Management and Operations of Networks, Services, and Systems

Network Provisioning with Python/Linux

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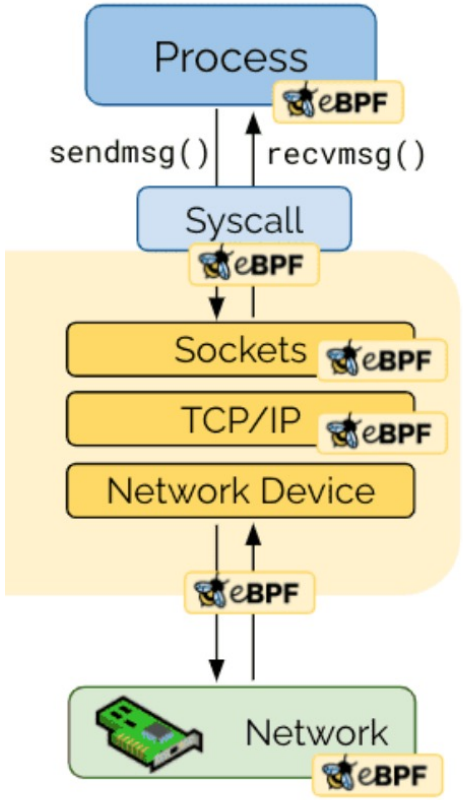
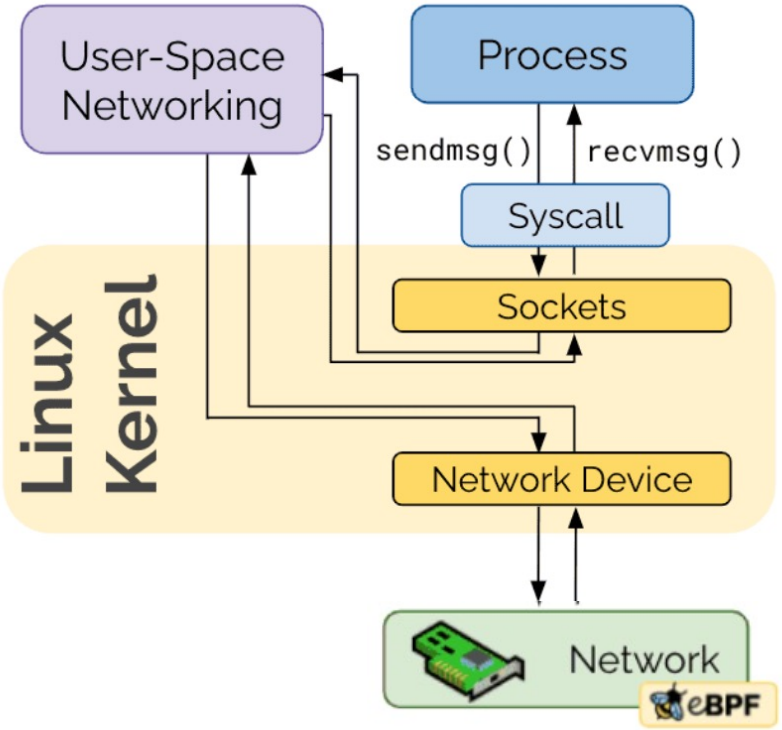
Linux networking

- User-space vs. kernel-space
- Routing
- Virtual interfaces and bridges
- Network namespaces

https://cilium.io/blog/2020/11/10/ebpf-future-of-networking/

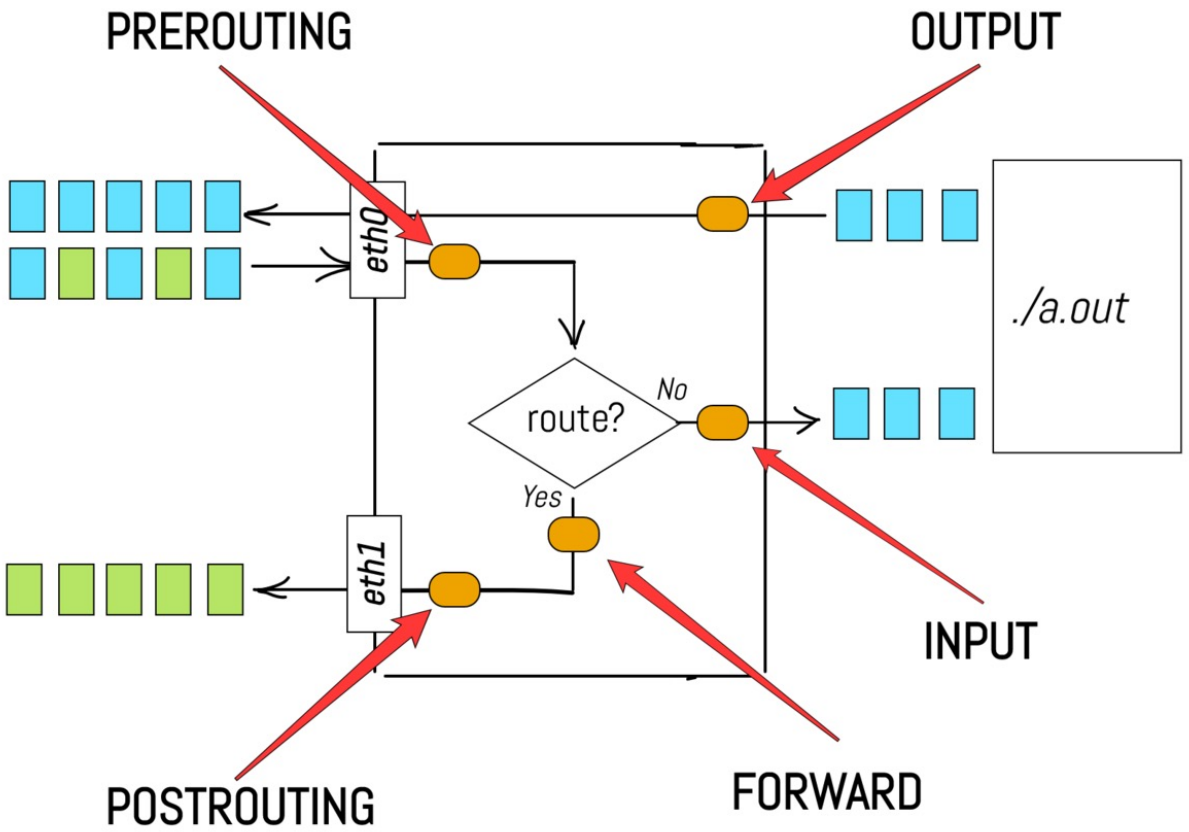
Linux kernel vs. user space networking





https://iximiuz.com/en/posts/laymans-iptables-101/

Linux routing (and iptables)



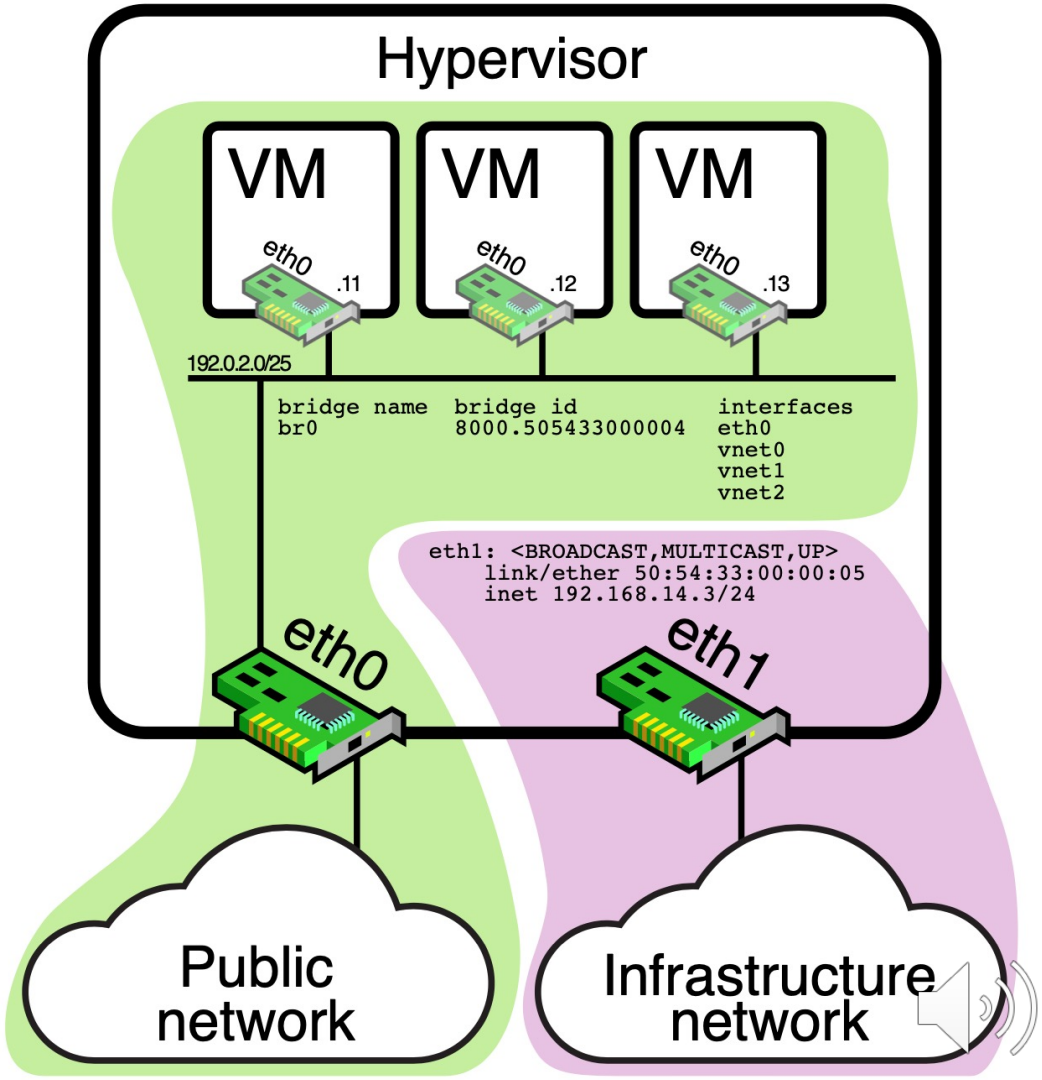
Virtual interface
Virtual bridge

Hypervisor eth0/eth1 – physical interfaces

Hypervisor bridge br0 – virtual switch

VM's eth0 – virtual interfaces

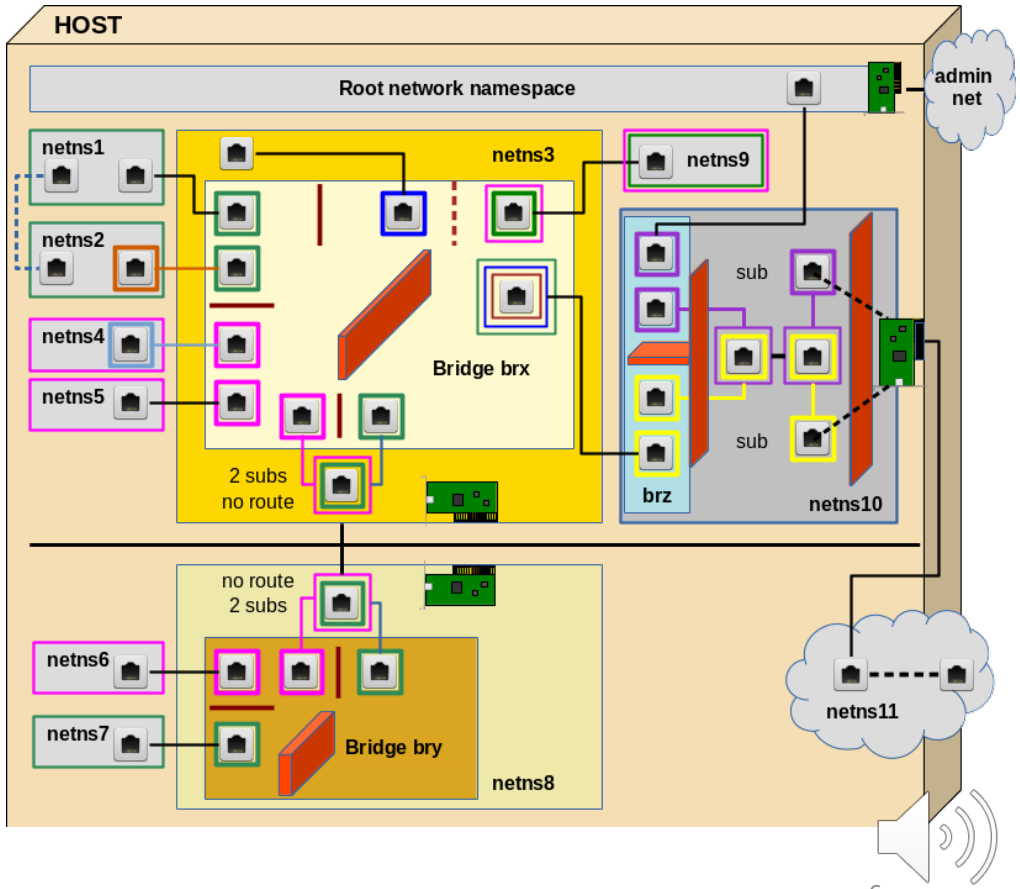
https://vincent.bernat.ch/en/blog/2017-linux-bridge-isolation



https://linux-blog.anracom.com/2017/11/12/fun-with-veth-devices-linux-bridges-and-vlans-in-unnamed-linux-network-namespaces-ii/

Namespace isolation, virtual cables

- veth pairs are virtual cables to connect virtual interfaces
- Arbitrarily complex virtual network topologies
- One giant router if no virtualization
- Network namespaces netns solve this problem



Python programming for network automation

- Network source of truth
- Typical provisioning steps
  - Prepare configurations
  - Define management access to target devices
  - Push commands
- Templates

Network source of truth

- Reference of network assets and intended configurations
  - Used as input for configuration etc.
- Manually ok for small deployments

```
router['interfaces'] = ['eth0', 'eth1']
router['IP'] ={'eth0': '10.1.1.254', 'eth1': '10.1.2.254'}
```

- Or code your way around big deployments

```
hosts = []
for i in range(0,20):
    Host_i = {'hostname':'ws' + str(i) + '.xpto.pt',
              'IP':'10.1.2.' + str(i) + '/24',
              'if':'eth1', 'gw': '10.1.2.254, 'host_i':i}
    hosts.append(host_i)
```

What's wrong with this code – network wise?

- Support:
  - Helper library nsot https://nsot.readthedocs.io
  - full blown NSoT application netbox

Prepare configurations

- Define function that sets ip address on interface

```
def set_ip_addr (if, ip):
  cmds = [
    'ip link set ' + if + ' up',
    'ip address add ' + ip + ' dev ' + if
  return cmds
```

- Host interfaces

```
host_cmds = {}
for host in hosts:
  cmds = set_ip_addr (host['if'], host['IP'])
  host_cmds[host['hostname']] = cmds
```

- Router interfaces

```
router_cmds = [
  'sysctl -w net.ipv4.ip_forward=1',
]
for if in router['IP'].keys():
  router_cmds.extend(set_ip_addr(if, router['IP'][if]))
```

- Sanity check

```
print (host_cmds, router_cmds)
```

Define management access to each host

- Management interface already configured

```
mngt['router.xpto.pt'] = {
    'address': 10.255.255.254, 'username': 'admin58234',
    'priv_key':'~/.ssh/id_rsa_xpto'
}
for host in hosts:
     mngt[host['hostname']] = {
          'address': 10.255.255.' + host['host_i'],
          'username': 'admin58234', 'priv_key':'~/.ssh/id_rsa_xpto' }
```

- For others may need to redirect via host (docker, mininet, …)

Push commands via ssh

- Import ssh/network library

```
import netmiko
```

  - Install if necessary

```
$pip install netmiko
```

- Run

```
for host in hosts:
  m = mngt[host['hostname']]
  device = ConnectHandler(
                  host=m['address'], username=m['username'],
                   device_type='linux', use_keys=True, key_file=m['priv_key'])
  cmds = host_cmds[host['hostname']]
  for cmd in cmds:
    device.send_command(cmd)
```

Templates

- Large configuration files with only a few parameters
- template + parameter db => config for each device
- Deploy config file

1. **jinja2 template for cisco switch**

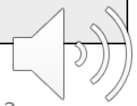
```
{% for name, desc in if_descr.items() %}
interface {{ name }}
  description {{ desc }}
{% end for %}
```

2. **jinja2 mapping**

```
if_descr = {
    'GigabitEthernet0/1': 'client port',
    'GigabitEthernet0/2': 'server port'
}
```

3. **jinja2 output**

```
interface GigabitEthernet0/1
  description client port
interface GigabitEthernet0/2
  description server port
```



Linux – a network in a box

- Span a new linux virtual machine
- Move half of the hosts to the network that only has the router
- Try to automatically create and provision the host and router interfaces
  - How are you going to connect to the management network? Do you need to adapt the commands to id the namespace?
- Make sure you test the connectivity between the two networks

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