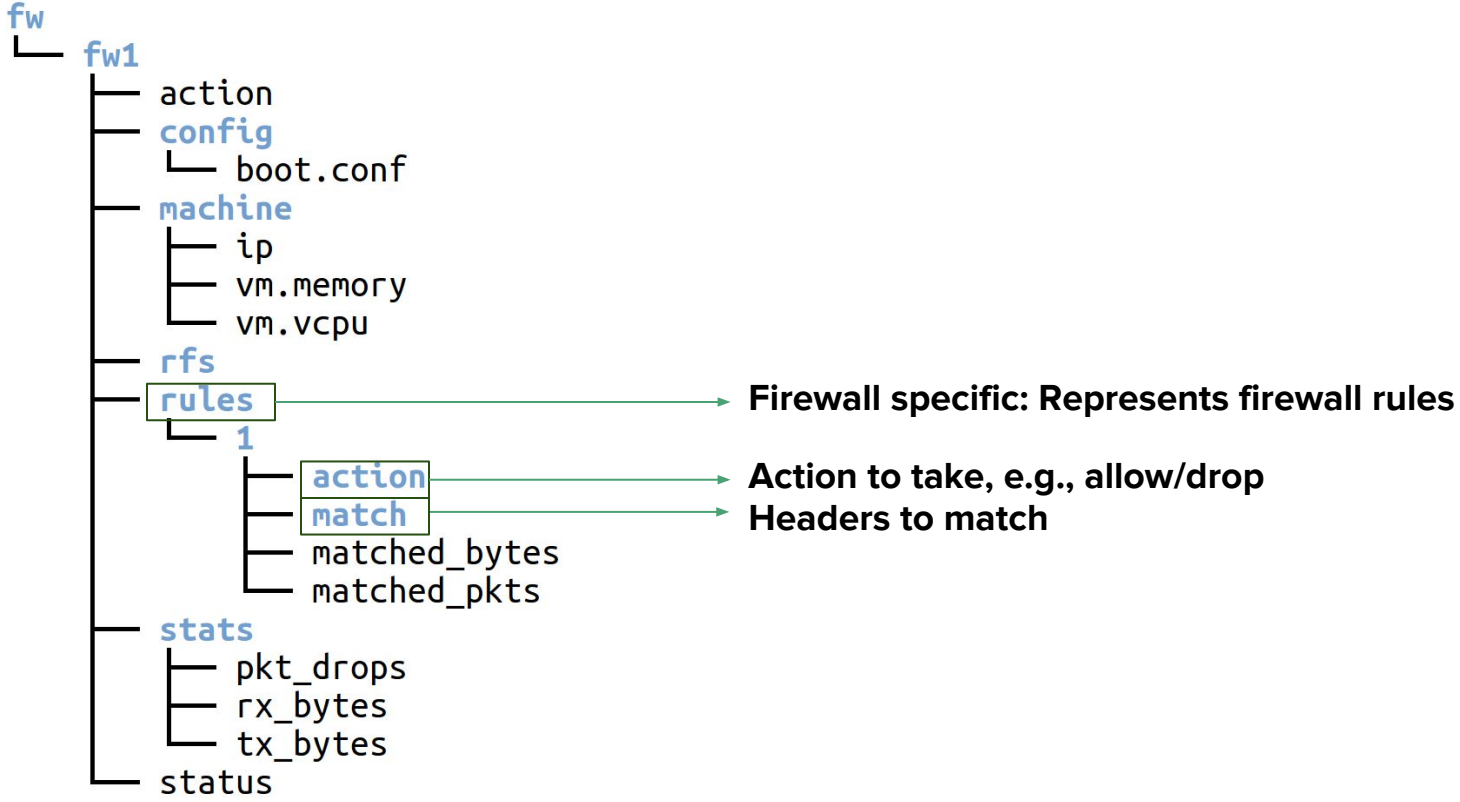
nf.io File System Abstraction: A Sample VNF



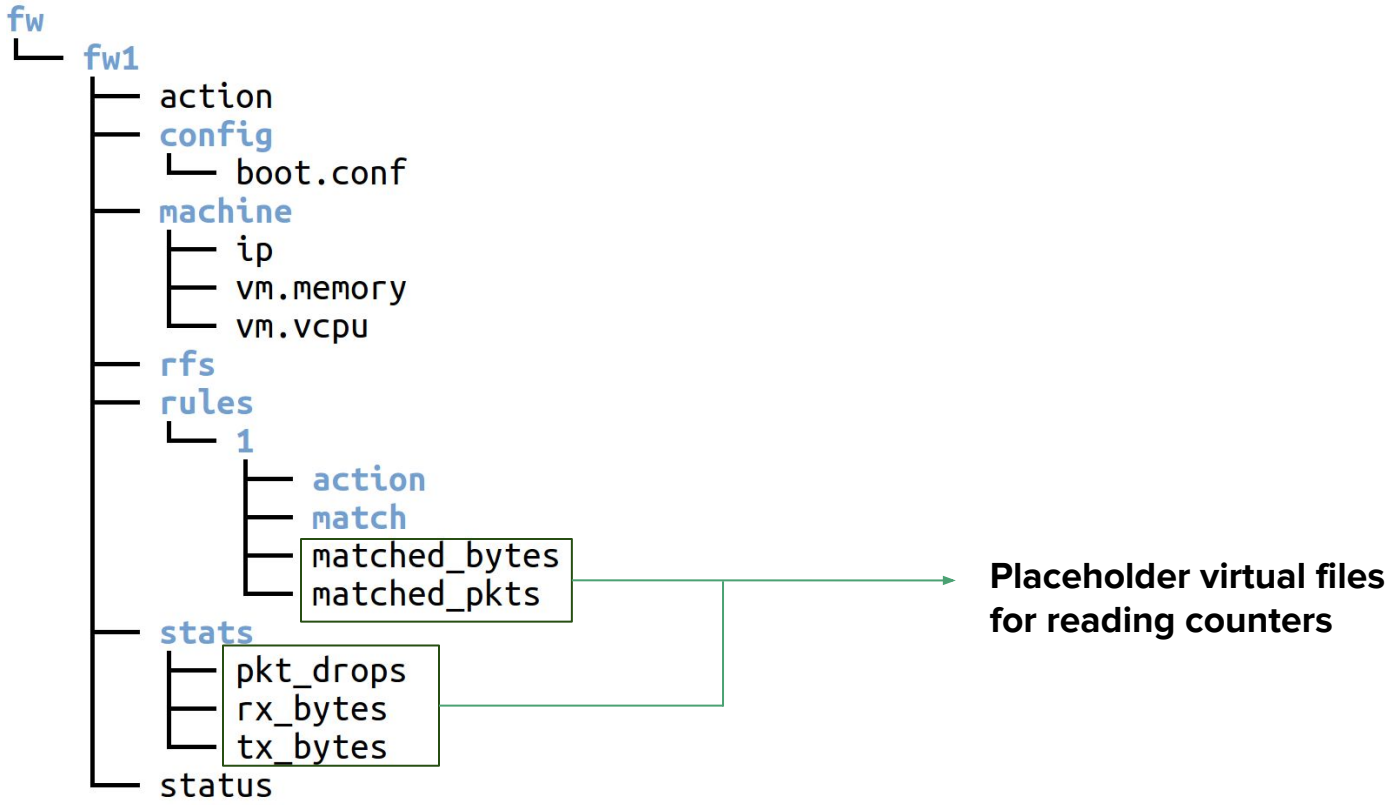
nf.io File System Abstraction: A Sample VNF



nf.io File System Abstraction: A Sample VNF



nf.io File System Abstraction: A Sample VNF



nf.io File System Abstraction: A VNF Chain

Example:


```
chns
├── chain-alpha
│   ├── action
│   ├── status
│   └── strand-1
│       ├── fw-alpha
│       │   ├── fw-alpha -> /vnfs/user-a/nf-types/fw/fw-alpha
│       │   └── next -> /vnfs/user-a/nf-types/proxy/proxy-alpha
│       ├── proxy-alpha
│       │   └── proxy-alpha -> /vnfs/user-a/nf-types/proxy/proxy-alpha
│       └── start -> /vnfs/user-a/nf-types/fw/fw-alpha
└── chain-beta
```

Represents branches of a chain

nf.io File System Abstraction: A VNF Chain

Example:


```
chns
├── chain-alpha
│   ├── action
│   ├── status
│   └── strand-1
│       ├── fw-alpha
│       │   ├── fw-alpha -> /vnfs/user-a/nf-types/fw/fw-alpha
│       │   └── next -> /vnfs/user-a/nf-types/proxy/proxy-alpha
│       ├── proxy-alpha
│       │   └── proxy-alpha -> /vnfs/user-a/nf-types/proxy/proxy-alpha
│       └── start -> /vnfs/user-a/nf-types/fw/fw-alpha
└── chain-beta
```

One directory for each chain component

nf.io File System Abstraction: A VNF Chain

Example:


```
chns
├── chain-alpha
│   ├── action
│   ├── status
│   └── strand-1
│       ├── fw-alpha
│       │   ├── fw-alpha -> /vnfs/user-a/nf-types/fw/fw-alpha
│       │   └── next -> /vnfs/user-a/nf-types/proxy/proxy-alpha
│       ├── proxy-alpha
│       │   └── proxy-alpha -> /vnfs/user-a/nf-types/proxy/proxy-alpha
│       └── start -> /vnfs/user-a/nf-types/fw/fw-alpha
└── chain-beta
```

Symbolic link to VNF instance

Symbolic link to next VNF

nf.io File System Abstraction: A VNF Chain

Example:


```
chns
├── chain-alpha
│   ├── action
│   ├── status
│   └── strand-1
│       ├── fw-alpha
│       │   ├── fw-alpha -> /vnfs/user-a/nf-types/fw/fw-alpha
│       │   └── next -> /vnfs/user-a/nf-types/proxy/proxy-alpha
│       ├── proxy-alpha
│       │   └── proxy-alpha -> /vnfs/user-a/nf-types/proxy/proxy-alpha
│       └── start -> /vnfs/user-a/nf-types/fw/fw-alpha
└── chain-beta
```

Symbolic link to the first VNF instance in the chain

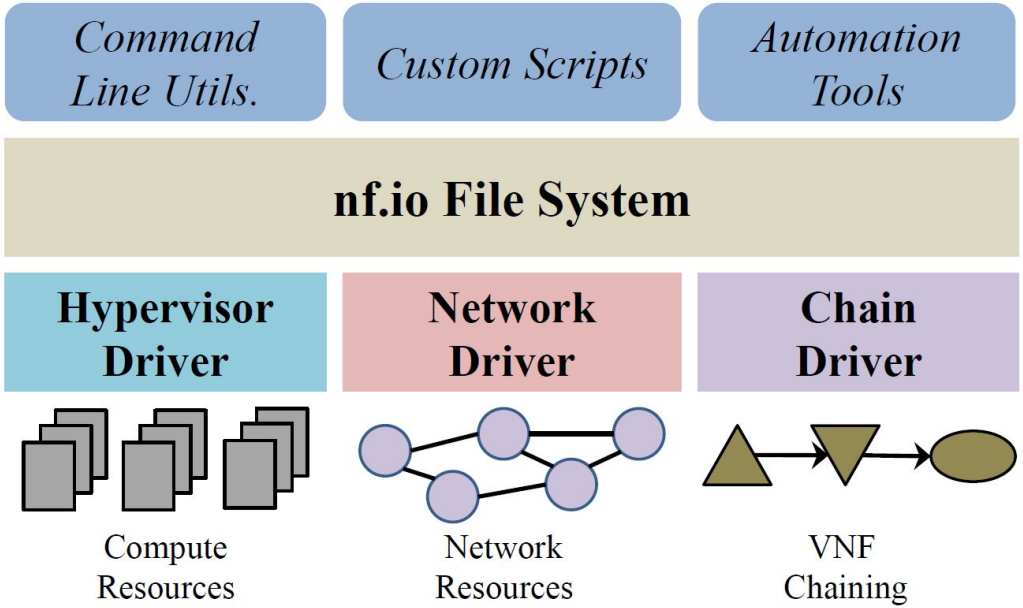
Sample Use Cases

- Deploy a VNF instance
  - **`mkdir nf-types/bro/ids-a`**
- Configure a VNF instance
  - Migrate a VNF instance to a different machine

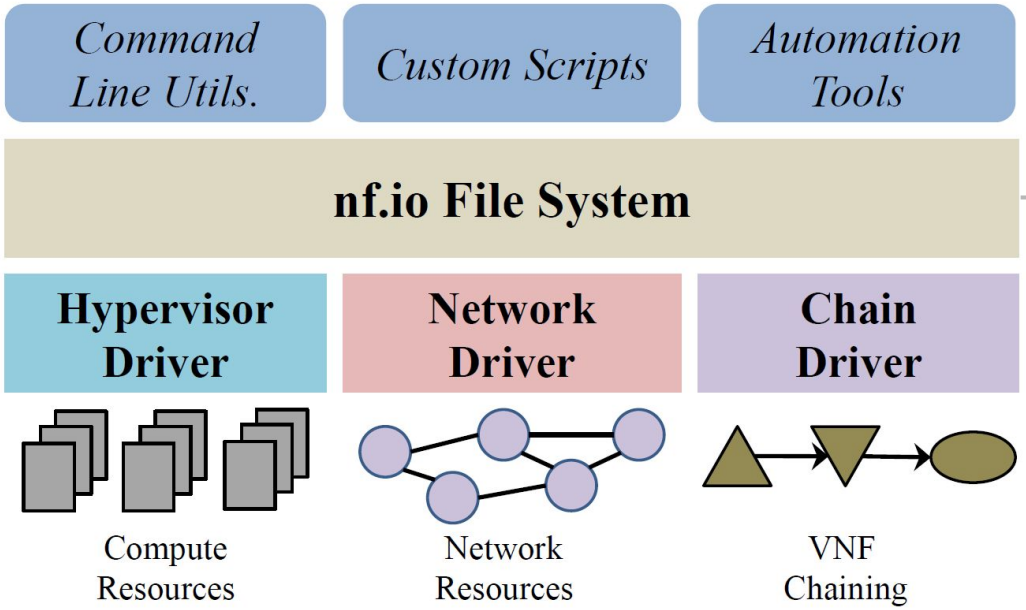
    `echo ‘10.0.0.15’ > chns/chain-alpha/ fw-alpha/fw-a/machine/ip`
- Monitor
  - Total number of packet drops along a chain:

    `find -L chns/chain-a pkt_drops | xargs cat | awk ‘{total += $1} END {print total}’`

System Architecture

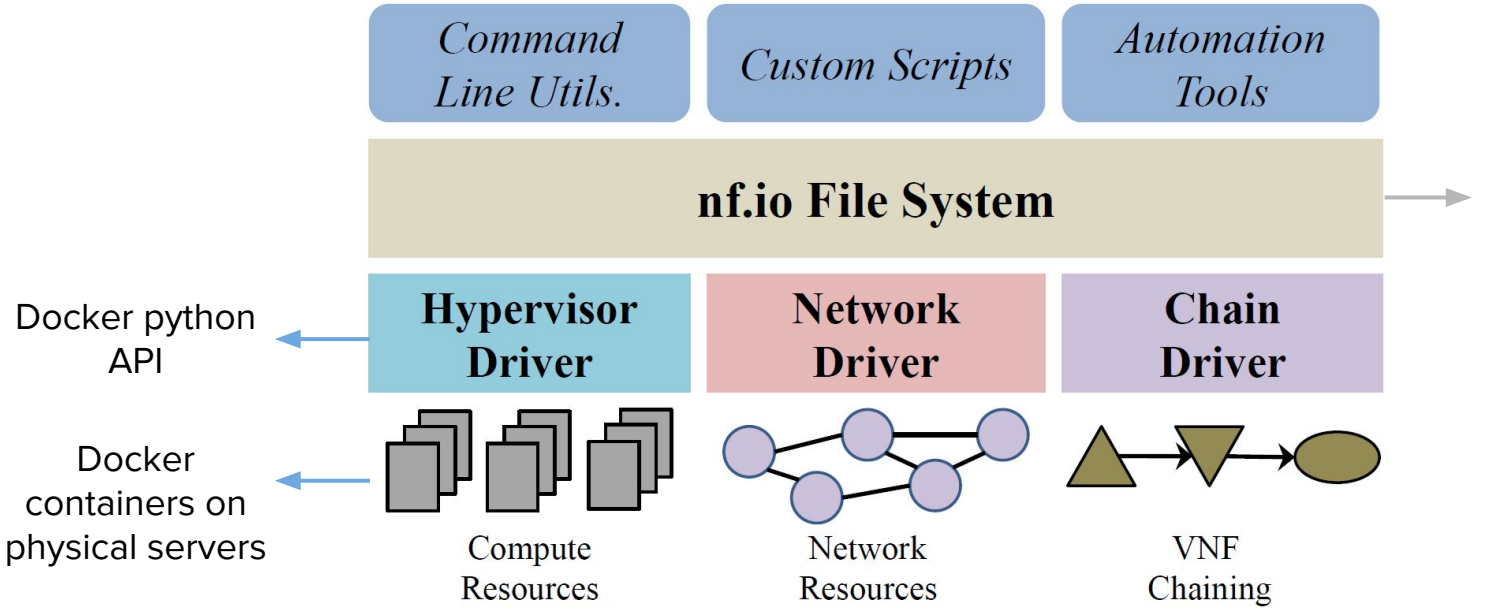


Prototype Implementation



User space filesystem using **FUSE** (**F**ile System in **Use**r Space) python library

Prototype Implementation

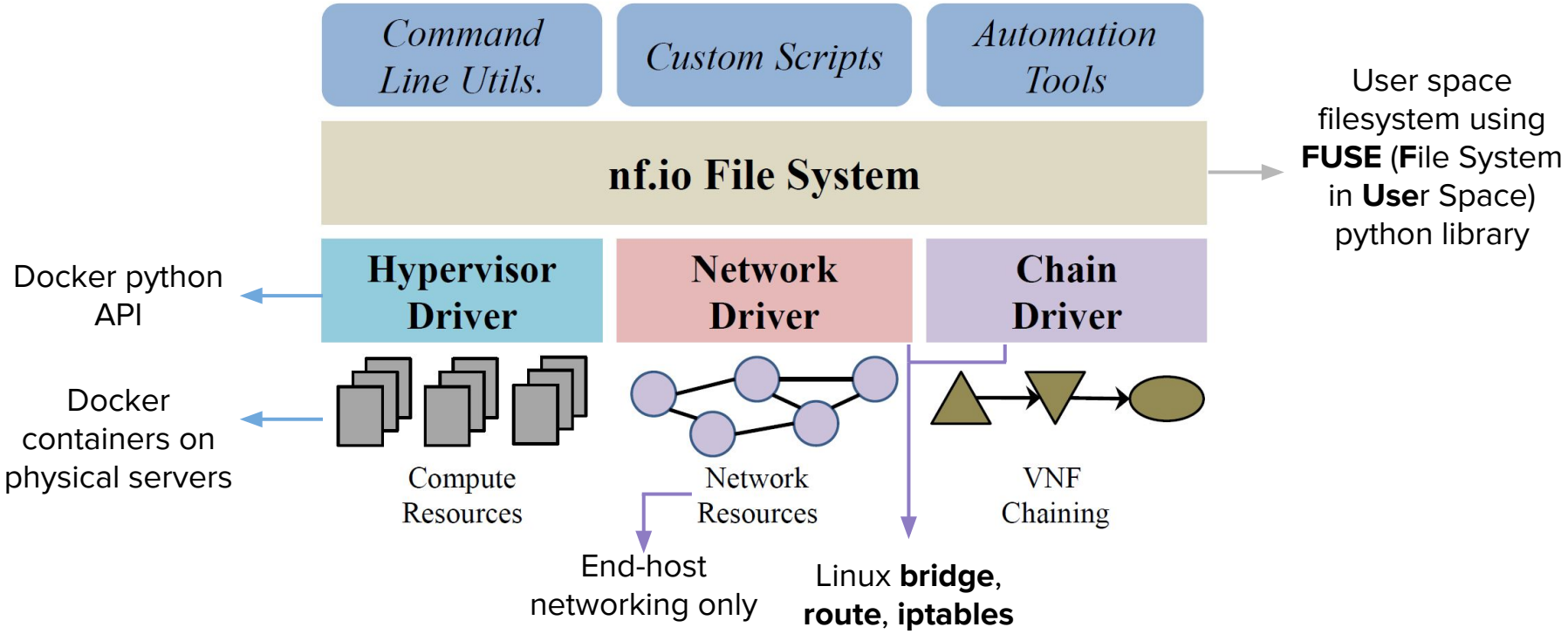


Docker python API

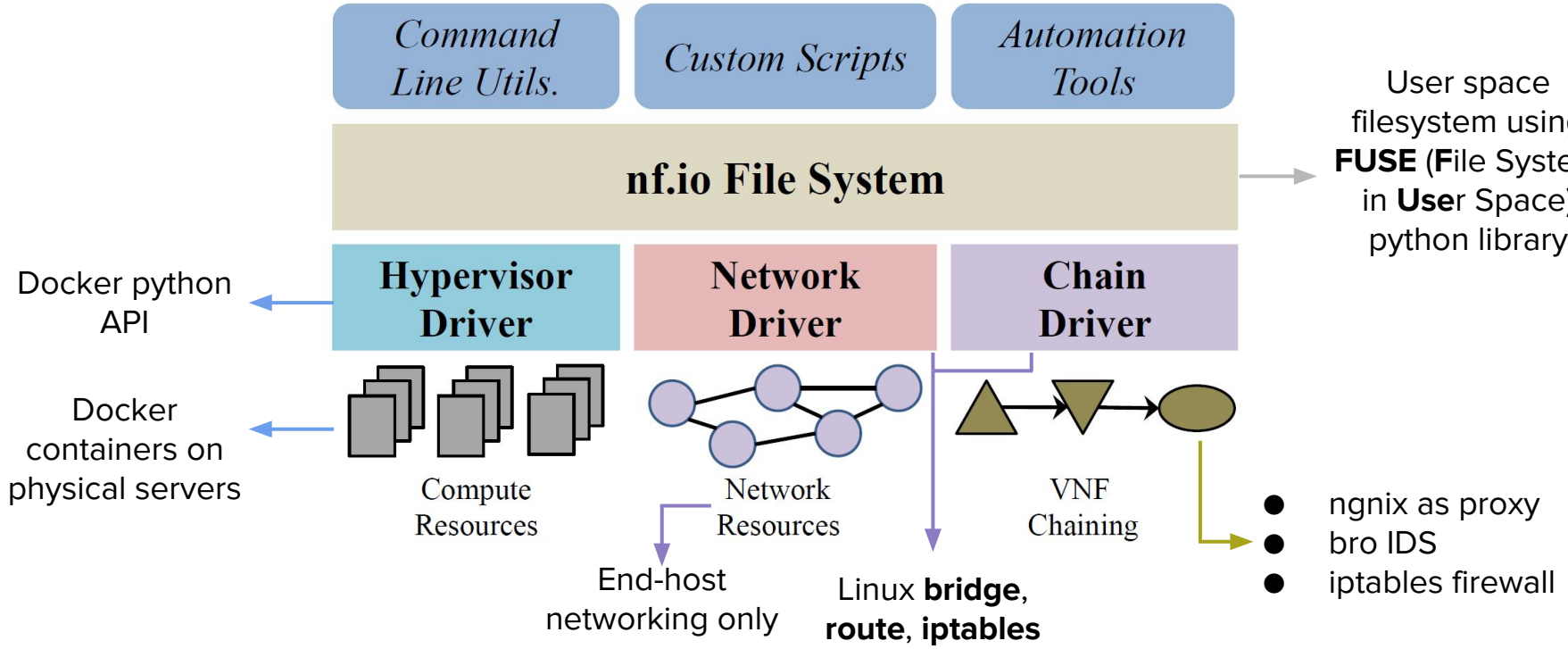
Docker containers on physical servers

User space filesystem using **FUSE** (**F**ile System in **Use**r Space) python library

Prototype Implementation



Prototype Implementation



Work In Progress

- Add support for VNF chains with branches
- Simplify VNF chain representation
- Open vSwitch for end-host data-path
  - Better Programmability
- Add more hypervisor support
  - Xen, KVM
- Integrate with OpenStack

Conclusion

- **nf.io**: A northbound interface for interacting with VNF Management and Orchestration Systems
- **nf.io** adapts the well known Linux File System abstraction
- **nf.io** allows high level infrastructure agnoistic VNF operations
- Live demo of **nf.io:**
  - http://faizulbari.github.io/nf.io/ (Link is also in the paper)
  - Try it out !

Questions?