Cross-platform/cross-hypervisor virtio vsock use in go

Usermode networking in CodeReady Containers

Christophe Fergeau
Senior Software Engineer

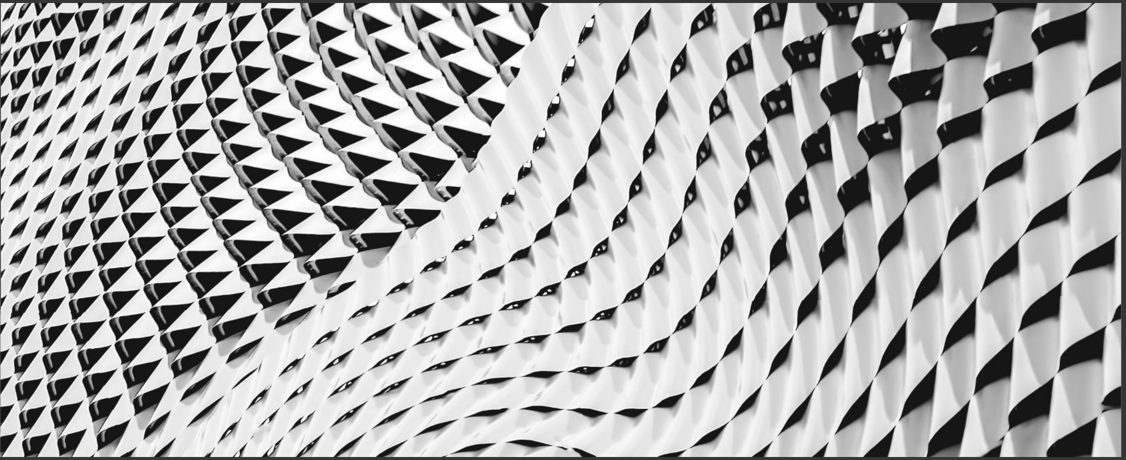
Introduction

- Christophe Fergeau <cfergeau@redhat.com>
- Working at Red Hat
- Member of the CodeReady Containers team
- Previously worked in the virtualization team (SPICE)

What we'll discuss today

- CodeReady Containers (aka `crc`)
- User-mode networking
- vsock usage in go
  - Linux
  - macOS
  - Windows

CodeReady Containers



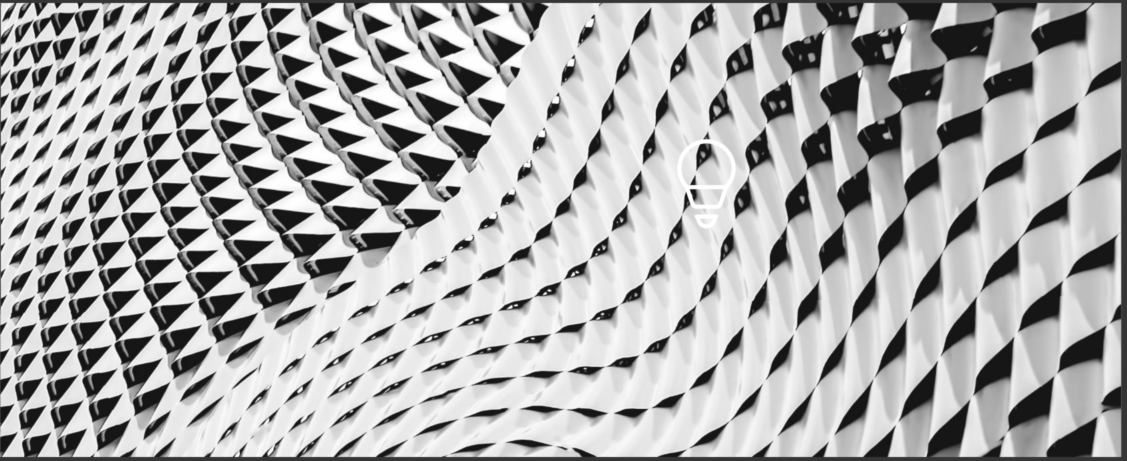
What is CodeReady Containers?

- Runs a Red Hat OpenShift 4 cluster on your laptop or desktop
  - « Red Hat® OpenShift® is an enterprise-ready Kubernetes container platform built for an open hybrid cloud strategy. »
- Meant for development and testing on a throw-away local cluster
- Works on Linux, macOS and Windows

Under the hood

- Go binary + pre-generated virtual machine image
- Uses native hypervisors
  - QEMU+KVM on linux
  - HyperKit on macOS
  - Hyper-V on Windows
- User-mode stack for VM networking

User-mode networking



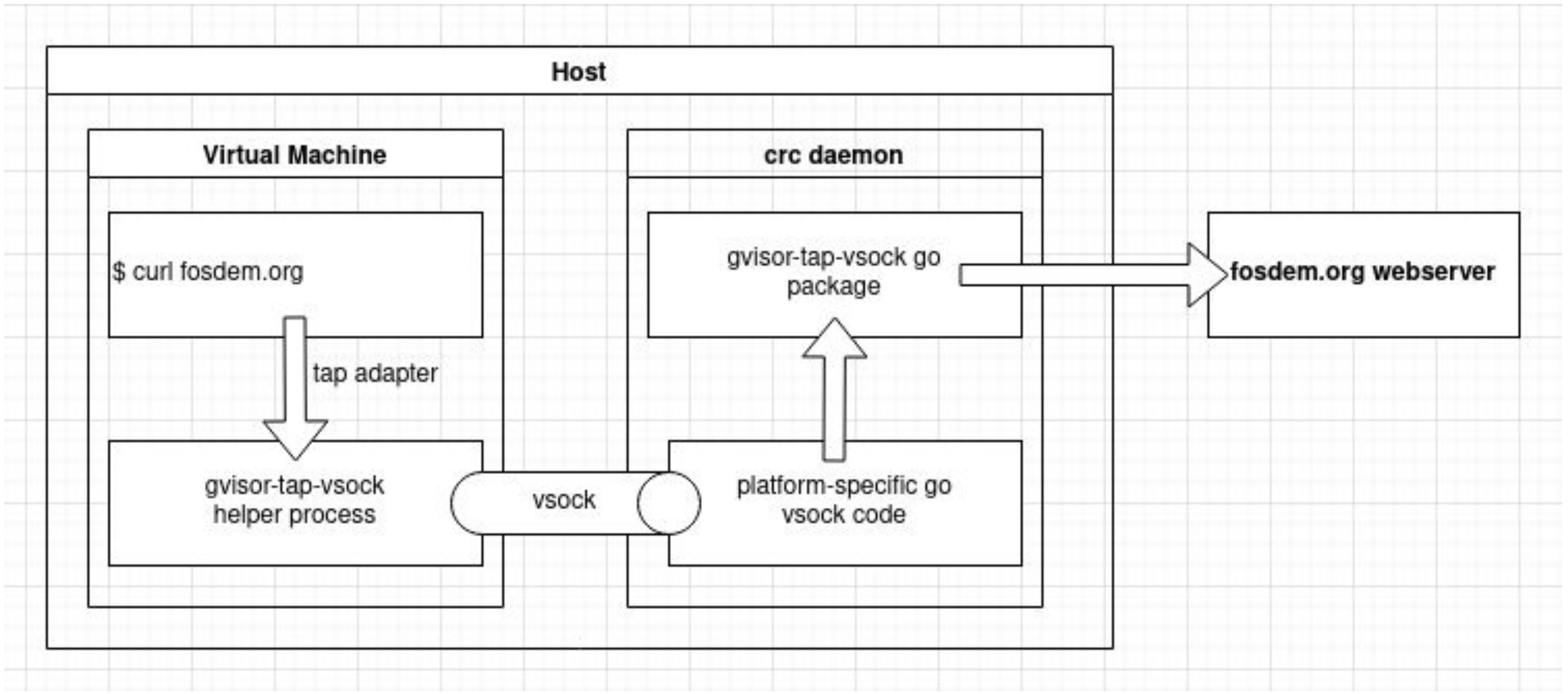
Why?

- Simplifies VM networking
- Consistent IP addressing
- Works around strict firewalls/VPNs

gvisor-tap-vsock

- https://github.com/containers/gvisor-tap-vsock
- Users:
  - crc
  - podman-machine
- Based on gVisor
  - « gVisor is an application kernel, written in Go, that implements a substantial portion of the Linux system call interface. »

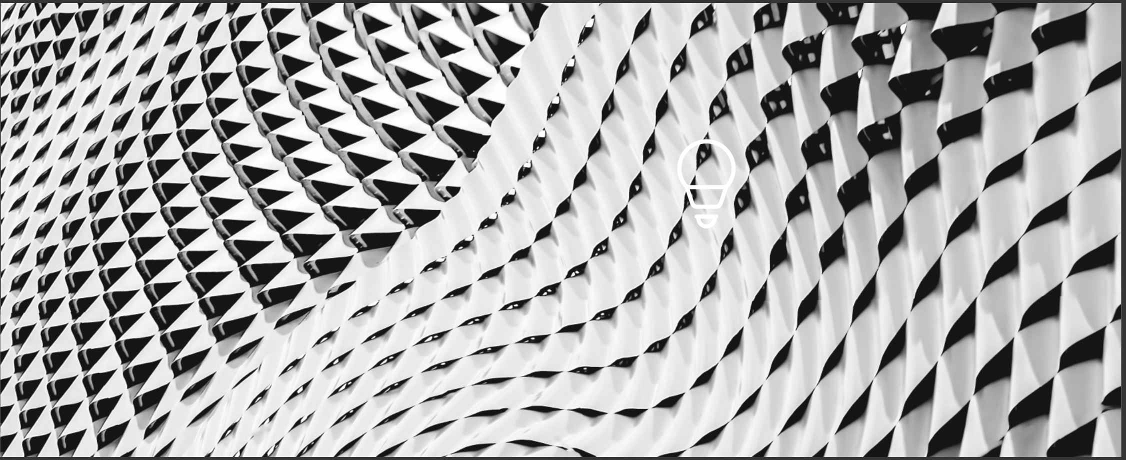
How does it work?


Host
Virtual Machine
$ curl fosdem.org
tap adapter
gvisor-tap-vsock helper process
vsock
crc daemon
gvisor-tap-vsock go package
platform-specific go vsock code
fosdem.org webserver

How does it work? (2)

- Need code for this on Linux, macOS, Windows
- More details regarding the networking in the containers devroom tomorrow!
- This presentation will focus on the virtio-vsock communication

Using virtio-vsock on multiple platforms

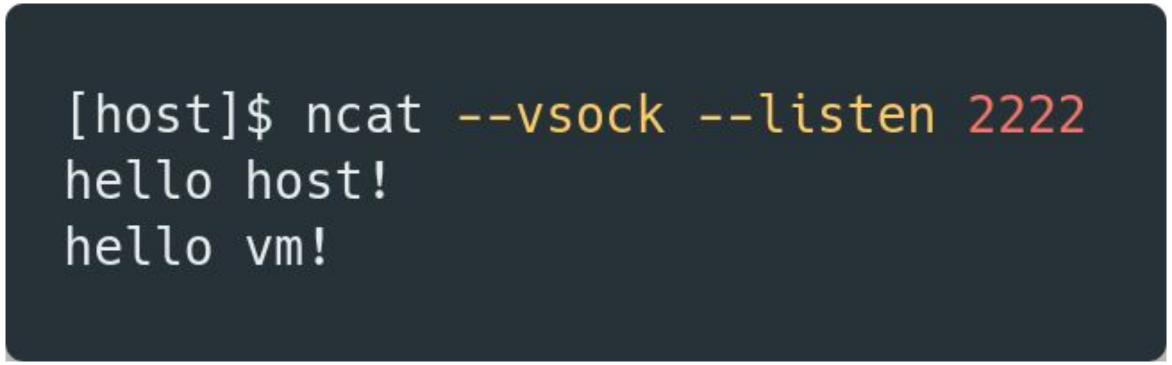


What is virtio-vsock?

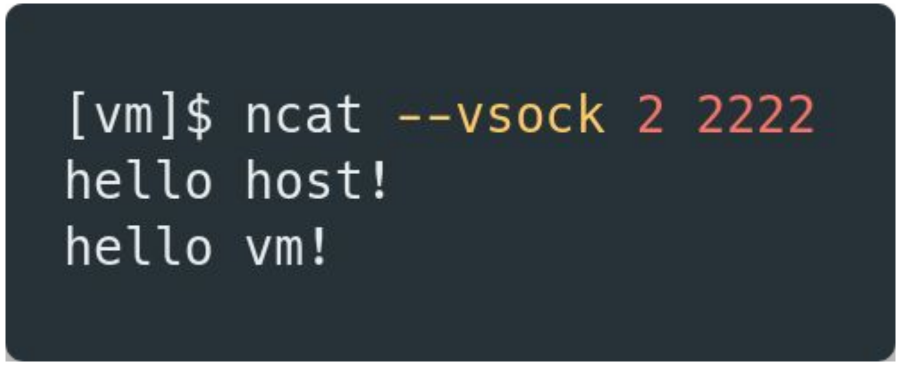
- https://wiki.qemu.org/Features/VirtioVsock
- POSIX Sockets API which allows applications in the guest and host to communicate
- Host/VMs each have their own CID (“address”)
- Applications connect to/listen on a given port

Linux - How to use virtio-vsock?

- Configure the VM to have a vsock device
- On the host:
  - load the `vhost_vsock` kernel module
  - `/dev/vsock` must be accessible by the user



```
[host]$ ncat --vsock --listen 2222
hello host!
hello vm!
```



```
[vm]$ ncat --vsock 2 2222
hello host!
hello vm!
```

Linux - virtual machine configuration

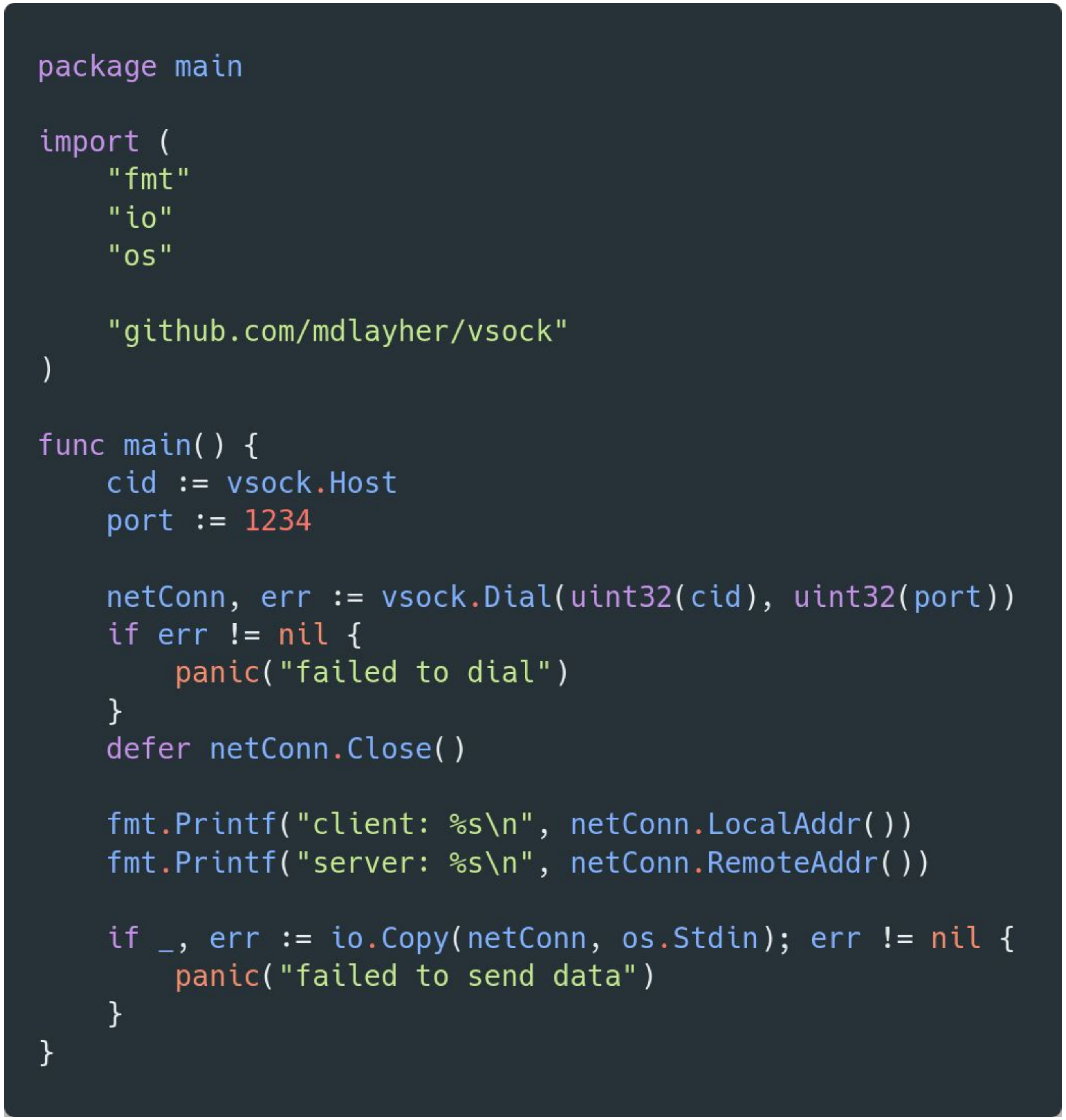
```xml
<vsock model='virtio'>
    <cid auto='yes'/>
</vsock>
```

```go
import "libvirt.org/go/libvirtxml"

func addVSock(domain *libvirtxml.Domain) {
    domain.Devices.VSock = &libvirtxml.DomainVSock{
        Model: "virtio",
        CID: &libvirtxml.DomainVSockCID{
            Auto: "yes",
        },
    }
}
```

Linux - Communication over virtio-vsock

- Low-level `AF_VSOCK` support in go
- But external package needed for vsock implementations of `net.Conn` and `net.Listener`
    - `import “github.com/mdlayher/vsock”`

virtio-vsock



```go
package main

import (
	"fmt"
	"io"
	"os"

	"github.com/mdlayher/vsock"
)

func main() {
	cid := vsock.Host
	port := 1234

	netConn, err := vsock.Dial(uint32(cid), uint32(port))
	if err != nil {
		panic("failed to dial")
	}
	defer netConn.Close()

	fmt.Printf("client: %s\n", netConn.LocalAddr())
	fmt.Printf("server: %s\n", netConn.RemoteAddr())

	if _, err := io.Copy(netConn, os.Stdin); err != nil {
		panic("failed to send data")
	}
}
```

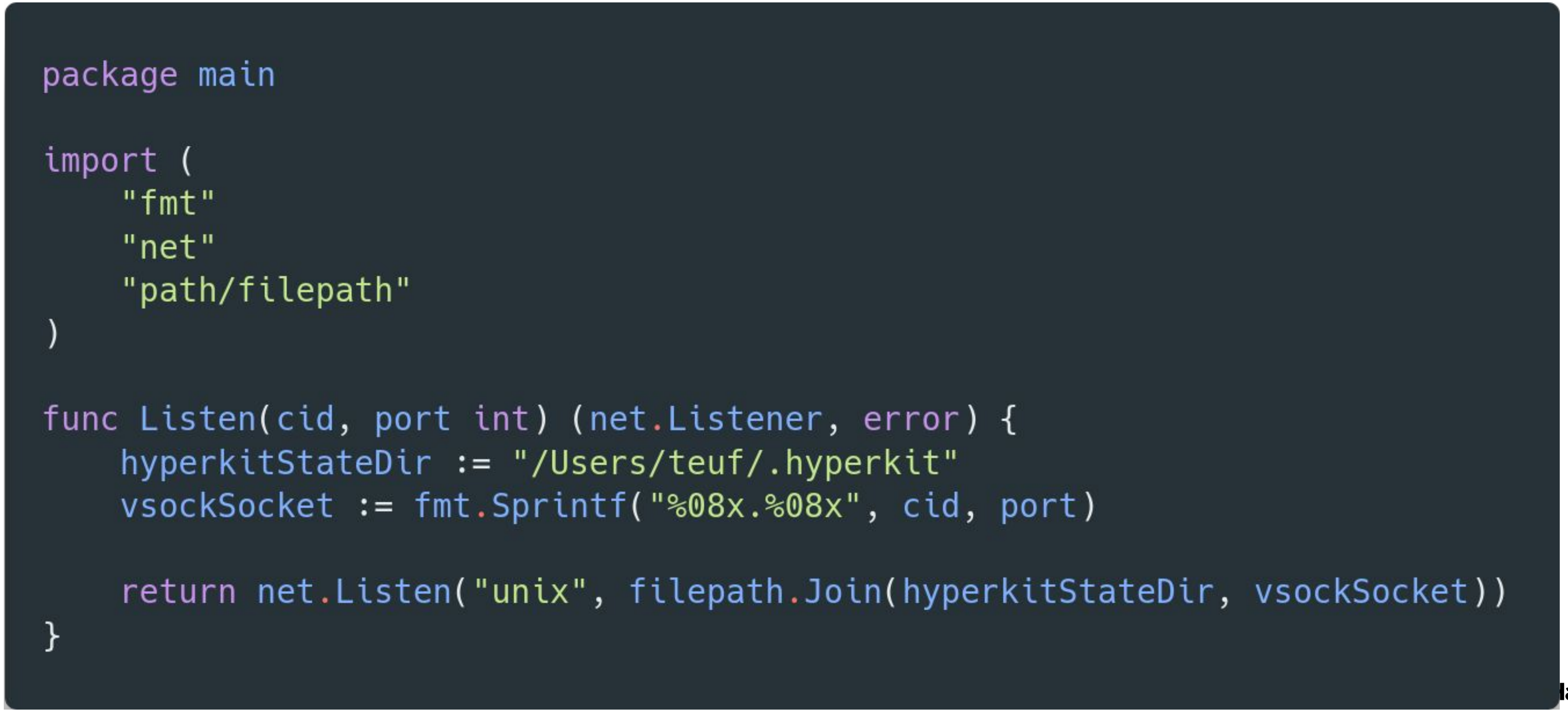
```go
package main

import (
    "io"
    "os"

    "github.com/mdlayher/vsock"
)

func main() {
    port := 1234

    listener, err := vsock.Listen(uint32(port))
    if err != nil {
        panic("failed to listen")
    }
    defer listener.Close()

    // Accept a single connection, and receive stream from that connection.
    conn, err := listener.Accept()
    if err != nil {
        panic("failed to accept")
    }
    defer conn.Close()

    if _, err := io.Copy(os.Stdout, conn); err != nil {
        panic("failed to receive data")
    }
}
```

macOS

- `hyperkit … -s $pciSlot,virtio-sock,guest_cid=3,path=~/.hyperkit`
- vsock communication will happen over the unix socket located at:

  `fmt.Sprintf(“~/.hyperkit/%08x.%08x”, cid, port)`
- If using port `1234` with cid 3: `~/.hyperkit/00000003.000004d2`

macOS



```go
package main

import (
    "fmt"
    "net"
    "path/filepath"
)

func Listen(cid, port int) (net.Listener, error) {
    hyperkitStateDir := "/Users/teuf/.hyperkit"
    vsockSocket := fmt.Sprintf("%08x.%08x", cid, port)

    return net.Listen("unix", filepath.Join(hyperkitStateDir, vsockSocket))
}
```

Windows

- Uses the `hf_vsock` kernel module in the linux VM
- Communication goes over the native Hyper-V VMBus
- The go code running on the Windows host uses https://github.com/linuxkit/virtsock/tree/master/pkg/hvsock
- This package provides `net.Conn` and `net.Listener` implementations for Hyper-V Sockets

Red Hat

Windows

- vsock communication must be explicitly enabled in the registry
- `HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows NT\CurrentVersion\Virtualization\GuestCommunicationServices\` must contain a key named following the well-known GUID template `HV_GUID_VSOCK_TEMPLATE 00000000-FACB-11E6-BD58-64006A7986D3`
- https://docs.microsoft.com/en-us/virtualization/hyper-v-on-windows/user-guide/make-integration-service
- https://github.com/tpn/winsdk-10/blob/9b69fd26ac0c7d0b83d378dba01080e93349c2ed/Include/10.0.16299.0/shared/hvsocket.h#L123-L147

Windows

```go
package main

import (
    "net"

    "github.com/linuxkit/virtsock/pkg/hvsock"
)

func Listen() (net.Listener, error) {
    svcid, err := hvsock.GUIDFromString("00000400-FACB-11E6-BD58-64006A7986D3")
    if err != nil {
        return nil, err
    }
    return hvsock.Listen(hvsock.Addr{
        VMID:      hvsock.GUIDWildcard,
        ServiceID: svcid,
    })
}
```

Going even further...

- Using systemd socket activation together with vsock
- Using vsock with a 4th hypervisor, macOS native virtualization framework
  - M1 support!
- Running Podman containers on macOS and Windows

Useful links

- CodeReady Containers: https://github.com/code-ready/crc/
- gvisor-tap-vsock: https://github.com/containers/gvisor-tap-vsock
- Contact information: cfergeau@redhat.com

Red Hat

Thank you

Red Hat is the world's leading provider of enterprise open source software solutions. Award-winning support, training, and consulting services make Red Hat a trusted adviser to the Fortune 500.

linkedin.com/company/red-hat

youtube.com/user/RedHatVideos

facebook.com/redhatinc

twitter.com/RedHat