FOSDEM'21

NTT

NoRouter

https://norouter.io

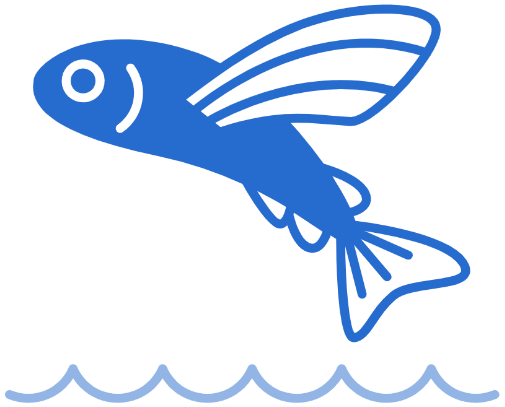
NoRouter: instant multi-cluster & multi-cloud container networking

No routing configuration is required. No root privilege is required.

Akihiro Suda, NTT

What is NoRouter?

- Instant multi-cluster & multi-cloud networking for dev environments
- No public IP address is required
- No routing configuration is required
- No root privilege is required
- Just needs stdio (aka shell access)



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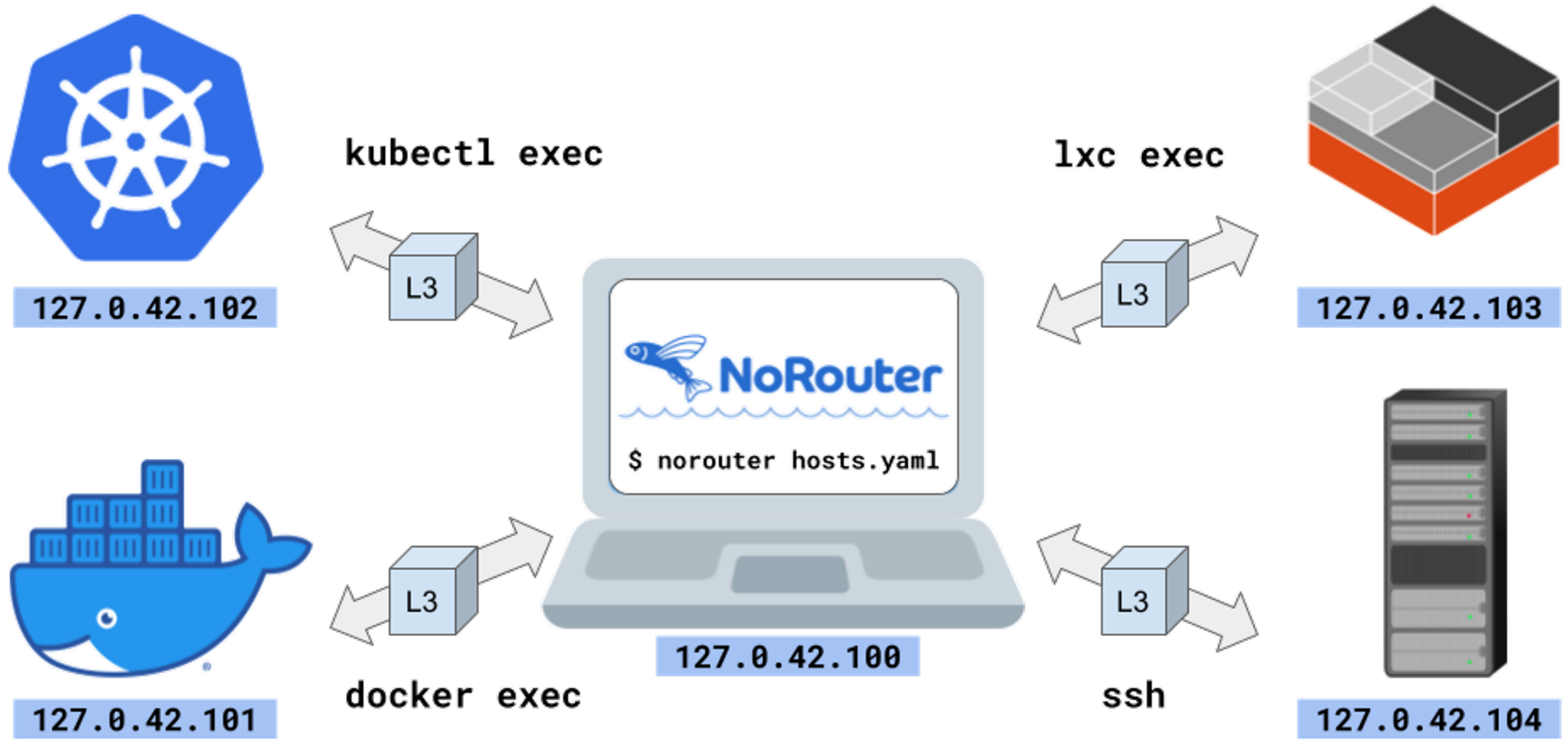


```
$ norouter hosts.yaml
```

Goals and Non-Goals

Goals

- Facilitate working with heterogeneous dev environments e.g.,
  - Kubernetes cluster1 on GPU-enabled rich cloud
  - Kubernetes cluster2 on cheaper cloud
  - On-premise baremetal IoT devices
  - Laptop at home

Goals and Non-Goals

Goals

- UX
  - Human-friendly CLI and YAML
- Security
  - No need to sacrifice security with `docker run --privileged`
- Portability
  - Mostly for Docker/Kubernetes containers, but not only for them
  - Works with Docker, Podman, LXC, Kubernetes, SSH, and whatever, as long as stdio is available

Goals and Non-Goals

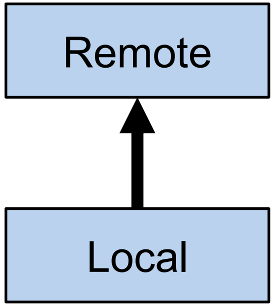
***Non*-Goals**

- Production quality performance
  - Approximately 350 Mbps at maximum, with two Docker containers on same host

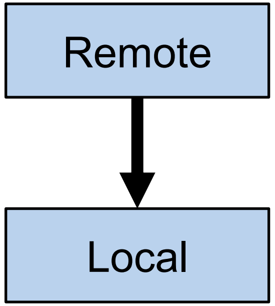
- Fault-tolerance
  - Could be achieved by running NoRouter with a distributed locker, e.g., Consul, though

Similar tools

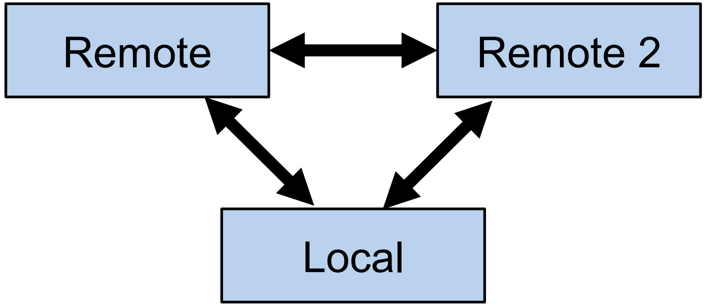
- `ssh -L` , `ssh -R`
  - Depends on SSH
  - No connectivity across multiple remote hosts



`ssh -L`



`ssh -R`



NoRouter

This slide was updated after the recording

Similar tools

- VDE (Virtual Distributed Ethernet)
  - Requires root to create TAP devices
    (VDE itself doesn’t require the root)
- SLiRP (c. 1995)
  - No connectivity across multiple remote hosts

Demo: Laptop + GKE + AKS

Virtual network 127.0.42.0/24

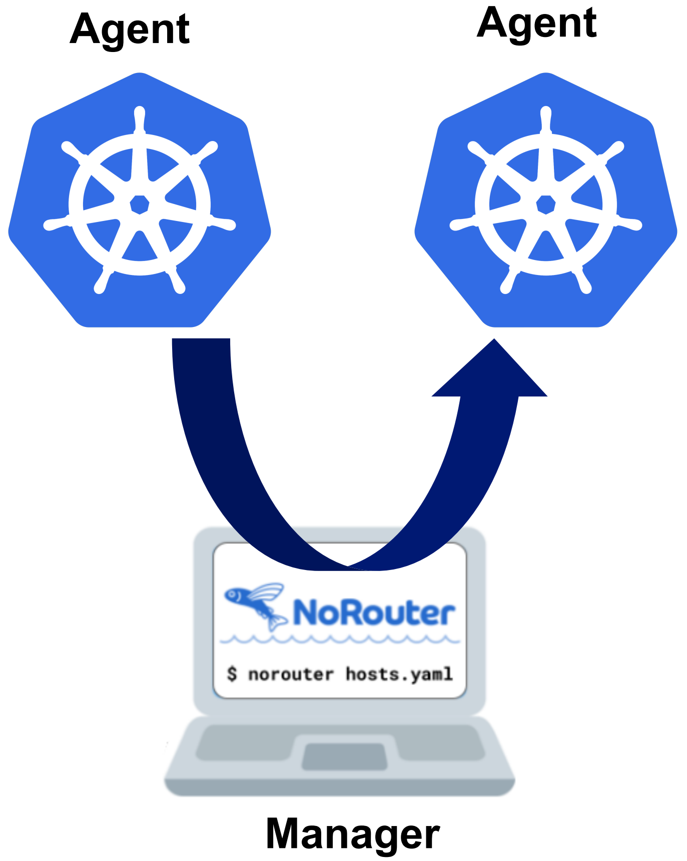
- **127.0.42.100:8080**: port 80 of the local laptop
- **127.0.42.101:8080**: port 80 of “gkepod” on Kubernetes context “gke”
- **127.0.42.102:8080**: port 80 of “akspod” on Kubernetes context “aks”

```
hosts:
  laptop:
    vip: "127.0.42.100"
  gkepod:
    vip: "127.0.42.101"
    cmd: "kubectl --context=gke exec -i gkepod -- norouter"
  akspod:
    vip: "127.0.42.102"
    cmd: "kubectl --context=aks exec -i akspod -- norouter"
hostTemplate:
  ports: ["8080:127.0.0.1:80"]
```

GKE: Google Kubernetes Engine, AKS: Azure Kubernetes Service

How it works

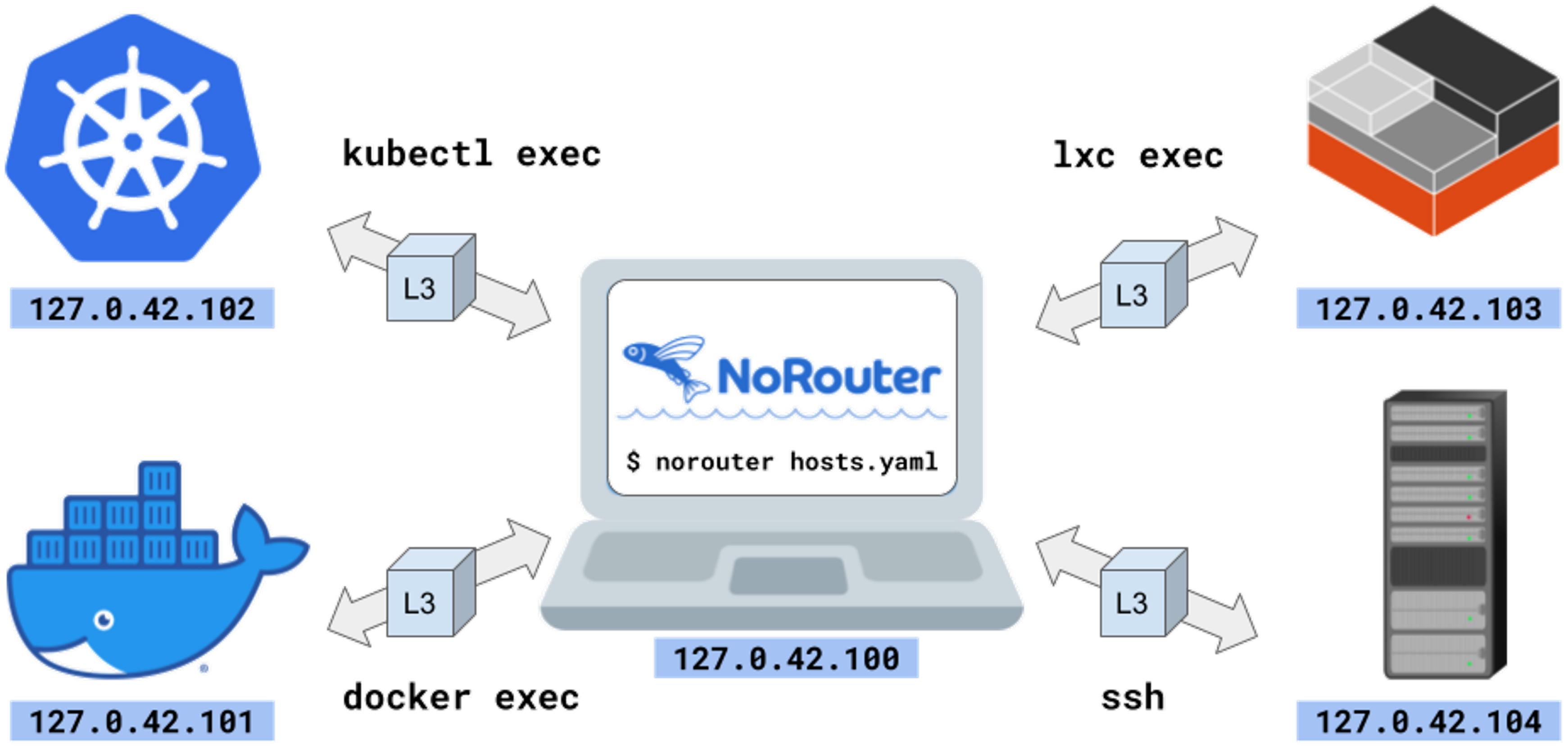
- Each of the hosts has `norouter` binary
- NoRouter manager process (on local laptop) launches NoRouter agent processes, e.g., `kubectl exec -i <POD> norouter`
- Agents send virtual L3 packets to the manager via stdio, and the manager works like a switch



How it works: Multi-loopback

- **Challenge**: How to create network devices without the root?
- TUN/TAP cannot be used because it requires the root (CAP_NET_ADMIN)
- **Solution**: Do not create devices at all
- NoRouter just uses the loopback interface with multiple IP addresses within 127.0.0.0/8
  - e.g. 127.0.42.100, 127.0.42.101, …

How it works: Multi-loopback



How it works: TCP/IP stack

- TCP/IP is implemented in userspace using Netstack
  - Originates from gVisor and Fuchsia
  - Written in Go

- The current NoRouter implementation only supports TCP (v4)

- UDP support is on plan

How it works: Name resolution

- **Challenge**: `/etc/{resolv.conf, hosts}` cannot be modified without the root

- **Solutions**:
  - `$HOSTALIASES` file (`~/.norouter/agent/hostaliases`)
    - › Similar to `/etc/hosts` but customizable without the root
    - › Not supported by all applications
  - HTTP proxy mode
    - › NoRouter agent works as a HTTP proxy with built-in name resolver
    - › Best fit for typical HTTP applications
  - SOCKS proxy mode
    - › Similar to HTTP proxy mode but SOCKS
    - › Supports both SOCKS4a and SOCKS5

VPN(-ish) using HTTP proxy mode

- HTTP proxy mode can be used as if it is a “VPN”
- Accesses to “http://<PRIVATE-IP>.eu-central-1.compute.internal” are routed via `ssh aws_bastion`
- Same applies to Azure and GCP addresses

```
hosts:
  local:
    vip: "127.0.42.100"
    http:
      listen: "127.0.0.1:18080"
  aws_bastion:
    cmd: "ssh aws_bastion -- norouter"
    vip: "127.0.42.101"
  azure_bastion:
    cmd: "ssh azure_bastion -- norouter"
    vip: "127.0.42.102"
  gcp_bastion:
    cmd: "ssh gcp_bastion -- norouter"
    vip: "127.0.42.103"
routes:
  - via: aws_bastion
    to: ["*.compute.internal“]
  - via: azure_bastion
    to: ["*.internal.cloudapp.net“]
  - via: gcp_bastion
    to: ["*.example-123456.internal“]
```

How to get started

- Binaries are available for Linux, FreeBSD, NetBSD, OpenBSD, DragonFly BSD, macOS, and Windows: https://github.com/norouter/norouter/releases
- `norouter show-example` shows an example YAML
- `norouter –e` opens `$EDITOR` with an example YAML
- Docs: https://norouter.io/docs/

Future work

- Support UDP
- Support MASQUE (HTTP/3 VPN-ish)
- Support TUN/TAP (with root)
- Automatically generate mTLS certs with NoRouter virtual IP addresses
- …

Recap

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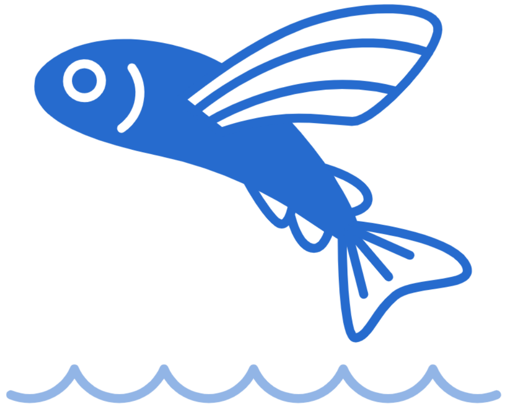
- No root privilege is required
- Just needs stdio (aka shell access)



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