Practical Network Defense

Master's degree in Cybersecurity 2024-25

Networking 101 lab

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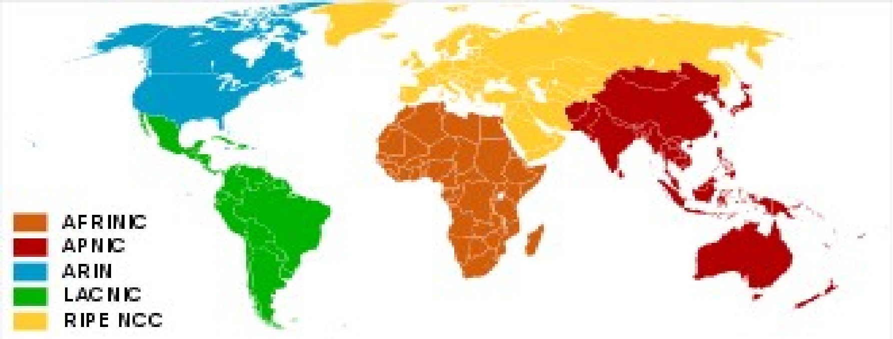
Main tasks

- Properly configure the topology provided in the lab packages
- Manual configuration
  - Via ip and via interfaces file
- Automatic configuration
  - Via DHCP
- Network debug
  - Fix configuration errors
- Reference link: https://www.debian.org/doc/manuals/debian-reference/ch05.en.html

Assigning IP addresses

- Blocks of public addresses are allocated by IANA (Internet Assigned Numbers Authority) and RIRs (regional Internet registries)
  - To companies, institutions, universities and so on
- Private addresses can be used by anyone
  - Manually
  - Automatically (via DHCP Dynamic Host Configuration Protocol)



To do the activities

- We will use Kathará (formerly known as netkit)
  - A container-based framework for experimenting computer networking: http://www.kathara.org/
- A virtual machine is made ready for you
  - https://drive.google.com/file/d/12w2wwdFo7jmokVxDWlUdpVWDgf4g8sRe/view
- For not-Cybersecurity students, please have a look at the Kathará official manuals
  - https://github.com/KatharaFramework/Kathara-Labs/tree/main/tutorials

The kathara_24 VM

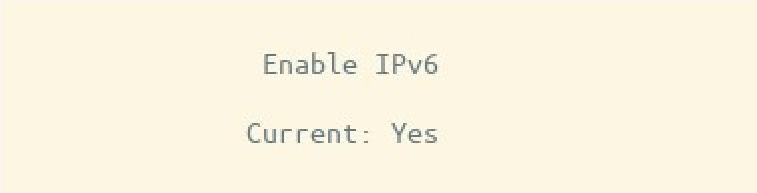
- It should work in both Virtualbox and VMware
- It should work in Linux, Windows and MacOS
- There are some alias (shortcuts) prepared for you
  - Check with **`alias`**
- All the exercises can be found in the git repository:
  - https://github.com/vitome/pnd-labs.git
- You can move in the directory and run lstart
  - **NOTE**: the first lstart attempt can (…will…) fail

Kathará main commands (aliases)

- All the commands should be used in the lab directory
- Start (restart) a lab exercise:
  - `lstart/lrestart`
- Stop a running lab exercise
  - `lclean`
- Wipe the kathara environment (when labs do not restart after a failure)
  - `kwipe`
- List virtual networks and virtual interfaces of VMs
  - `docker network list`

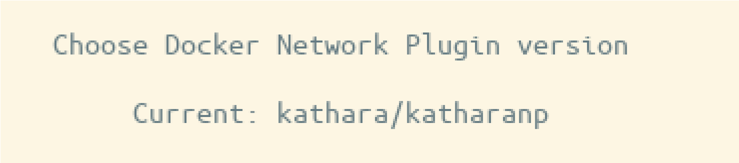
Katharà settings

- Change the default
  - `kathara settings`
- Enable Ipv6
  - It should be option 9
- Modify the default network driver
  - It should be option 10
  - Select kathara with Linux bridges



```
Enable IPv6

Current: Yes
```

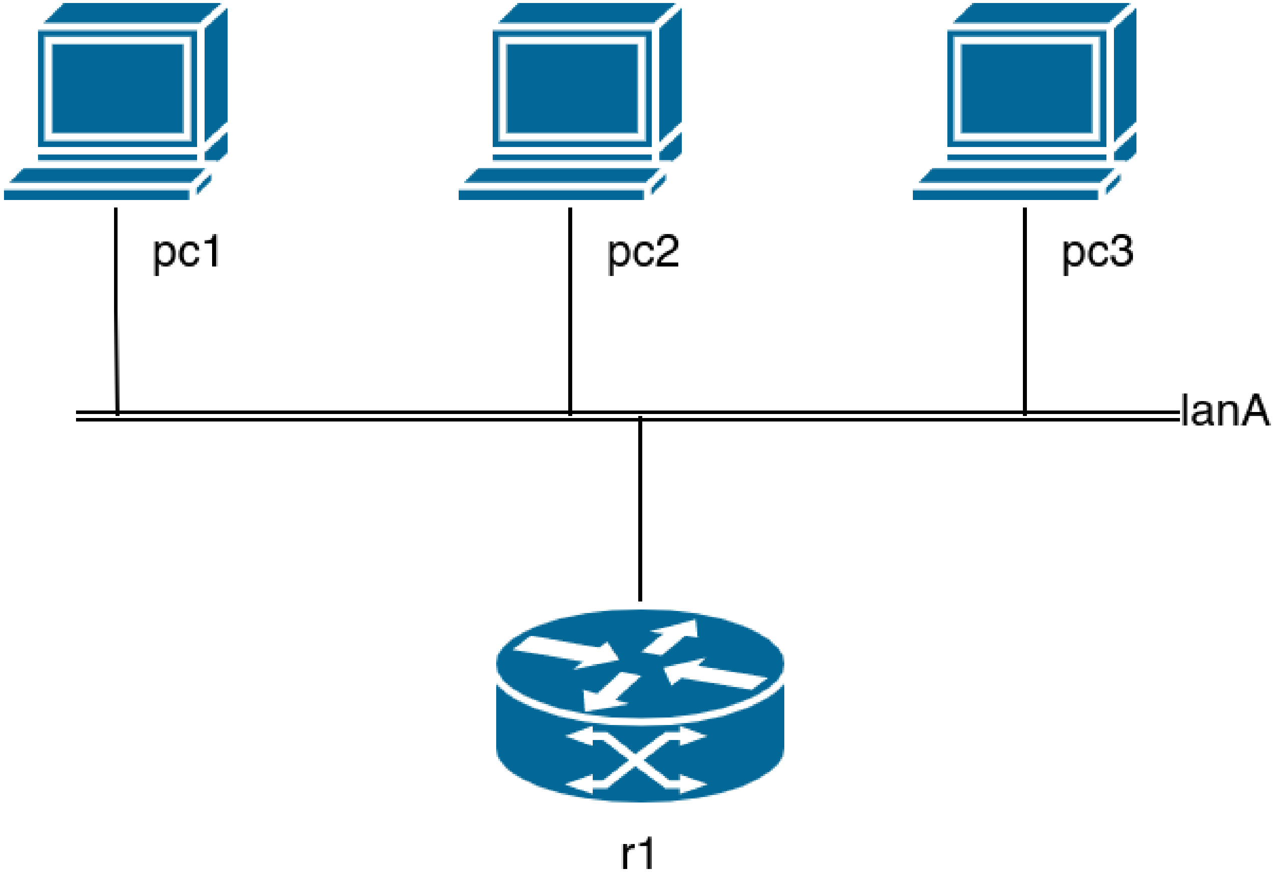


```
Choose Docker Network Plugin version

Current: kathara/katharanp
```

Lab activity: ex1

Exercise 1: pnd-labs/lab1/ex1 topology



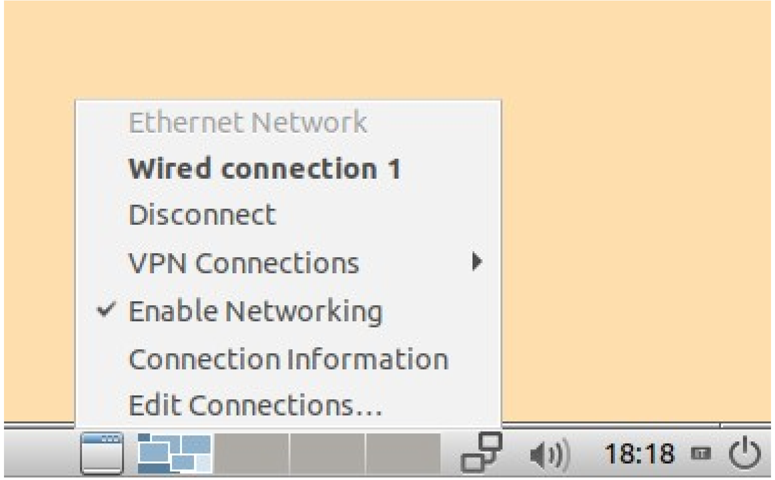
Exercise 1: pnd-labs/lab1/ex1

- Manually configure pc1, pc2 and pc3 in order to be in the same network than the r1 host, with IP **192.168.100.30/29**
  - Configure pc1 using the `interfaces` file
  - Configure pc2 using the `ip` command
  - Configure pc3 using the `ifconfig` command
- The DNS server can be the server used by the host machine
  - This should be used also in the `r1.startup` file
- The default gateway must be the r1 host (already configured)
- Verify connectivity within the network and with the Internet (ex: `wget www.google.com`)

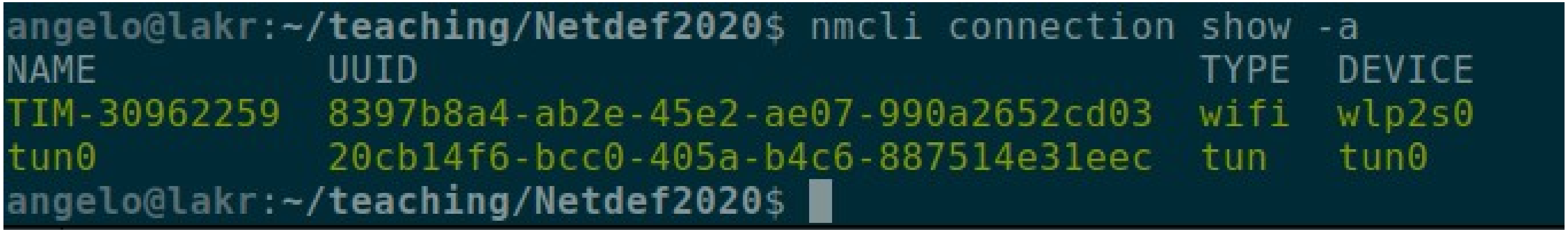
Properly configure a host

- In order to (properly) use Internet a host has to receive **4 main pieces** of information
  - The IP address
  - The netmask
  - The IP address of its default gateway
    - Namely the host of its local network able to access to the distribution layer
  - The IP address of a DNS (Domain Name Server)
    - Namely a remote host able to translate human intelligible names to IP addresses

Systems with a GUI



- Use the related tool
- Most used one: network-manager
  - Counterpart from command line: nmcli



```
angelo@lakr:~/teaching/Netdef2020$ nmcli connection show -a
NAME          UUID                                  TYPE  DEVICE
TIM-30962259  8397b8a4-ab2e-45e2-ae07-990a2652cd03  wifi  wlp2s0
tun0          20cb14f6-bcc0-405a-b4c6-887514e31eec  tun   tun0
angelo@lakr:~/teaching/Netdef2020$ 
```

- Quite extensible with plugins
  - Example: for managing additional VPN types

Manual configuration via interfaces file

- Generally located in **`/etc/network/interfaces`**
- Usually you can insert additional configuration files in the **`/etc/network/interfaces.d/`** directory
  - Ex: **`/etc/network/interfaces.d/eth0`**
- After the modifications, use the **`ifup/ifdown`** commands

Example for eth0 manual setup

```
auto eth0
iface eth0 inet static
    address 192.0.2.7/24
    gateway 192.0.2.254
    dns-nameservers 1.1.1.1 8.8.8.8
```

Example for eth0 DHCP

```
auto eth0

allow-hotplug eth0

iface eth0 inet dhcp
```

Warning: since kathara is based on docker, the ifup command will not change the /etc/resolv.conf file and you have to do it manually

Manual network configuration (linux) (old school – legacy)

- **ifconfig** to assign the IP address
  - This command is used to configure network interfaces, or to display their current configuration. In addition to activating and deactivating interfaces with the “up” and “down” settings
- **route** to define the default gateway
  - The route command is the tool used to display or modify the routing table
- **/etc/resolv.conf** to specify the DNS server(s)
  - Insert a line like “**`nameserver 8.8.8.8`**”

Manual network configuration using ip (preferred)

- **ip addr** to assign the IP address
  - This command is used to configure network interfaces, or to display their current configuration. In addition to activating and deactivating interfaces with the “up” and “down” settings
- **ip route** to define the default gateway
  - The route command is the tool used to display or modify the routing table
- **/etc/resolv.conf** to specify the DNS server(s)
  - Insert a line like “**`nameserver 8.8.8.8`**”

Other details about ip command

- Show interfaces

  -
    ```
    ip link show
    ```
- Bringing interface up/down

  -
    ```
    ip link set eth0 (up|down)
    ```
- Set MAC address

  -
    ```
    ip link set eth0 address 00:11:22:33:44:55
    ```
- Show IP address

  -
    ```
    ip address show [dev eth0]
    ```
- Add/remove IP address

  -
    ```
    ip address (add|del) 10.0.0.1/8 dev eth0
    ```
- Flush any IP address (remove the assigned address/es)

  -
    ```
    ip address flush [dev eth0]
    ```

ip for routing purposes

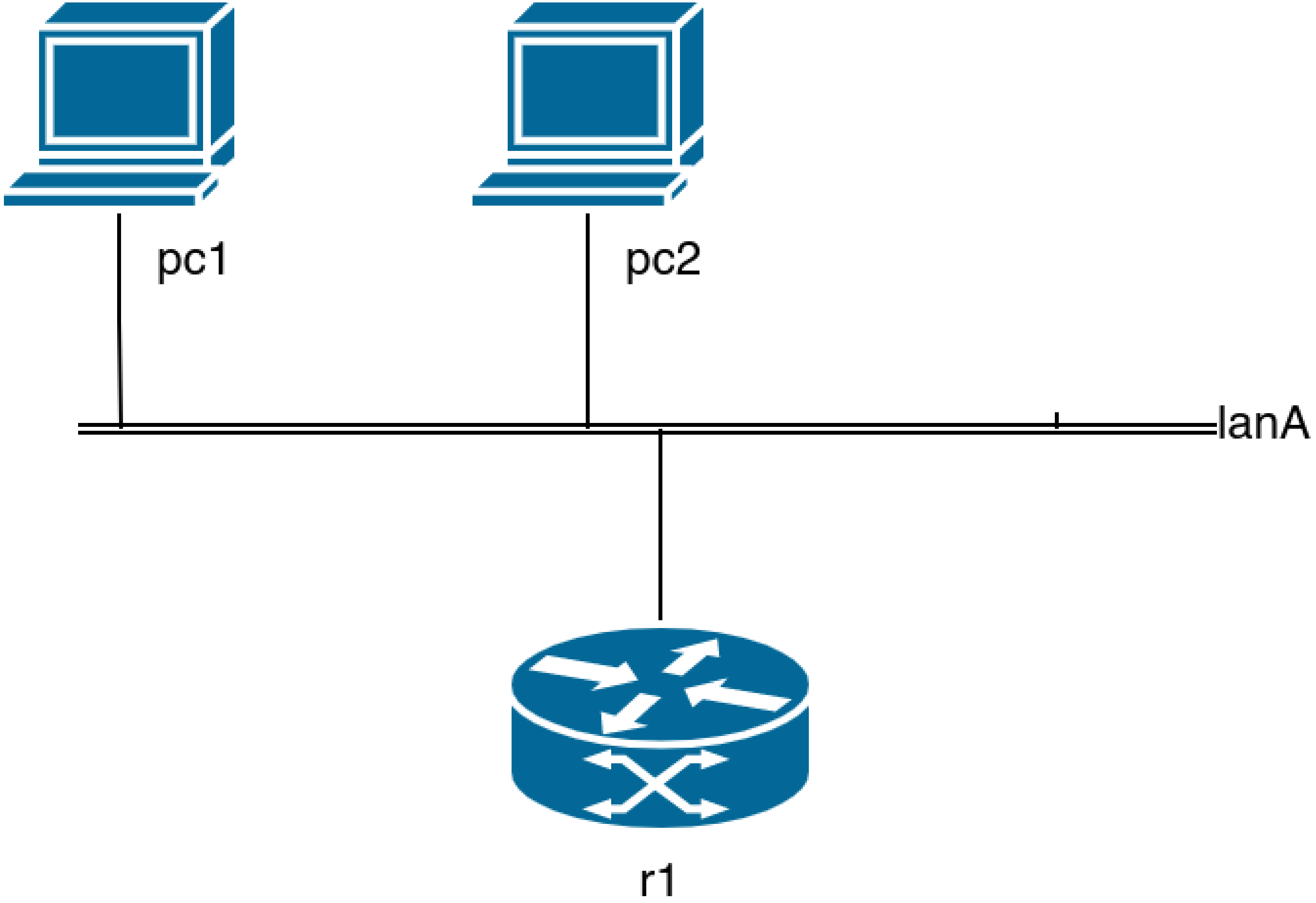
- List/flush routing table
  - `ip route (list|flush)`
- Add/del routes
  - next hop
    - `ip route (add|del) 10.0.0.0/8 via 10.0.0.1`
  - default
    - `ip route (add|del) default via 10.0.0.1`
  - direct forwarding
    - `ip route (add|del) 10.0.0.0/24 dev eth0`

ip for ARP and more

- Show ARP cache
  - `ip neigh show [dev eth0]`
- Flush ARP cache
  - `ip neigh flush dev eth0`
- Add/del/change/replace ARP cache entry
  - `ip neigh (add|del|change|replace) to 10.0.0.2 lladdr 00:11:22:33:44:55 dev eth0 nud “state_name”`
    - (state_name: permanent, stale, noarp, reachable…)
- IP tunneling (IPinIP, IPinGRE, IPv6 tunneling)
  - `ip tunnel`

Lab activity: ex2

Exercise 1: pnd-labs/lab1/ex2 topology



Exercise 2: pnd-labs/lab1/ex2

- Configure r1, pc1 and pc2 in order to receive their networking configuration from a DHCP server (r1)
  - The DNS server can be the server used by the host machine
  - The default gateway must be the r1 machine, with IP address 192.168.100.30/29
- Configure r1 in order to operate as a DHCP server on the eth0 interface
  - You can install **udhcpd** or any other server
    - (apt install udhcpd)
- Configure pc1 using the **`interfaces`** file
- Configure pc2 using the **`dhclient`** command (after run)
- Verify connectivity within the network and with the Internet (ex: ping www.google.com)

DHCP

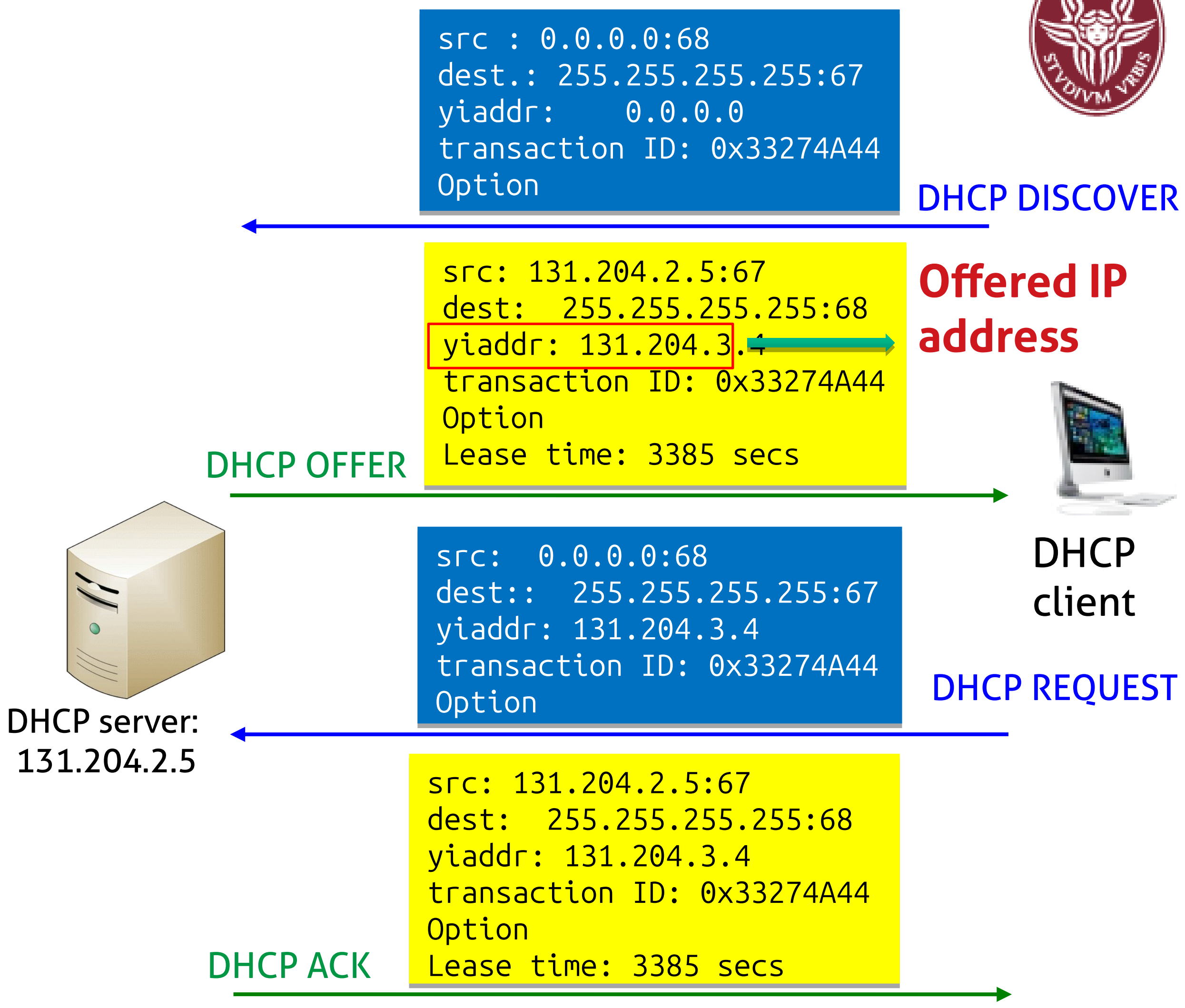
- Client-server mechanism
- Server has a pool of IP addresses to distribute, together with the network configuration
- Client requesting a new IP address receive a proposal and accept it
- Once accepted, the IP is reserved for a "leasing time"
- Observations?

DHCP Client/Server

DHCP procedure:

1. Host broadcasts "DHCP Discover"
2. DHCP server responds with "DHCP Offer"
3. Host requests IP address: "DHCP Request"
4. DHCP server sends address: "DHCP ACK"

yiaddr: (offered) your IP address



DHCP DISCOVER

```
src : 0.0.0.0:68
dest.: 255.255.255.255:67
yiaddr:    0.0.0.0
transaction ID: 0x33274A44
Option
```

DHCP OFFER

```
src: 131.204.2.5:67
dest:  255.255.255.255:68
yiaddr: 131.204.3.4
transaction ID: 0x33274A44
Option
Lease time: 3385 secs
```

Offered IP address

DHCP REQUEST

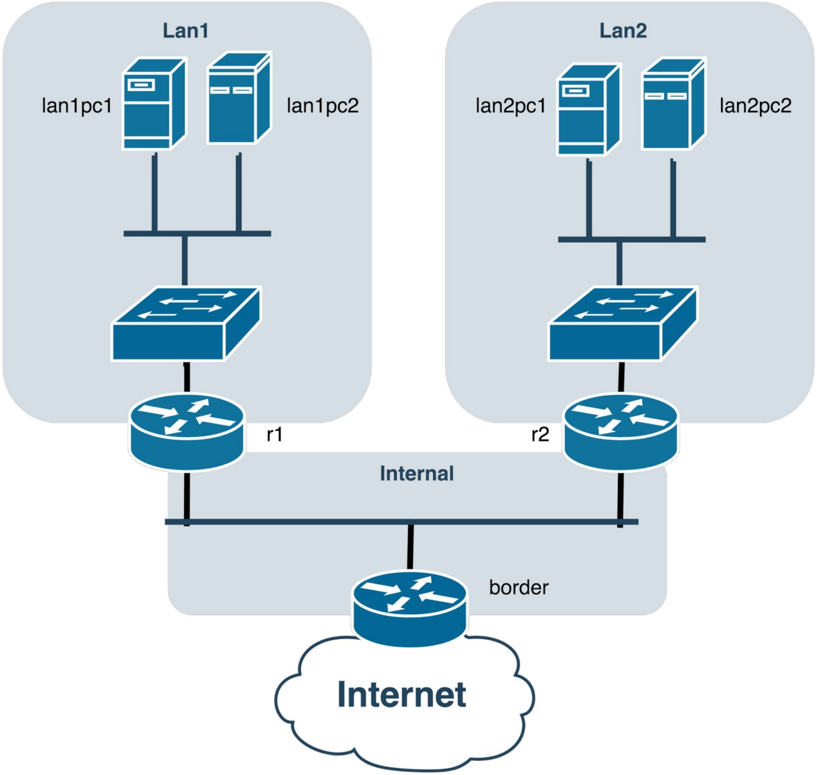
```
src:  0.0.0.0:68
dest::  255.255.255.255:67
yiaddr: 131.204.3.4
transaction ID: 0x33274A44
Option
```

DHCP ACK

```
src: 131.204.2.5:67
dest:  255.255.255.255:68
yiaddr: 131.204.3.4
transaction ID: 0x33274A44
Option
Lease time: 3385 secs
```

Lab activity: ex3

Exercise 3: pnd-labs/lab1/ex3



- The border r0 is already configured to act as the gateway.
- eth0 on r0 has not to be configured.
- PC from the two lans have to be able to reach each other and to reach internet

ex3 activity

- Configure the 4 pc and the three routers so that the two lans are reachable and all can reach the Internet
  - You have to use the 172.16.0.0/16 network and assign subnetworks to all the LANs in the topology. Think about the most suitable approach.
  - r0 has to be the default gateway of the whole network. It is already set up to act as the default gateway. It is connected to the internet via eth0.
  - r1 and r2 have to be the default gateways for "lan1" and "lan2", respectively. They have to have a default route towards r0 and static routes to reach lan1 or lan2
    - you can use the **ip route** command (man ip-route)
  - the DNS server can be the server used by the host machine (this has to be set in all the pcs of the lab)
  - the PCs can be configured as you prefer

That’s all for today

- Questions?