TNE30019/TNE80014 – Unix for Telecommunications

Building a FreeBSD Router

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Outline

- What is a router
- Why configure a Unix system as router
- How to configure a FreeBSD router
- Configuring entries in routing table

Routers

- Route packets in IP network (network layer)
- Decisions made on destination IP address (not MAC address)
- Uses routing table instead of list of known MAC addresses
  - Routing Information Base (RIB): all routes learned
  - Forward Information Base (FIB): out interfaces for destinations

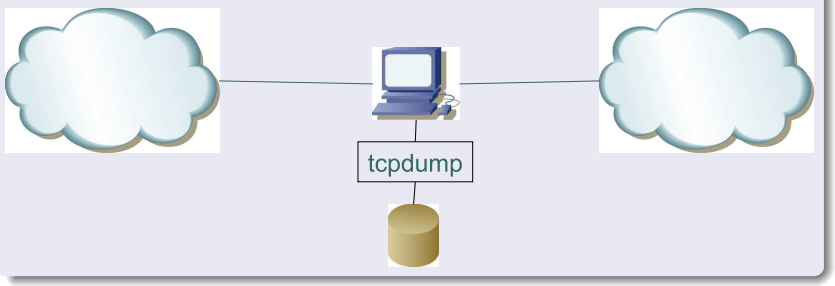
For each IP packet received

1. Check destination IP
2. If for local host, pass to kernel local-in handler → application
3. If not, determine correct next hop based on routing table
4. Forward Packet

- Low-performance routers are cheaper than PCs
- High-performance routers expensive, but much faster than PCs
- Why would we use PC for routing?

Why Unix Routers

Can monitor and manipulate passing network traffic traffic



- Simple means of providing monitoring point in network
- Can simulate different network conditions
  - Delays
  - Rate limiting
  - Packet loss
- IP rule-based firewall
- IP traffic shaping and prioritisation

Building FreeBSD Router

- All Unix systems already contain necessary code to be router
  - Support for multiple network interfaces
  - Support for different IP network configuration on each interface
  - Routing table to decide which interface to output packets to
  - Routing protocol implementations (may be optional packages)
- By default, kernel will **NOT** route packets between interfaces
  - Why?

FreeBSD – Enabling Routing

- Need to turn it on
- `sysctl` variable
  - `net.inet.ip.forwarding=1`

Alternatively enable in `/etc/rc.conf`

`gateway_enable=‘‘YES’’`

- When `/etc/rc.d/routing` script is run, the `net.inet.ip.forwarding` variable is set to **1**

Router Configuration

- Need to manage routing tables
  - Can be **statically** configured
  - Can be **dynamically** updated using routing protocols

FreeBSD – Static Routes

- Adding Routes with `route`
- See `man route`
- Displaying routing table with `netstat -nr`

FreeBSD – Routing Protocols

- `routed` is standard BSD routing daemon (RIP v1/2)
- Zebra (`/usr/ports/net/zebra`) is a routing service that supports RIP, OSPF and BGP

Routing Table Example

```
> netstat -nr
Routing tables

Internet:
Destination        Gateway            Flags     Refs      Use  Netif Expire
default            136.186.229.1      UGS          0 88317114    em0
127.0.0.1          link#11            UH           0   202212    lo0
136.186.229.0/24   link#5             U            0  7024213    em0
136.186.229.217    link#5             UHS          0        0    lo0
```

Static Routes Example

- Interface **if0** (**192.168.0.2, gateway 192.168.0.1**)
- Interface **if1** (**192.168.1.2, gateway 192.168.1.1**)
- Want to add new routes
  - Networks **192.168.2.*** can be reached via **192.168.0.1**
  - Networks **192.168.3.*** and **192.168.4.*** can be reached via **192.168.1.1**

route Commands

```
route add -net 192.168.2.0/24 192.168.0.1
route add -net 192.168.3.0/24 192.168.1.1
route add -net 192.168.4.0/24 192.168.1.1
```

- But routes disappear when system is rebooted

Permanent Static Routes Example

/etc/rc.conf

```
static_routes=‘‘net2 net3 net4’’
route_net2=‘‘-net 192.168.2.0/24 192.168.0.1’’
route_net3=‘‘-net 192.168.3.0/24 192.168.1.1’’
route_net4=‘‘-net 192.168.4.0/24 192.168.1.1’’
```

- **rc** scripts will
  1. Read `static_routes` variable
  2. Loop through all corresponding `route_*` variables
  3. Add configured routes to routing table

Routing Table With User Static Routes Example

```
> netstat -nr
Routing tables

Internet:
Destination        Gateway            Flags     Refs      Use  Netif Expire
default            136.186.229.1      UGS          0 88317114    em0
127.0.0.1          link#11            UH           0   202212    lo0
136.186.229.0/24   link#5             U            0  7024213    em0
136.186.229.217    link#5             UHS          0        0    lo0
192.168.2.0/24     192.168.0.1        UGS          0        0    em1
192.168.3.0/24     192.168.1.1        UGS          0        0    em2
192.168.4.0/24     192.168.1.1        UGS          0        0    em2
```


FreeBSD Dynamic Routing With RIP

- Need to enable `routed`
- For configuration options see `man routed`

Enable in /etc/rc.conf

```
router_enable=‘‘YES’’
```

- Can configure gateway parameters in `/etc/gateways`