CONTAINERlab

Free and opensource networking lab environment for the modern age

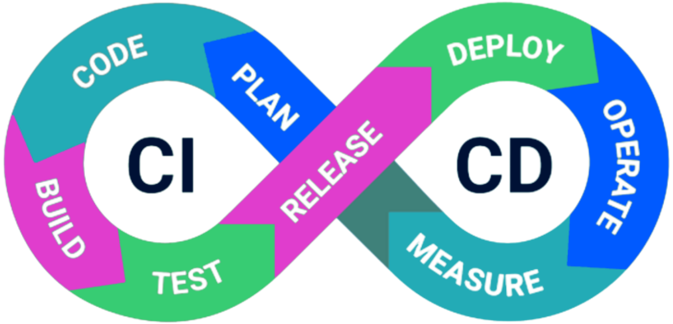
Roman Dodin @ntdvps

RONOG 8

Virtual labs

A right, not a privilege

Education
and Learning



Change management
and validation

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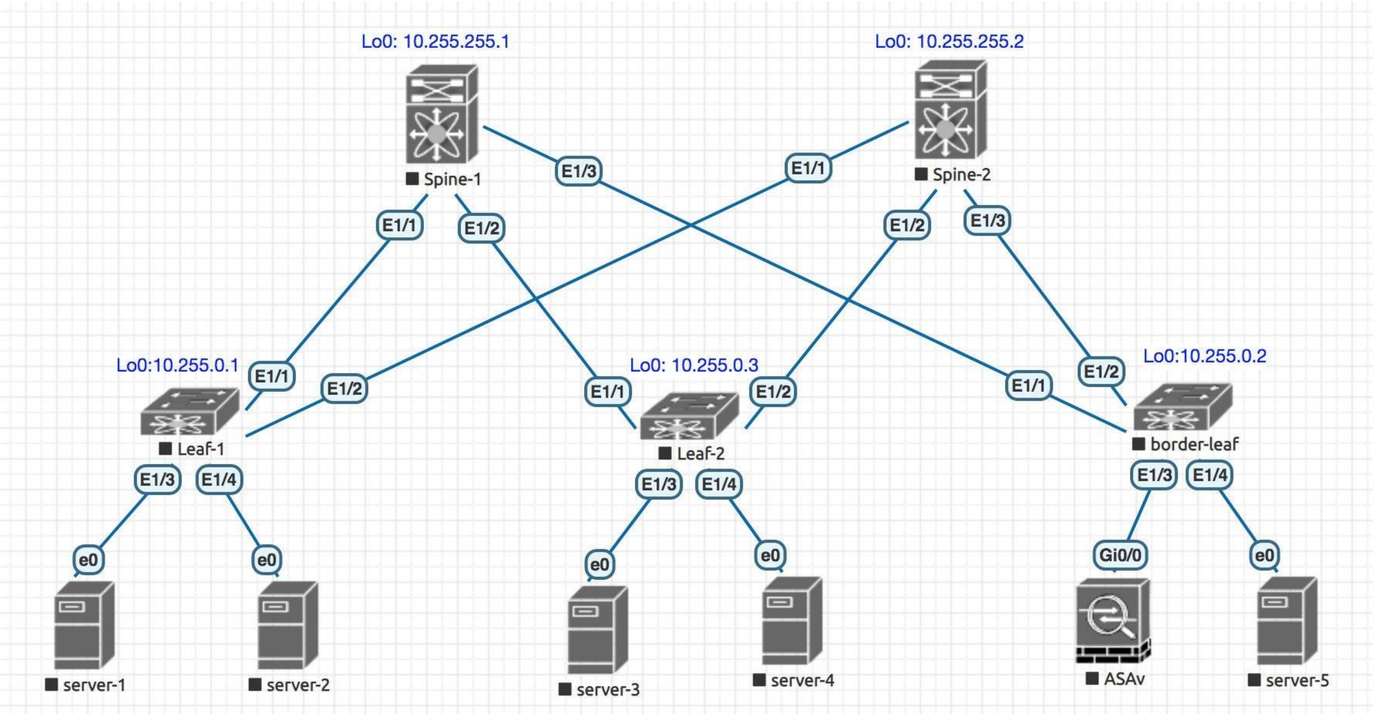
How do we (typically) run labs?



Pic from reddit

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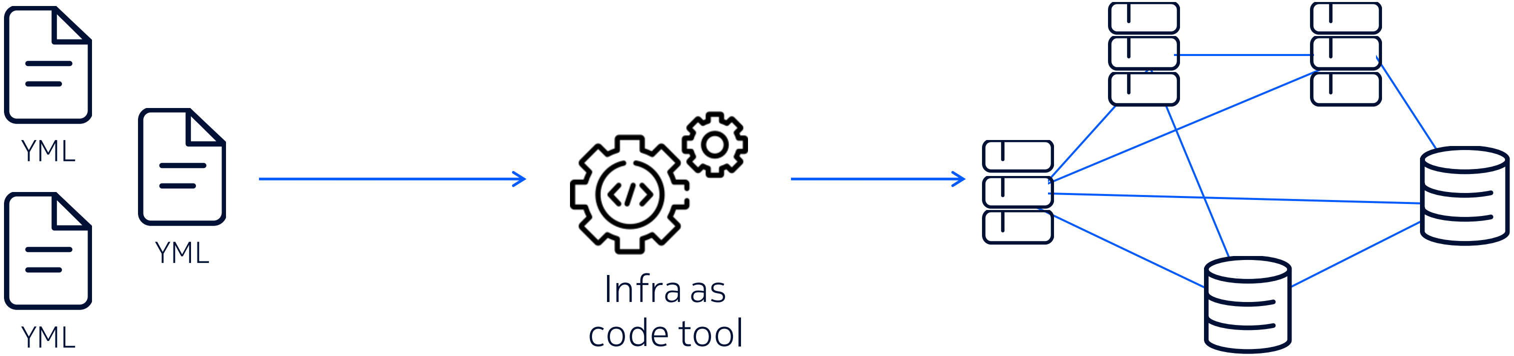
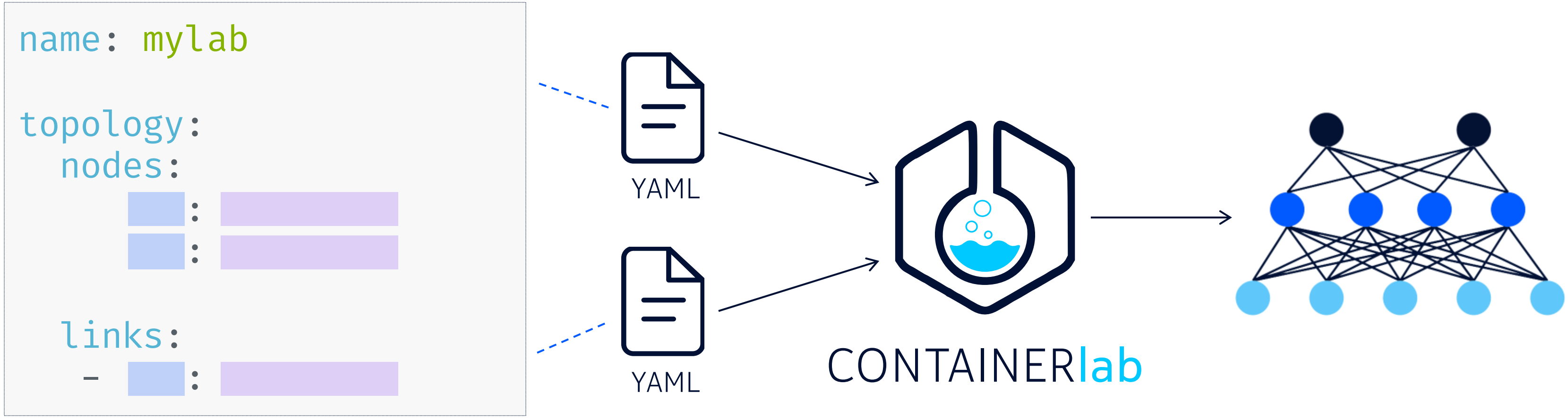
How do application teams (typically) deploy the services?

Declarative way



Bringing declarativeness to network labs



```
name: mylab

topology:
  nodes:
     ▨: ▨
     ▨: ▨

  links:
   - ▨: ▨
```

containerlab.dev

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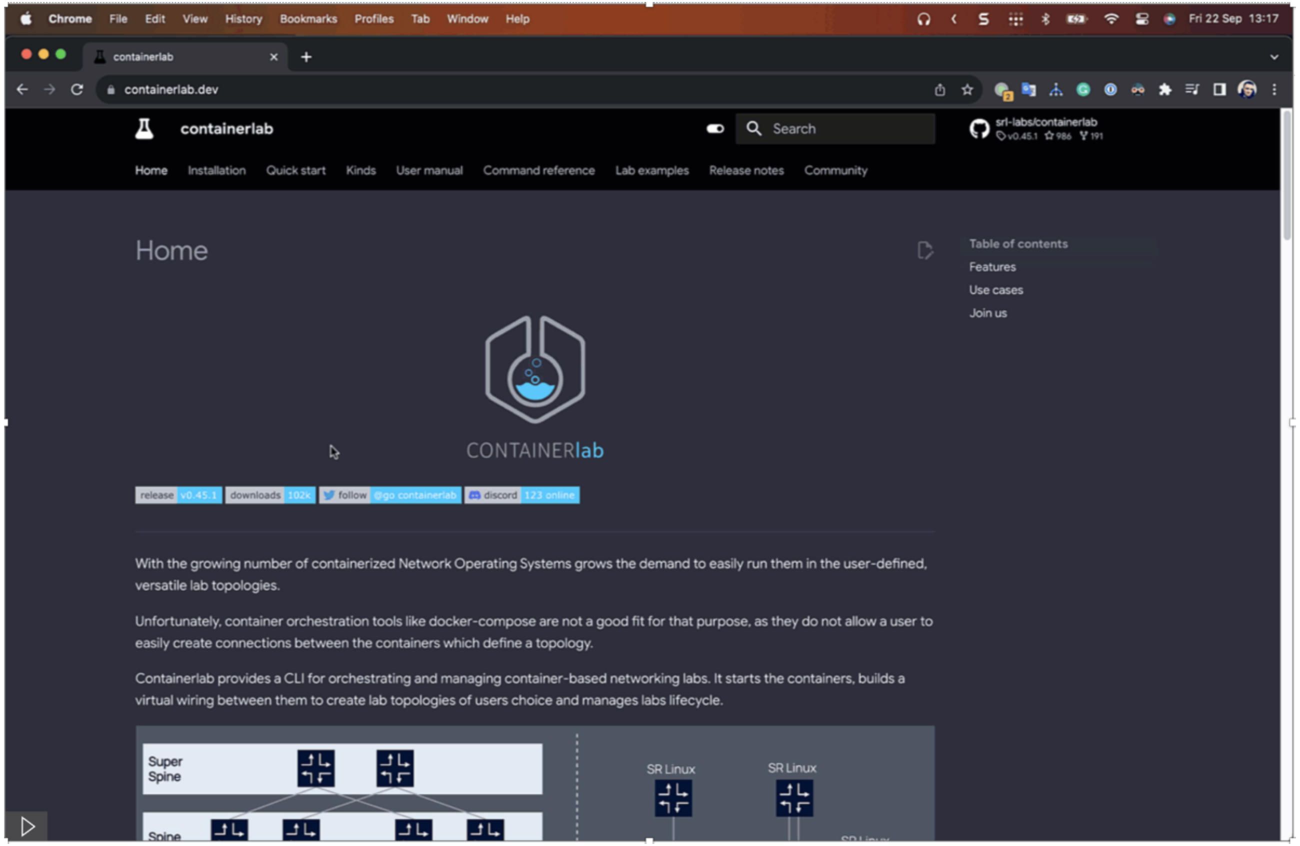
Installation



Home

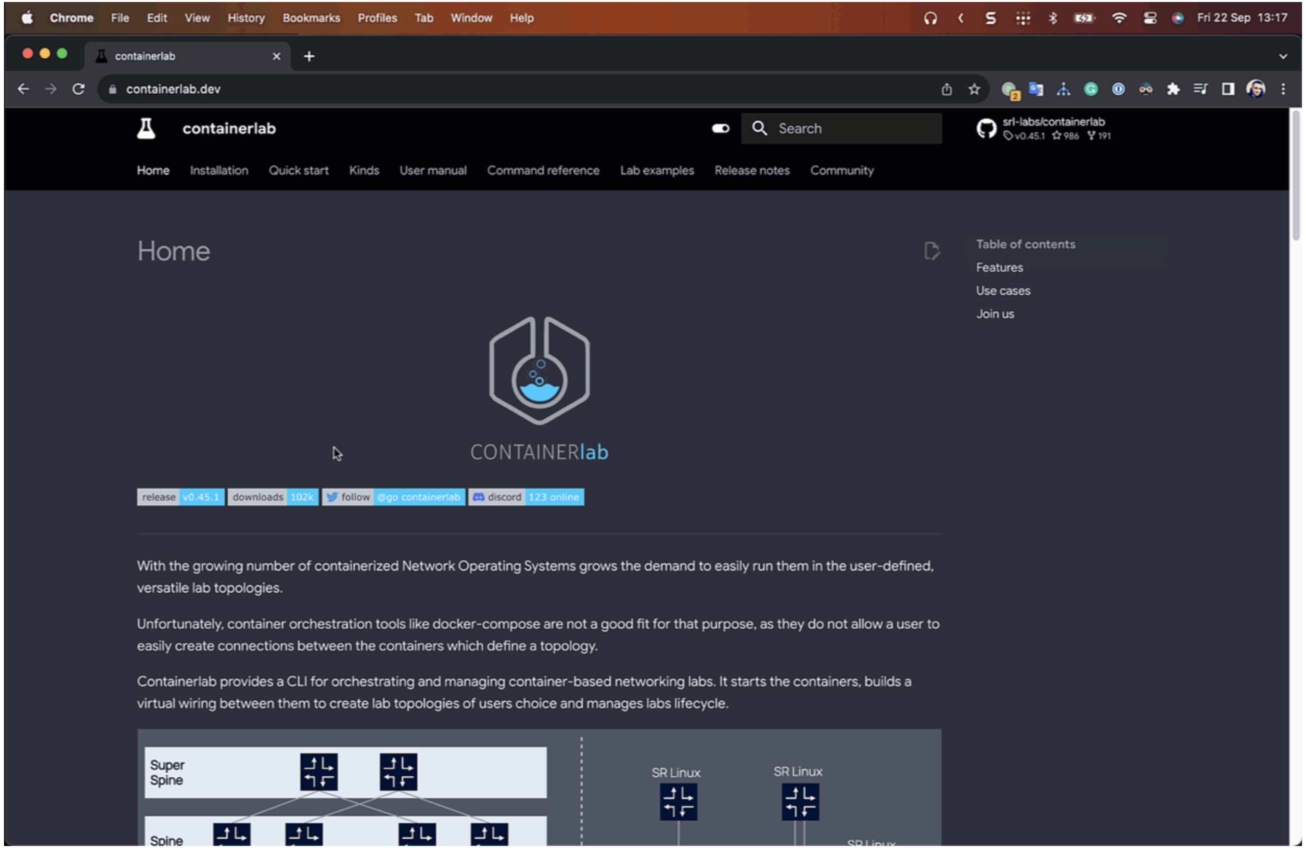
With the growing number of containerized Network Operating Systems grows the demand to easily run them in the user-defined, versatile lab topologies.

Unfortunately, container orchestration tools like docker-compose are not a good fit for that purpose, as they do not allow a user to easily create connections between the containers which define a topology.

Containerlab provides a CLI for orchestrating and managing container-based networking labs. It starts the containers, builds a virtual wiring between them to create lab topologies of users choice and manages labs lifecycle.

Other installation options:
https://containerlab.dev/install/

Installation



Home

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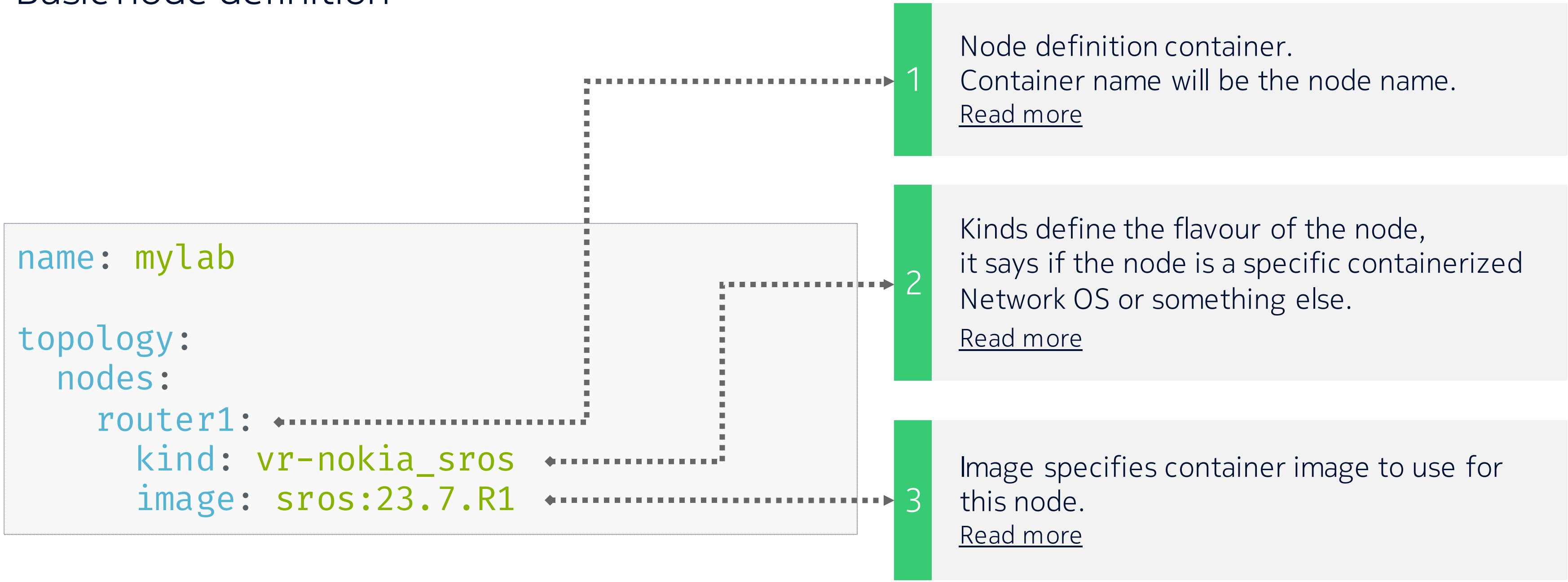
Topology file

Basic node definition



```yaml
name: mylab

topology:
  nodes:
    router1:
      kind: vr-nokia_sros
      image: sros:23.7.R1
```

1 Node definition container.
Container name will be the node name.
Read more

2 Kinds define the flavour of the node,
it says if the node is a specific containerized
Network OS or something else.
Read more

3 Image specifies container image to use for this node.
Read more

topology definition file

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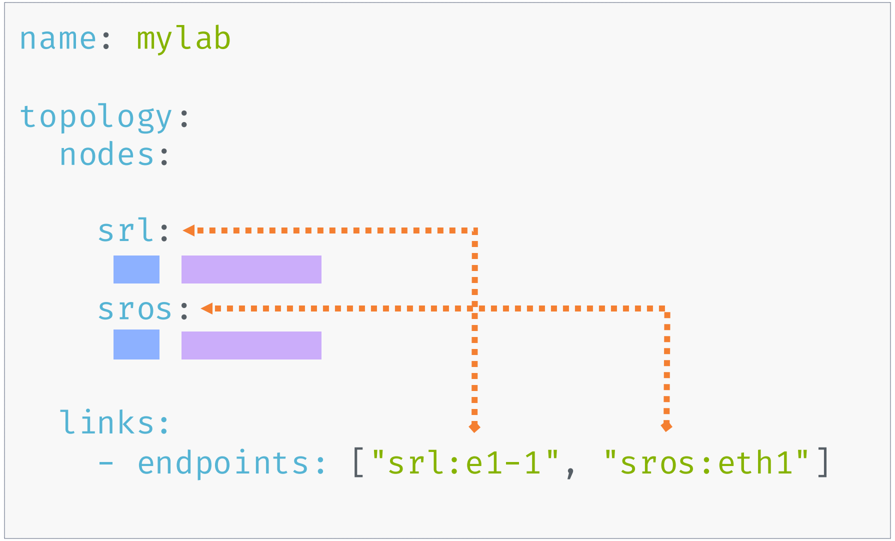
Topology file

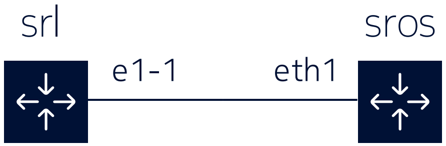
Links definition

Topology definition



```
name: mylab

topology:
  nodes:

    srl:

    sros:


  links:
    - endpoints: ["srl:e1-1", "sros:eth1"]
```

Logical view



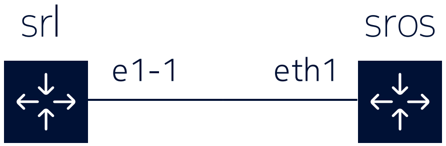
Topology file

Bringing nodes and links together

Topology definition

```yaml
name: mylab

topology:
  nodes:

    srl:
      kind: nokia_srlinux
      image: ghcr.io/nokia/srlinux:23.7.1

    sros:
      kind: vr-nokia_sros
      image: sros:23.7.R1
      license: license.txt

  links:
    - endpoints: ["srl:e1-1", "sros:eth1"]
```

Logical view



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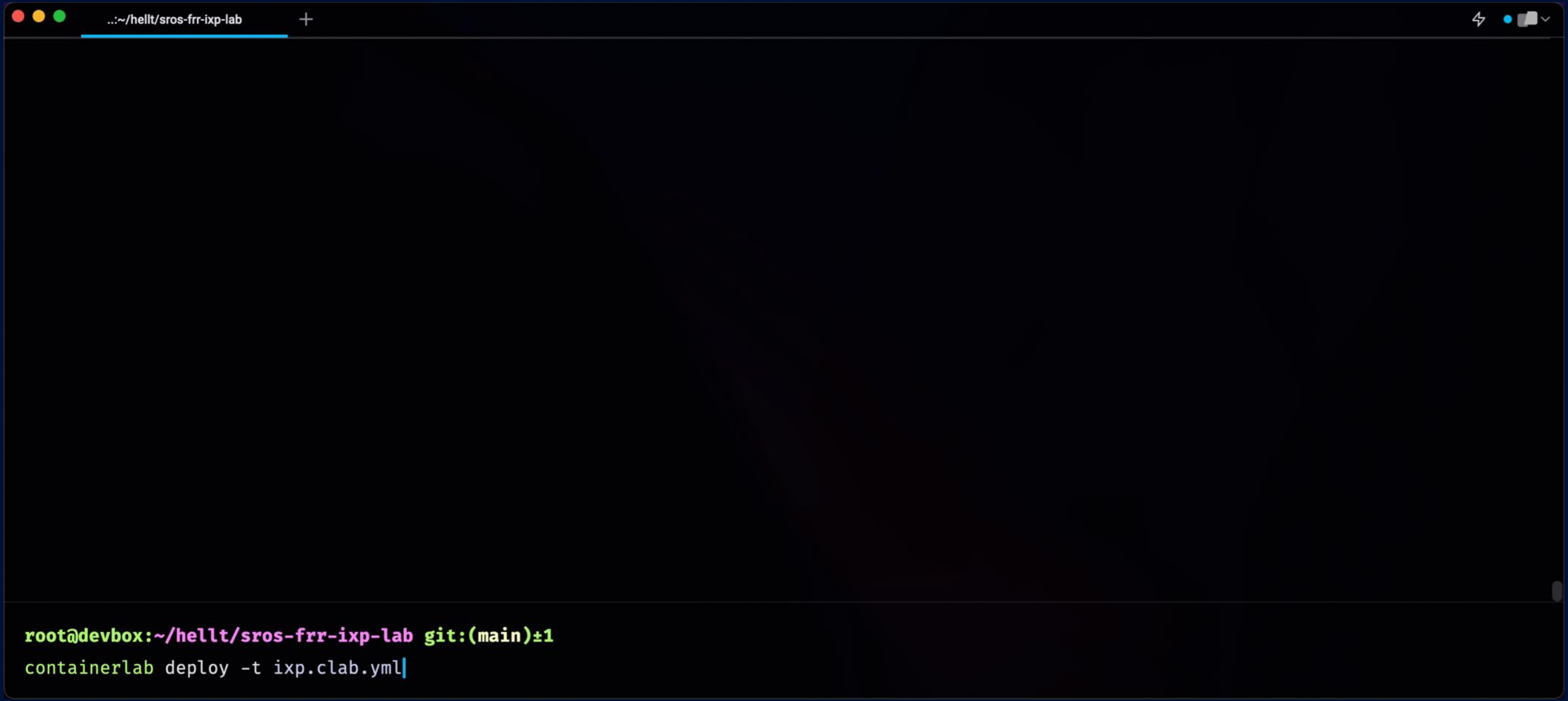
Deploying a lab



```
root@devbox:~/hellt/sros-frr-ixp-lab git:(main)±1
containerlab deploy -t ixp.clab.yml
```

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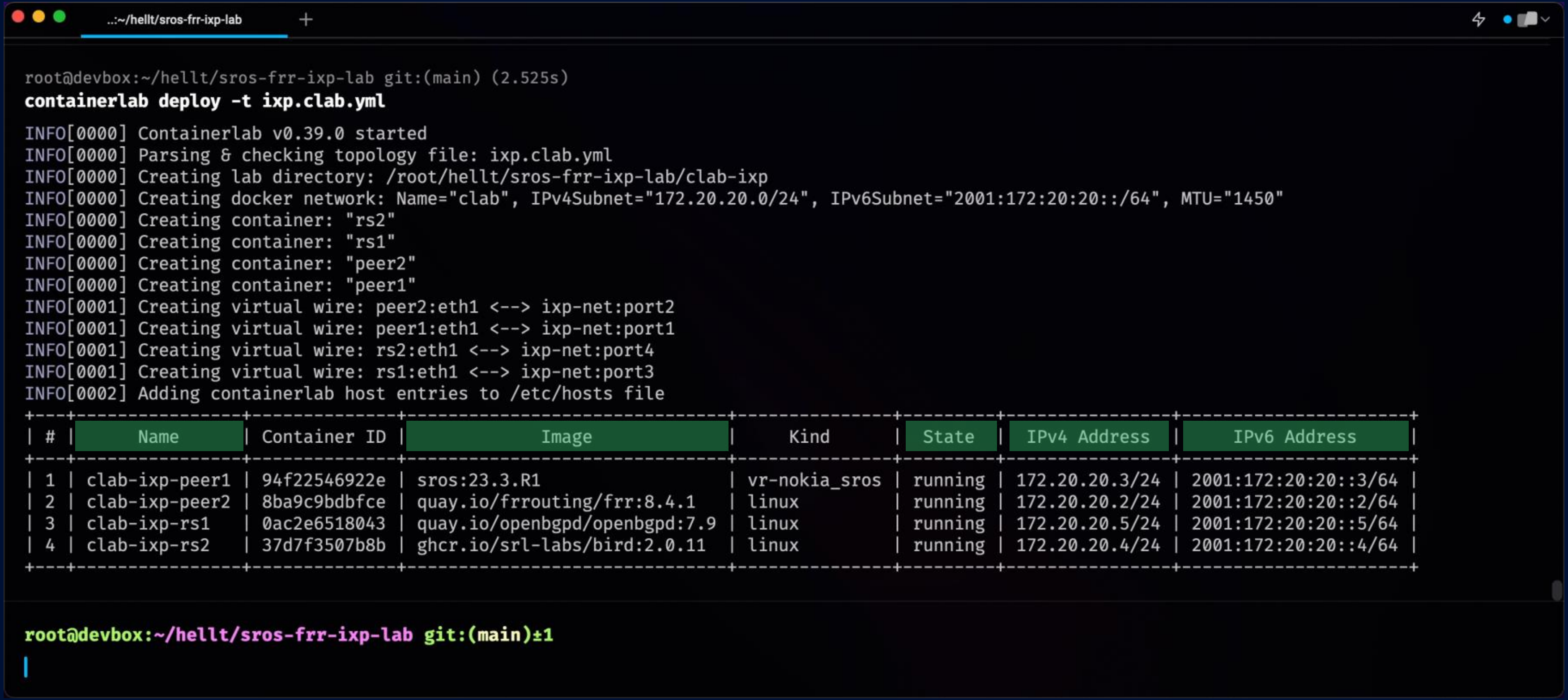
Deployment summary



```
root@devbox:~/hellt/sros-frr-ixp-lab git:(main) (2.525s)
containerlab deploy -t ixp.clab.yml
INFO[0000] Containerlab v0.39.0 started
INFO[0000] Parsing & checking topology file: ixp.clab.yml
INFO[0000] Creating lab directory: /root/hellt/sros-frr-ixp-lab/clab-ixp
INFO[0000] Creating docker network: Name="clab", IPv4Subnet="172.20.20.0/24", IPv6Subnet="2001:172:20:20::/64", MTU="1450"
INFO[0000] Creating container: "rs2"
INFO[0000] Creating container: "rs1"
INFO[0000] Creating container: "peer2"
INFO[0000] Creating container: "peer1"
INFO[0001] Creating virtual wire: peer2:eth1 <--> ixp-net:port2
INFO[0001] Creating virtual wire: peer1:eth1 <--> ixp-net:port1
INFO[0001] Creating virtual wire: rs2:eth1 <--> ixp-net:port4
INFO[0001] Creating virtual wire: rs1:eth1 <--> ixp-net:port3
INFO[0002] Adding containerlab host entries to /etc/hosts file
+---+----------------+--------------+-------------------------------+---------------+---------+----------------+----------------------+
| # |      Name      | Container ID |             Image             |     Kind      |  State  |  IPv4 Address  |     IPv6 Address     |
+---+----------------+--------------+-------------------------------+---------------+---------+----------------+----------------------+
| 1 | clab-ixp-peer1 | 94f22546922e | sros:23.3.R1                  | vr-nokia_sros | running | 172.20.20.3/24 | 2001:172:20:20::3/64 |
| 2 | clab-ixp-peer2 | 8ba9c9bdbfce | quay.io/frrouting/frr:8.4.1   | linux         | running | 172.20.20.2/24 | 2001:172:20:20::2/64 |
| 3 | clab-ixp-rs1   | 0ac2e6518043 | quay.io/openbgpd/openbgpd:7.9 | linux         | running | 172.20.20.5/24 | 2001:172:20:20::5/64 |
| 4 | clab-ixp-rs2   | 37d7f3507b8b | ghcr.io/srl-labs/bird:2.0.11  | linux         | running | 172.20.20.4/24 | 2001:172:20:20::4/64 |
+---+----------------+--------------+-------------------------------+---------------+---------+----------------+----------------------+

root@devbox:~/hellt/sros-frr-ixp-lab git:(main)±1
```

Connecting to the nodes

SSH

```
ssh admin@clab-ixp-peer1

admin@clab-ixp-peer1's password:

[/]
A:admin@peer1#
```

Docker exec

```
docker exec -it clab-ixp-rs2 birdc

BIRD 2.0.11 ready.
bird>
```

Containerlab node types

Containerized Network OSes

- Sourced by the vendor
- Fast to spin up
- Small footprint
- Shareability and versioning

A current trend is to **move away from VM** packaging towards containers **for new NOSes**

NOKIA
SR Linux

JUNIPER NETWORKS
cRPD

ARISTA
cEOS

CISCO
XRd

NVIDIA
cVX

KEYSIGHT TECHNOLOGIES
IXIA-c

and others…

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Containerlab node types

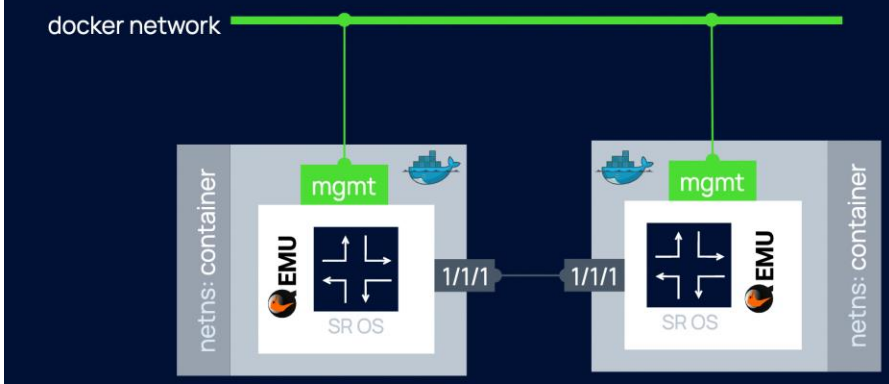
Regular container images

- All available container images
- Emulating clients
- Hundreds of network-focused software
  - Telemetry, logging stacks
  - Peering software
  - Flow collectors
  - etc

Containerlab node types

Virtual machines in container packaging

- Traditional Network OS packaged as a VM
- Integrated with containerlab through vrnetlab open-source project
- Onboard existing VM-based NOSes



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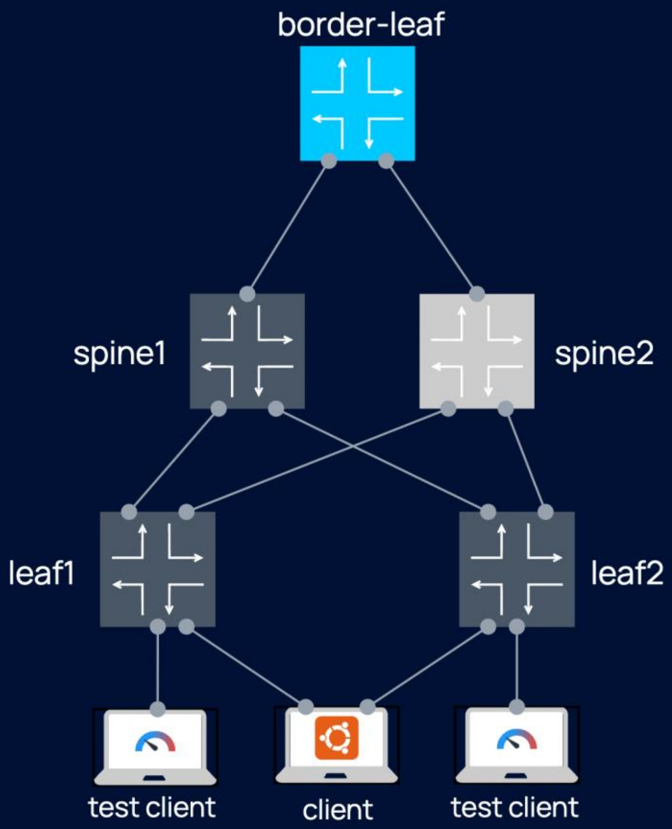

border-leaf

spine1

spine2

leaf1

leaf2

test client

client

test client

- 🟦 traditional virtual router packaged in a container
- ⬜ containerized NOS vendor A
- ⬛ containerized NOS vendor B

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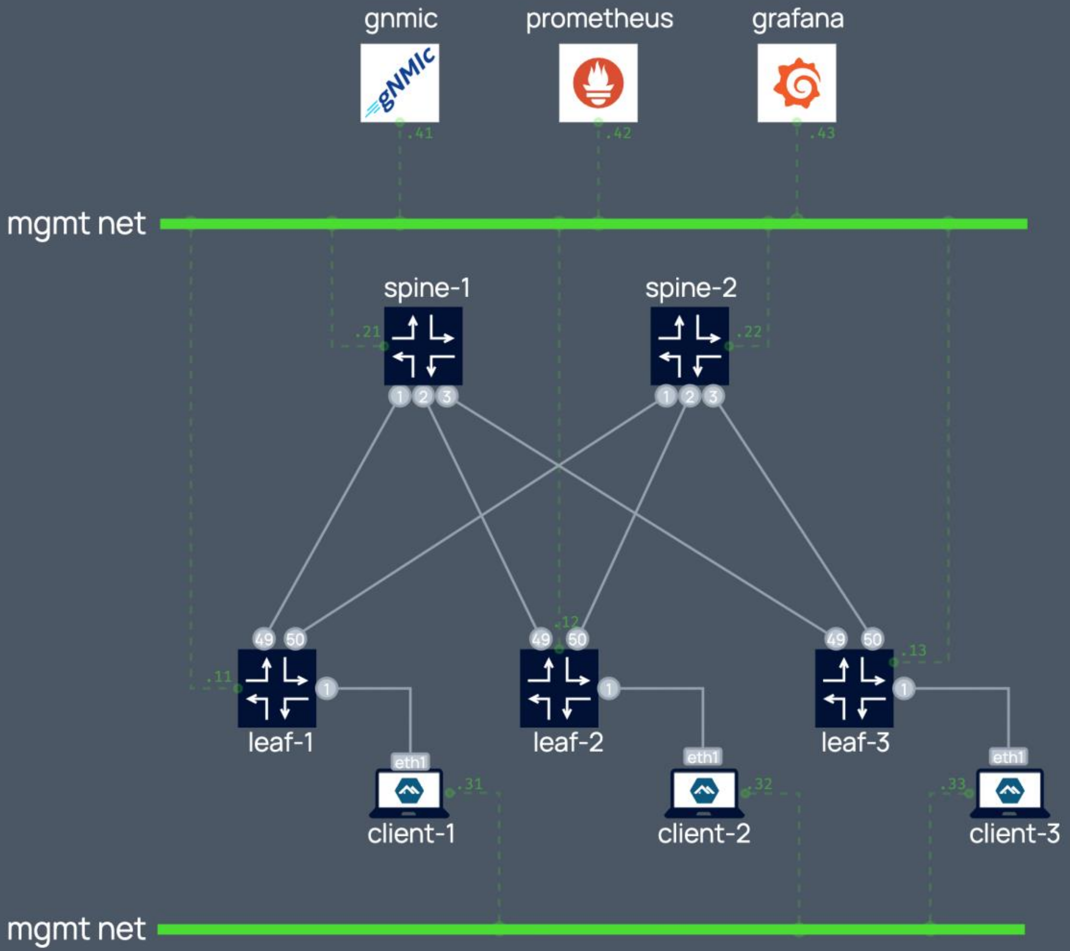
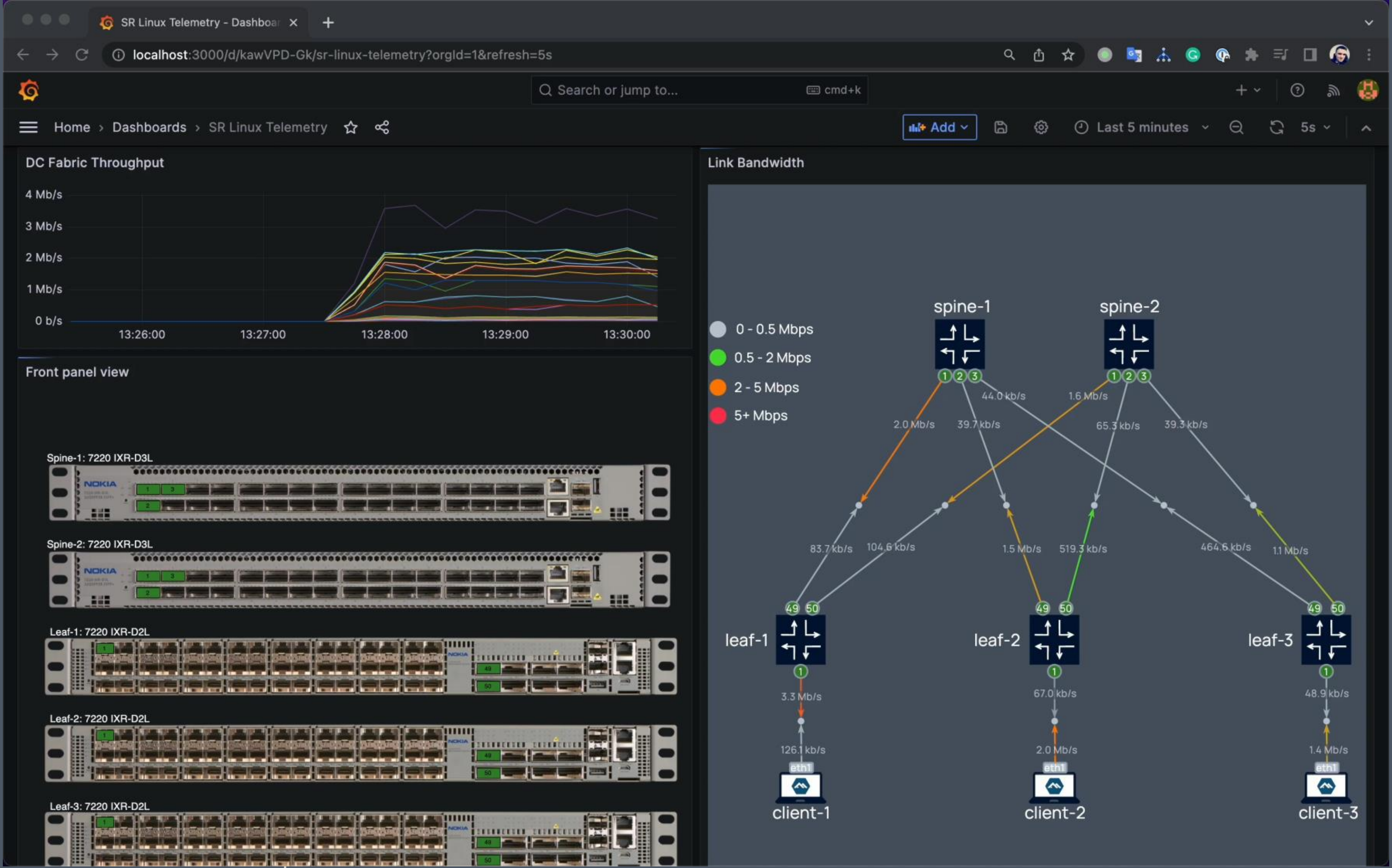
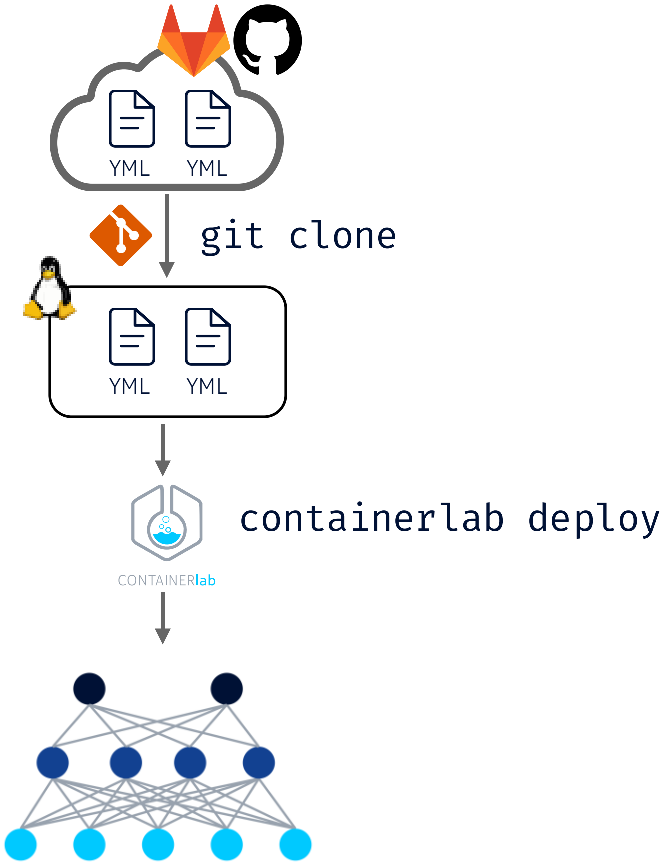

gnmic
prometheus
grafana
gNMIc
.41
.42
.43
mgmt net
spine-1
spine-2
.21
.22
1
2
3
1
2
3
49
50
49
50
49
50
.11
.12
.13
1
1
1
leaf-1
leaf-2
leaf-3
eth1
eth1
eth1
.31
.32
.33
client-1
client-2
client-3
mgmt net


SR Linux Telemetry - Dashboar
localhost:3000/d/kawVPD-Gk/sr-linux-telemetry?orgId=1&refresh=5s
Search or jump to...
cmd+k
Home › Dashboards › SR Linux Telemetry
Add
Last 5 minutes
5s
DC Fabric Throughput
4 Mb/s
3 Mb/s
2 Mb/s
1 Mb/s
0 b/s
13:26:00
13:27:00
13:28:00
13:29:00
13:30:00
Front panel view
Spine-1: 7220 IXR-D3L
Spine-2: 7220 IXR-D3L
Leaf-1: 7220 IXR-D2L
Leaf-2: 7220 IXR-D2L
Leaf-3: 7220 IXR-D2L
Link Bandwidth
● 0 - 0.5 Mbps
● 0.5 - 2 Mbps
● 2 - 5 Mbps
● 5+ Mbps
spine-1
spine-2
1 2 3
1 2 3
44.0 kb/s
1.6 Mb/s
2.0 Mb/s
39.7 kb/s
65.3 kb/s
39.3 kb/s
83.7 kb/s
104.6 kb/s
1.5 Mb/s
519.3 kb/s
464.6 kb/s
1.1 Mb/s
49 50
leaf-1
leaf-2
leaf-3
1
3.3 Mb/s
67.0 kb/s
48.9 kb/s
126.1 kb/s
2.0 Mb/s
1.4 Mb/s
eth1
client-1
client-2
client-3

Lab As Code

Telemetry Lab



```
git clone
```

```
containerlab deploy
```

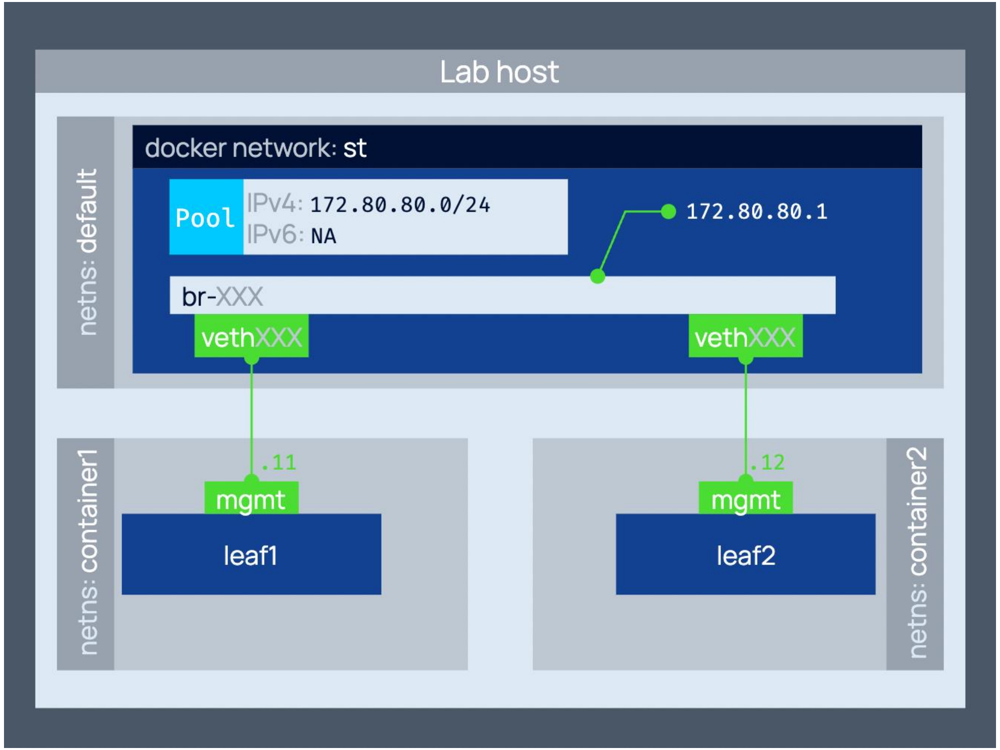
Management network

Staticly assigned IP addresses

```
mgmt:
  network: st
  ipv4-subnet: 172.80.80.0/24

topology:
  nodes:
    leaf1:
      mgmt-ipv4: 172.80.80.11

    leaf2:
      mgmt-ipv4: 172.80.80.12
```



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Startup configuration

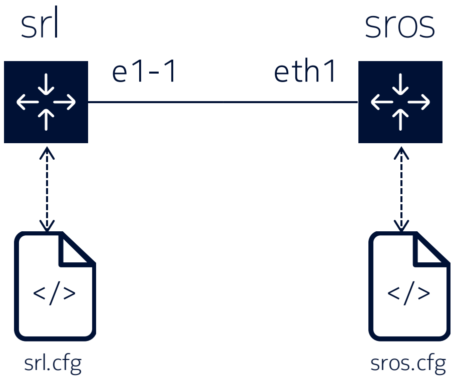
Topology definition

```
topology:
  nodes:

    srl:
      kind: nokia_srlinux
      image: ghcr.io/nokia/srlinux:23.7.1
      startup-config: srl.cfg


    sros:
      kind: vr-nokia_sros
      image: sros:23.7.R1
      startup-config: sros.cfg
```

Logical view



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Executing commands

- Exec is a list of commands executed inside the container once it reaches running state
  - configure network params (ip, mac)
  - run the provisioning or workload scripts

```yaml
nodes:
  server:
    kind: linux
    image: alpine:3
    exec:
      - ip address add 172.17.0.1/24 dev eth1
```

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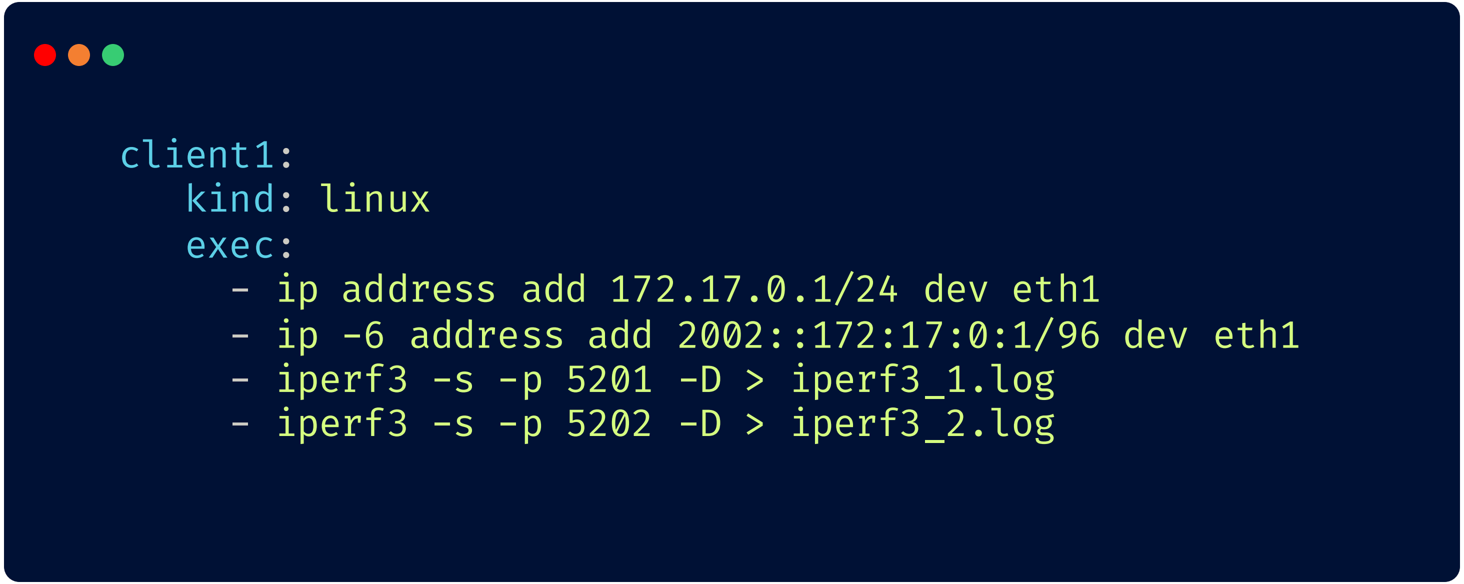
Executing commands

How we used it in the lab?



```
client1:
   kind: linux
   exec:
     - ip address add 172.17.0.1/24 dev eth1
     - ip -6 address add 2002::172:17:0:1/96 dev eth1
     - iperf3 -s -p 5201 -D > iperf3_1.log
     - iperf3 -s -p 5202 -D > iperf3_2.log
```

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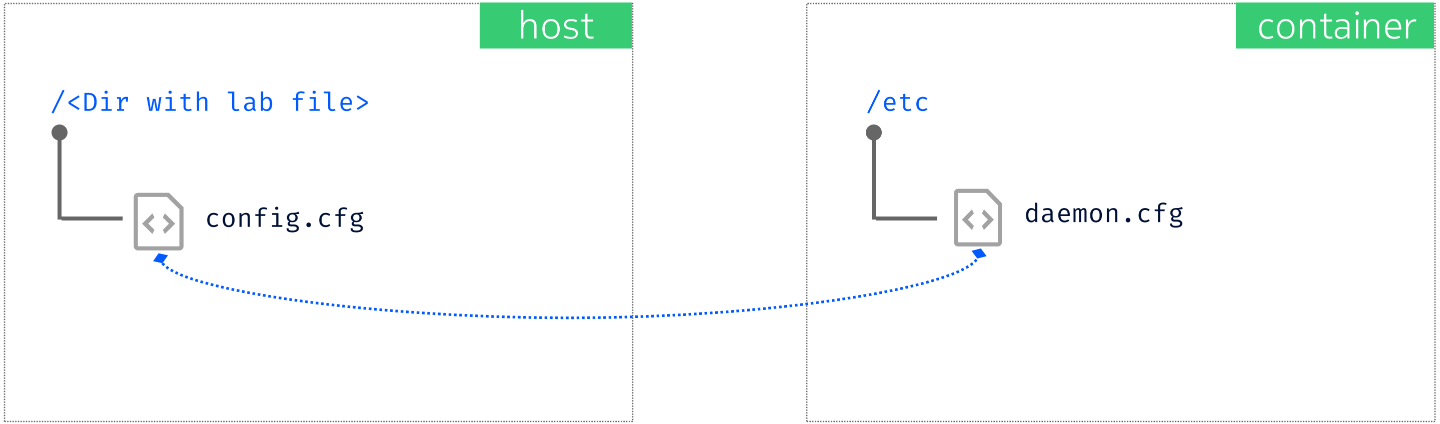
File binding

```
server:
  kind: linux
  binds:
    - config.cfg:/etc/daemon.cfg
```

- Bind mount files from host to a container
  - Providing configuration files
  - Providing executable scripts
  - Access to container’s files



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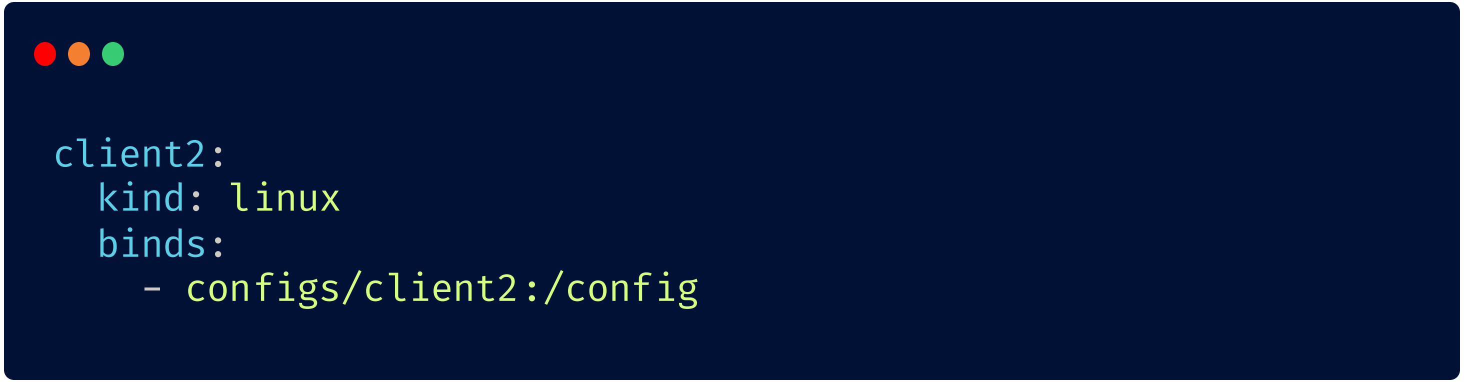
File binding

How we used it in the lab?

- Share a config folder with shell scripts from the host to the node
  - Provide iperf.sh script that manages traffic flow



```
client2:
  kind: linux
  binds:
    - configs/client2:/config
```

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Entrypoint and command

- Entrypoint is the “command” that starts in a container
- Command (aka CMD) is a list of arguments passed to the entrypoint

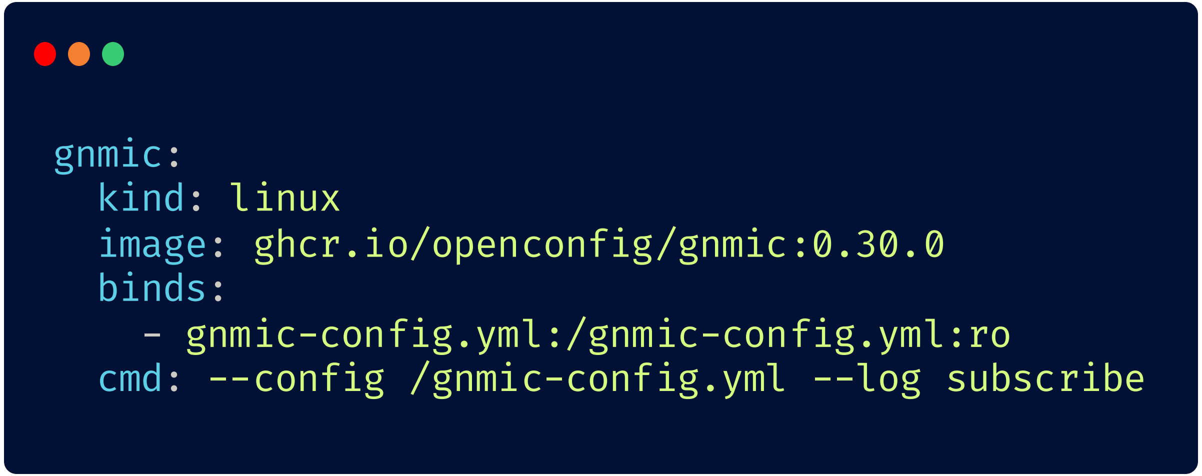
```
server:
  kind: linux
  image: alpine:3
  entrypoint: sleep
  cmd: ”10”
```

SReXperts - Confidential

Entrypoint and command

How we used it in the lab?

- Provide configuration options to the processes running in a container



```
gnmic:
  kind: linux
  image: ghcr.io/openconfig/gnmic:0.30.0
  binds:
    - gnmic-config.yml:/gnmic-config.yml:ro
  cmd: --config /gnmic-config.yml --log subscribe
```

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Environment variables

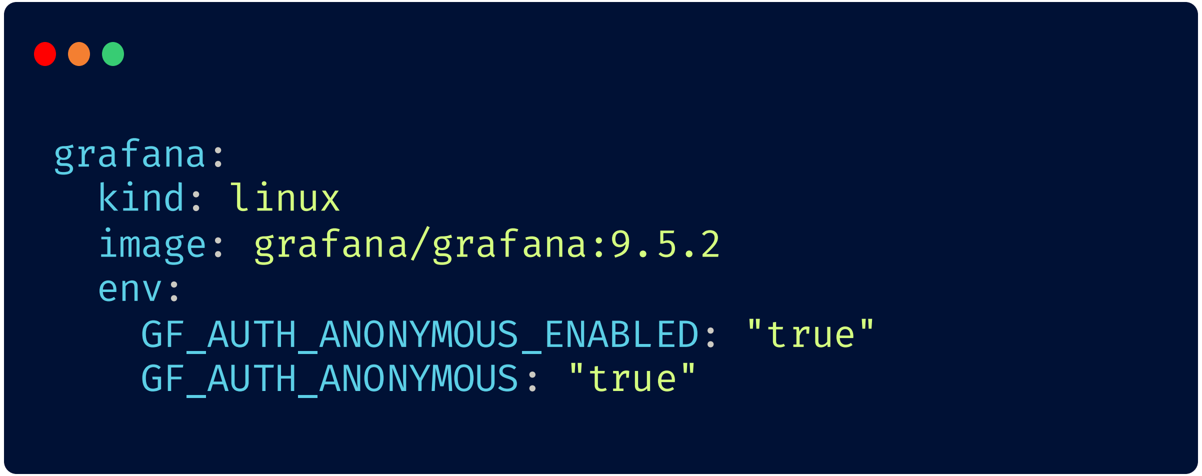
- Configure processes via env vars

```
server:
  kind: linux
  image: alpine:3
  env:
    MYVAR:SOMEVALUE
```

Environment variables

How we used it in the lab?

- Provide configuration options for some nodes



```yaml
grafana:
  kind: linux
  image: grafana/grafana:9.5.2
  env:
    GF_AUTH_ANONYMOUS_ENABLED: "true"
    GF_AUTH_ANONYMOUS: "true"
```

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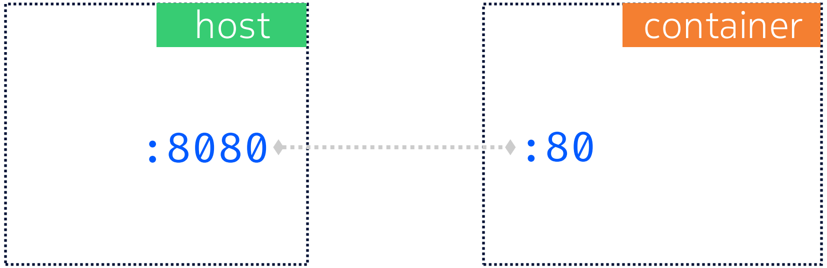
Exposing ports

- Make services inside a container available to containerlab host

```yaml
server:
  kind: linux
  image: nginx
  ports:
    - 8080:80
```



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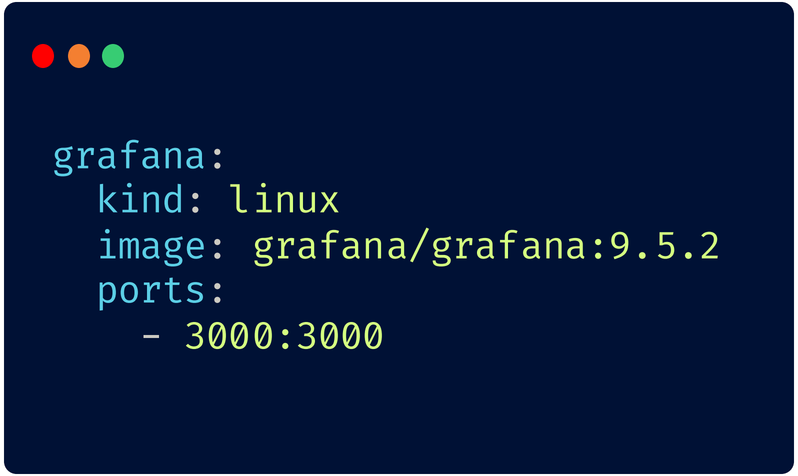
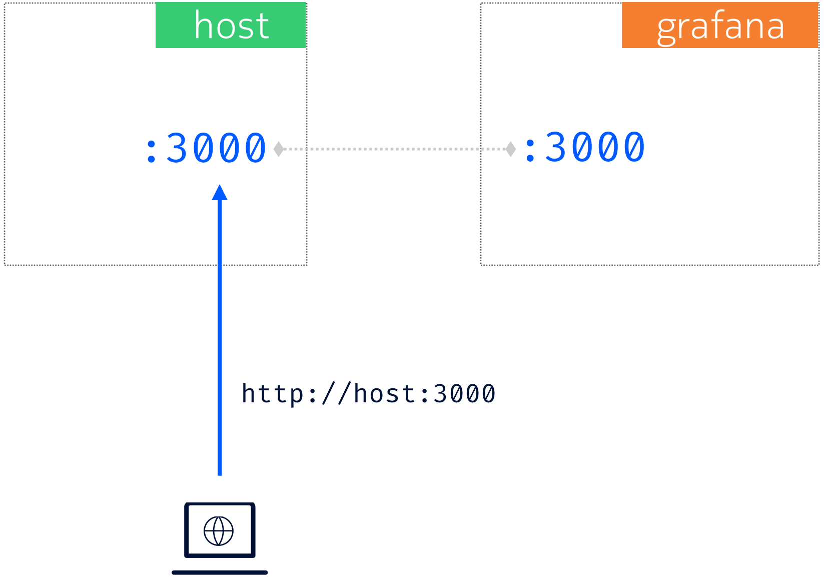
Exposing ports

How we used it in the lab?

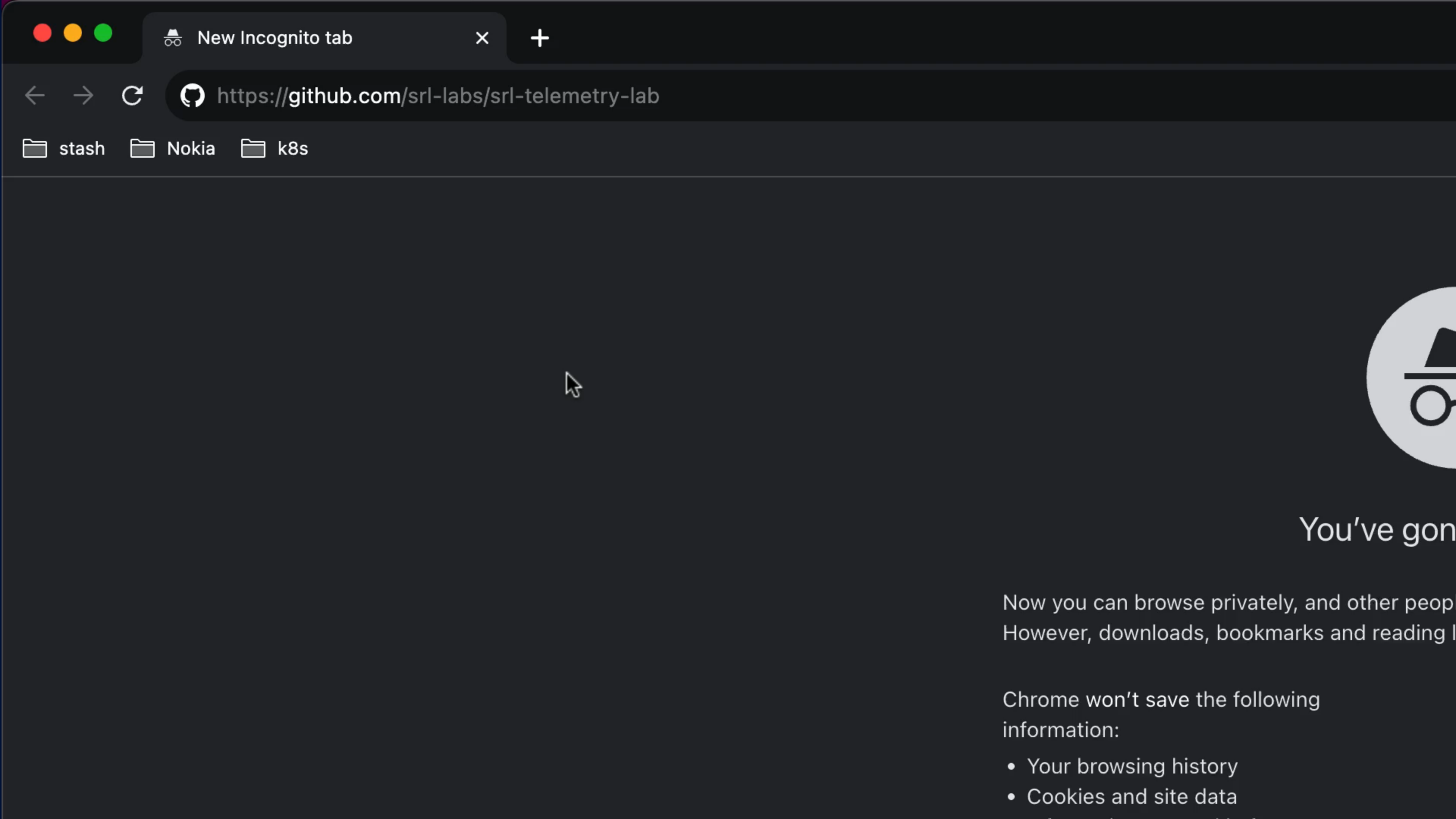
- Expose Grafana Web UI to allow remote access



```
grafana:
  kind: linux
  image: grafana/grafana:9.5.2
  ports:
    - 3000:3000
```



Let’s deploy the lab!

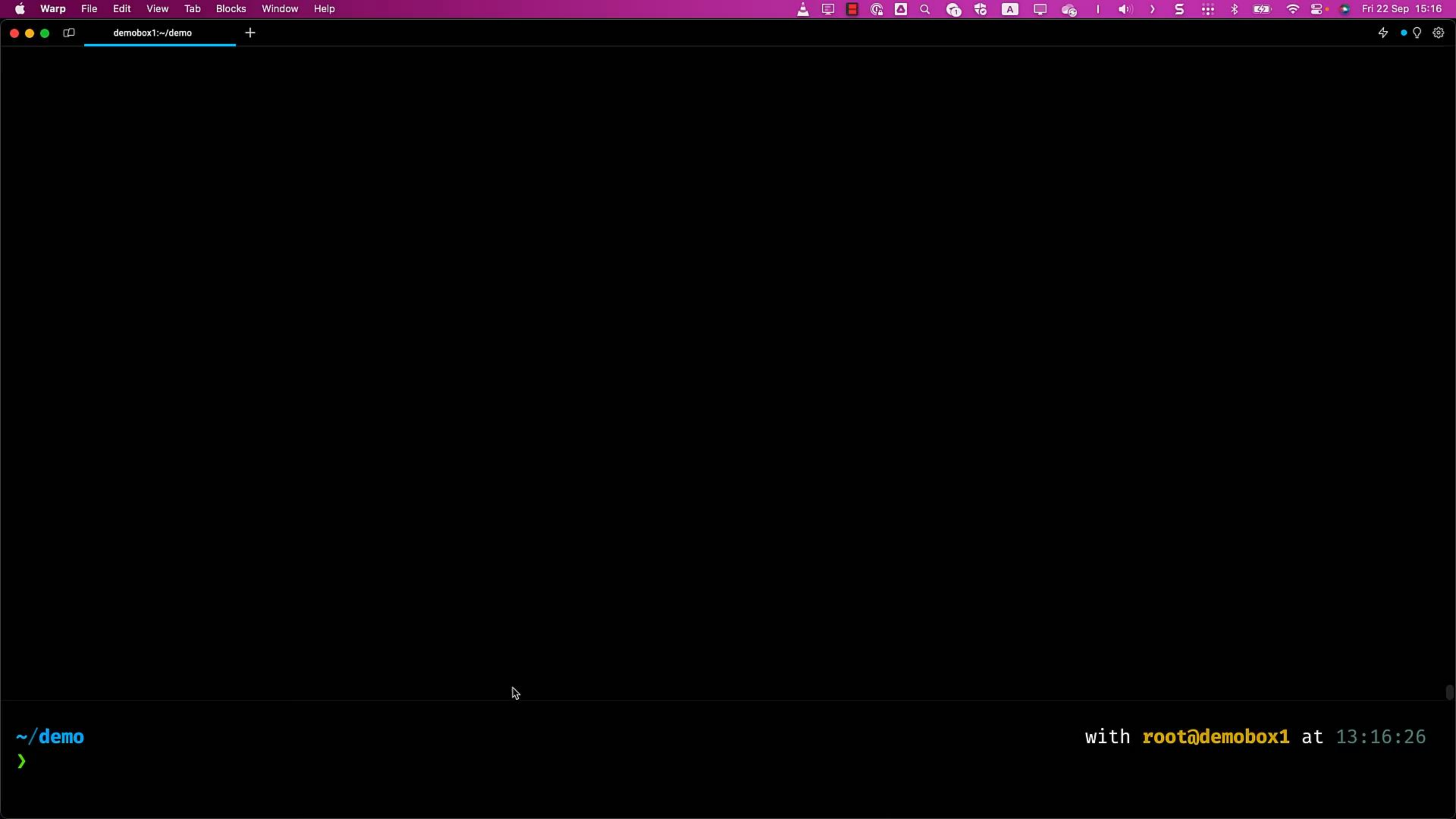


You've gon

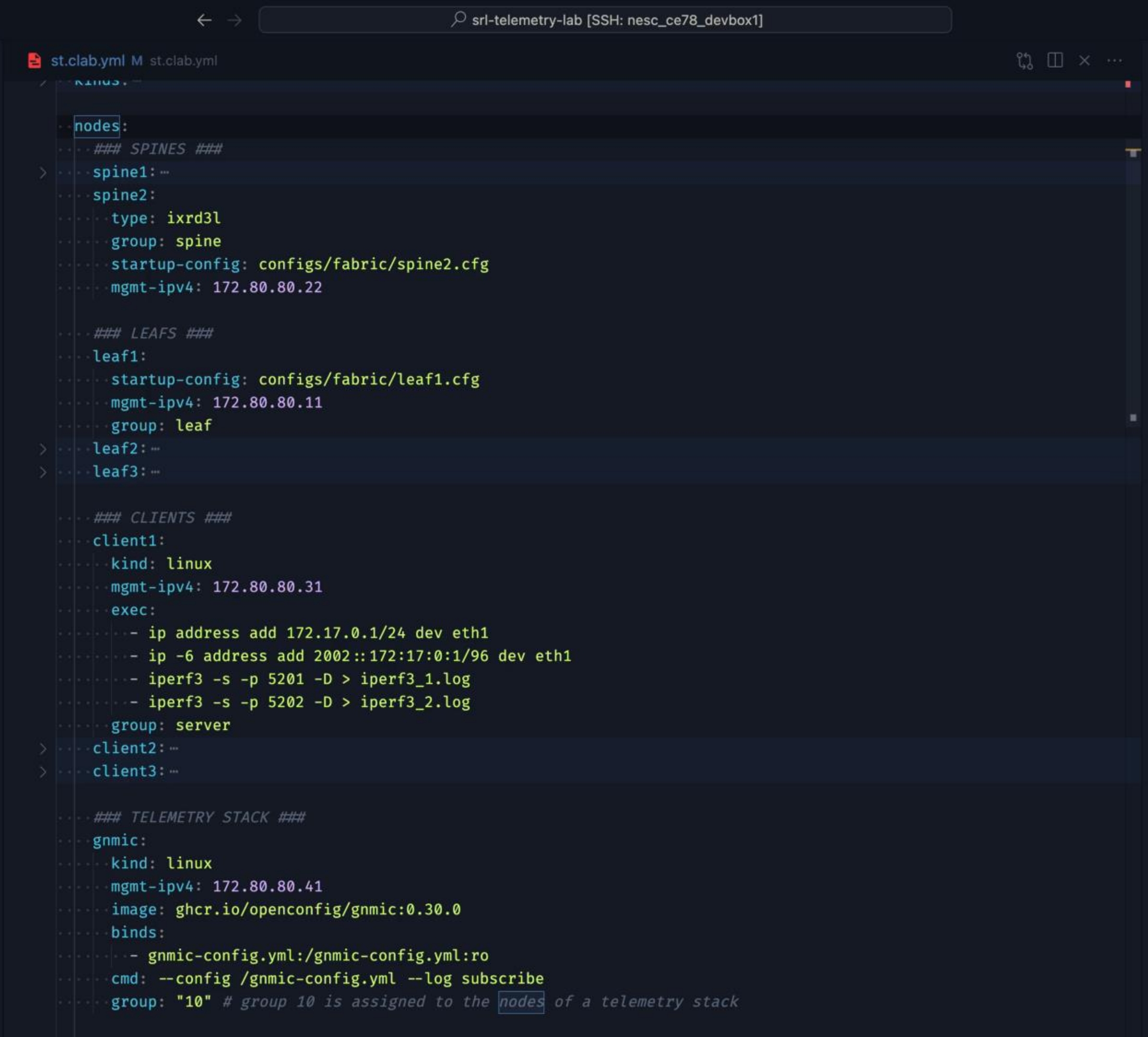
Now you can browse privately, and other peop
However, downloads, bookmarks and reading l

Chrome won't save the following information:

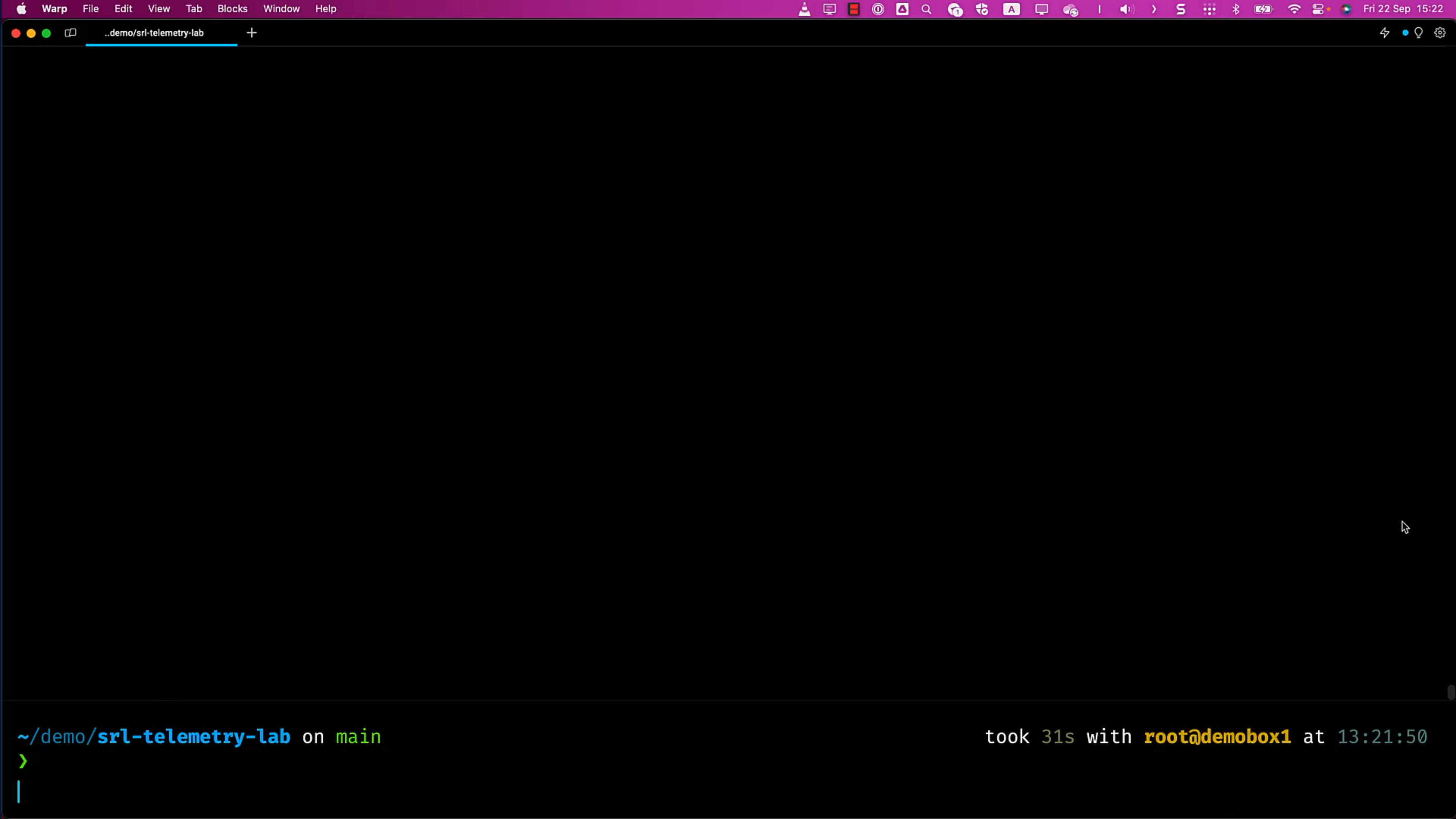
- Your browsing history
- Cookies and site data



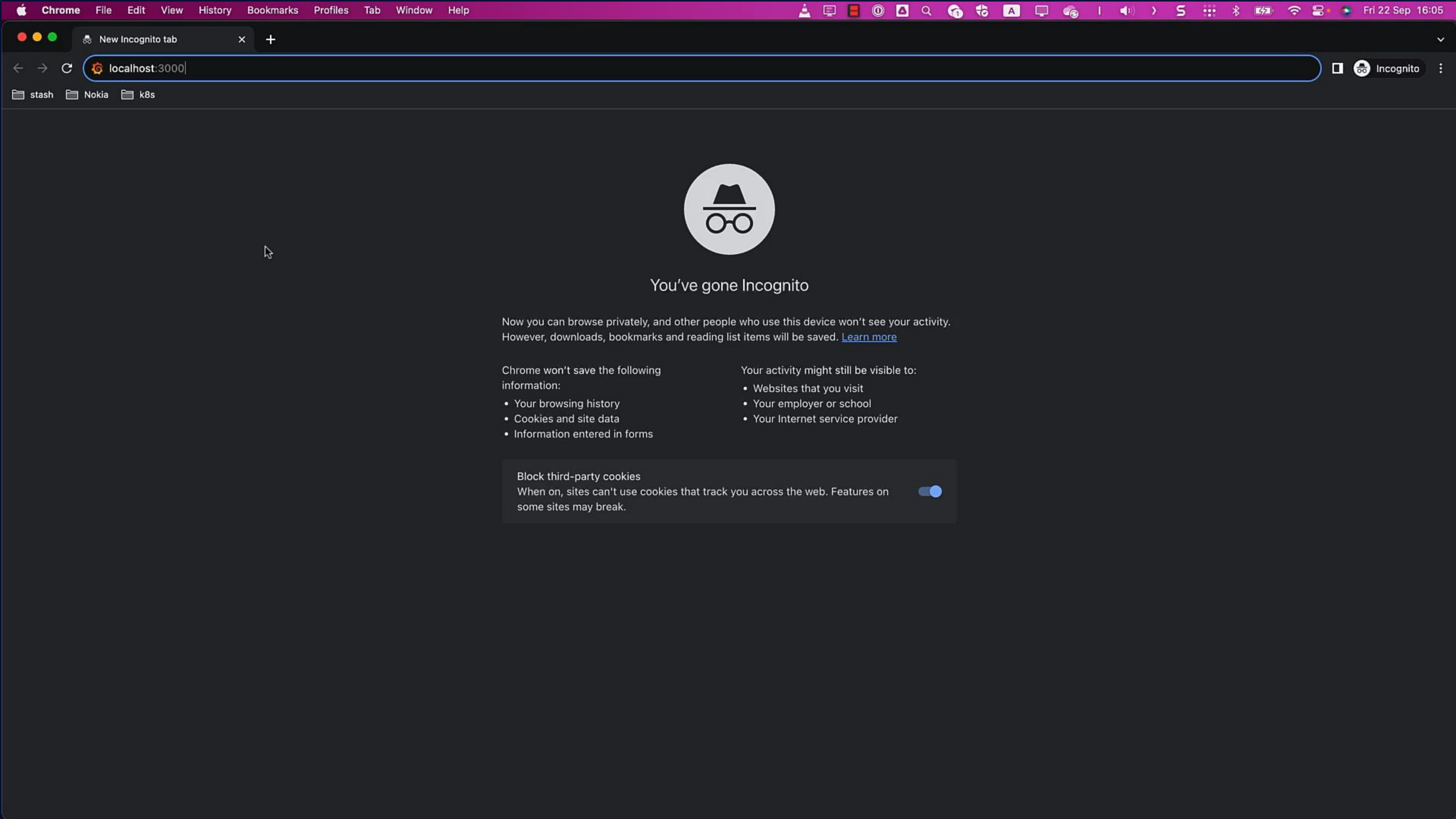
```
~/demo                                              with root@demobox1 at 13:16:26
❯
```


srl-telemetry-lab [SSH: nesc_ce78_devbox1]
st.clab.yml M st.clab.yml

```
  kinds: ⋯

  nodes:
    ### SPINES ###
    spine1: ⋯
    spine2:
      type: ixrd3l
      group: spine
      startup-config: configs/fabric/spine2.cfg
      mgmt-ipv4: 172.80.80.22

    ### LEAFS ###
    leaf1:
      startup-config: configs/fabric/leaf1.cfg
      mgmt-ipv4: 172.80.80.11
      group: leaf
    leaf2: ⋯
    leaf3: ⋯

    ### CLIENTS ###
    client1:
      kind: linux
      mgmt-ipv4: 172.80.80.31
      exec:
        - ip address add 172.17.0.1/24 dev eth1
        - ip -6 address add 2002::172:17:0:1/96 dev eth1
        - iperf3 -s -p 5201 -D > iperf3_1.log
        - iperf3 -s -p 5202 -D > iperf3_2.log
      group: server
    client2: ⋯
    client3: ⋯

    ### TELEMETRY STACK ###
    gnmic:
      kind: linux
      mgmt-ipv4: 172.80.80.41
      image: ghcr.io/openconfig/gnmic:0.30.0
      binds:
        - gnmic-config.yml:/gnmic-config.yml:ro
      cmd: --config /gnmic-config.yml --log subscribe
      group: "10" # group 10 is assigned to the nodes of a telemetry stack
```



```
~/demo/srl-telemetry-lab on main                                         took 31s with root@demobox1 at 13:21:50
❯
```



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Chrome won't save the following information:

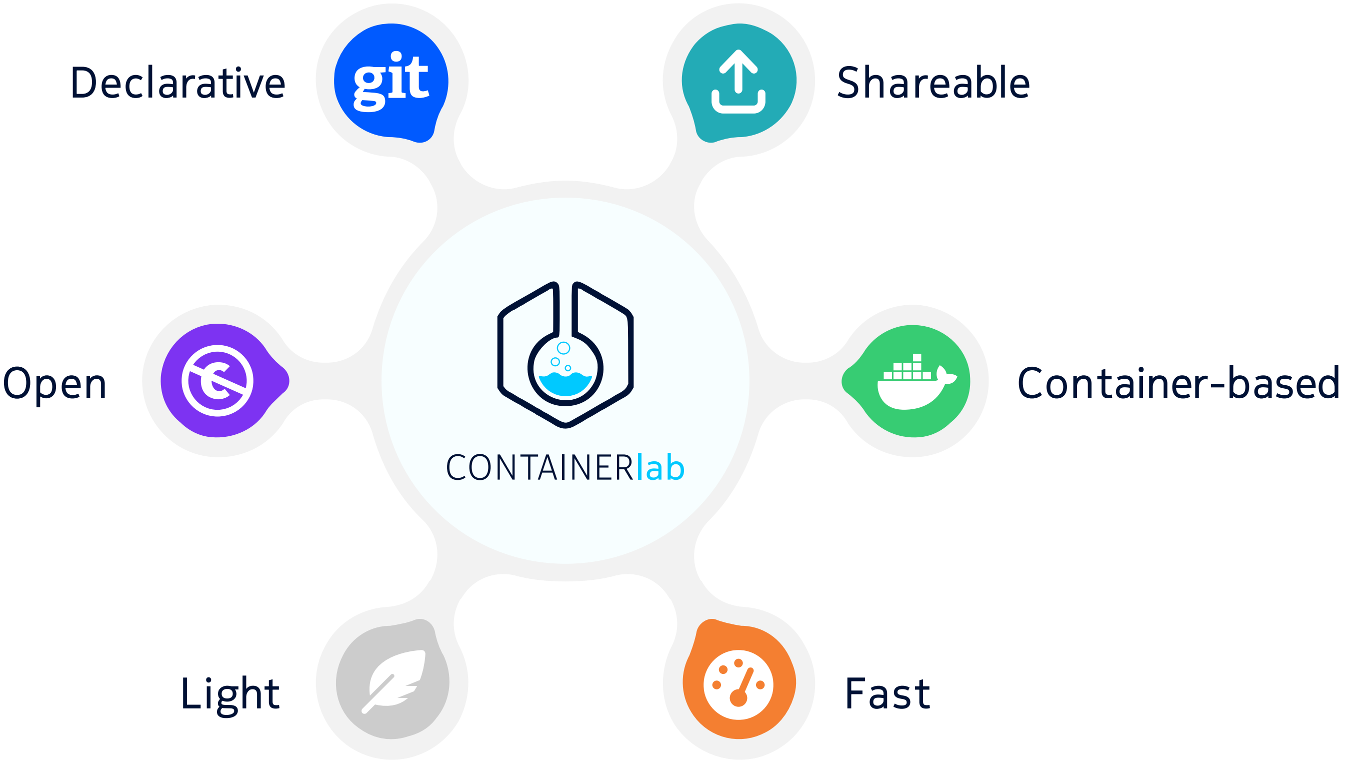
- Your browsing history
- Cookies and site data
- Information entered in forms

Your activity might still be visible to:

- Websites that you visit
- Your employer or school
- Your Internet service provider

Block third-party cookies
When on, sites can't use cookies that track you across the web. Features on some sites may break. ●

Containerlab



Declarative

Shareable

Open

Container-based

Light

Fast

CONTAINERlab

https://containerlab.dev