Ethics

Be Good!

Networking

IP Address

- A unique identification number to reach a computer in a network

- Assigned to a computer as part of network configuration

IP Address

#20, Street 3, City A   #45, Street 5, City B

"Hello!"

"Hello, back!"

10.0.4.57   10.0.49.27

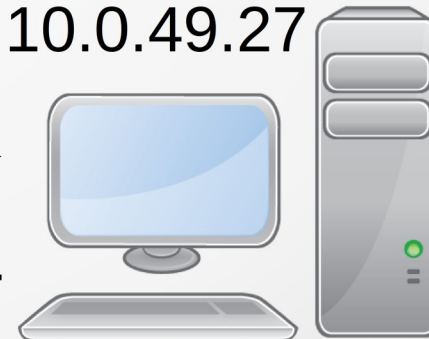"Hello!"

"Hello, back!"

IPv4 Addresses

- 32 bit (4 bytes) numbers

- Written using a dotted notation like 192.168.36.2

- Each part is a number from 0 to 255

- Hence the range is 0.0.0.0 to 255.255.255.255

IP Address

172 . 16 . 254 . 1

↓ ↓ ↓ ↓

10101100 . 00010000 . 11111110 . 00000001

1 Byte, 8 bits

4 Bytes, 32 bits

IPv6 Addresses

- 128 bit (16 bytes) numbers

- Has 2^{128} addresses and that's a big number

- Example: 2001:0db8:85a3:0000:0000:8a2e:0370:7334

Public vs Private IP Address

- Public addresses are unique across the Internet

- Private addresses are unique only in a private network

  - 192.168.0.0 to 192.168.255.255

  - 172.16.0.0 to 172.31.255.255

  - 10.0.0.0 to 10.255.255.255

IP Address Assignment

- Manually in network configuration (static)

- Dynamically assigned by a DHCP server

  - Dynamic Host Configuration Protocol

- Automatic configuration (Zeroconf, Local Link addresses)

Checking IP Address

```
kirk@ent:~$ ip addr list

...

2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500
qdisc pfifo_fast state UP group default qlen 1000
    link/ether 48:5b:39:67:e9:74 brd
ff:ff:ff:ff:ff:ff
    inet 192.168.0.10/24 brd 192.168.0.255 scope
global eth0
       valid_lft forever preferred_lft forever
    inet6 fe80::4a5b:39ff:fe67:e974/64 scope link
       valid_lft forever preferred_lft forever
```
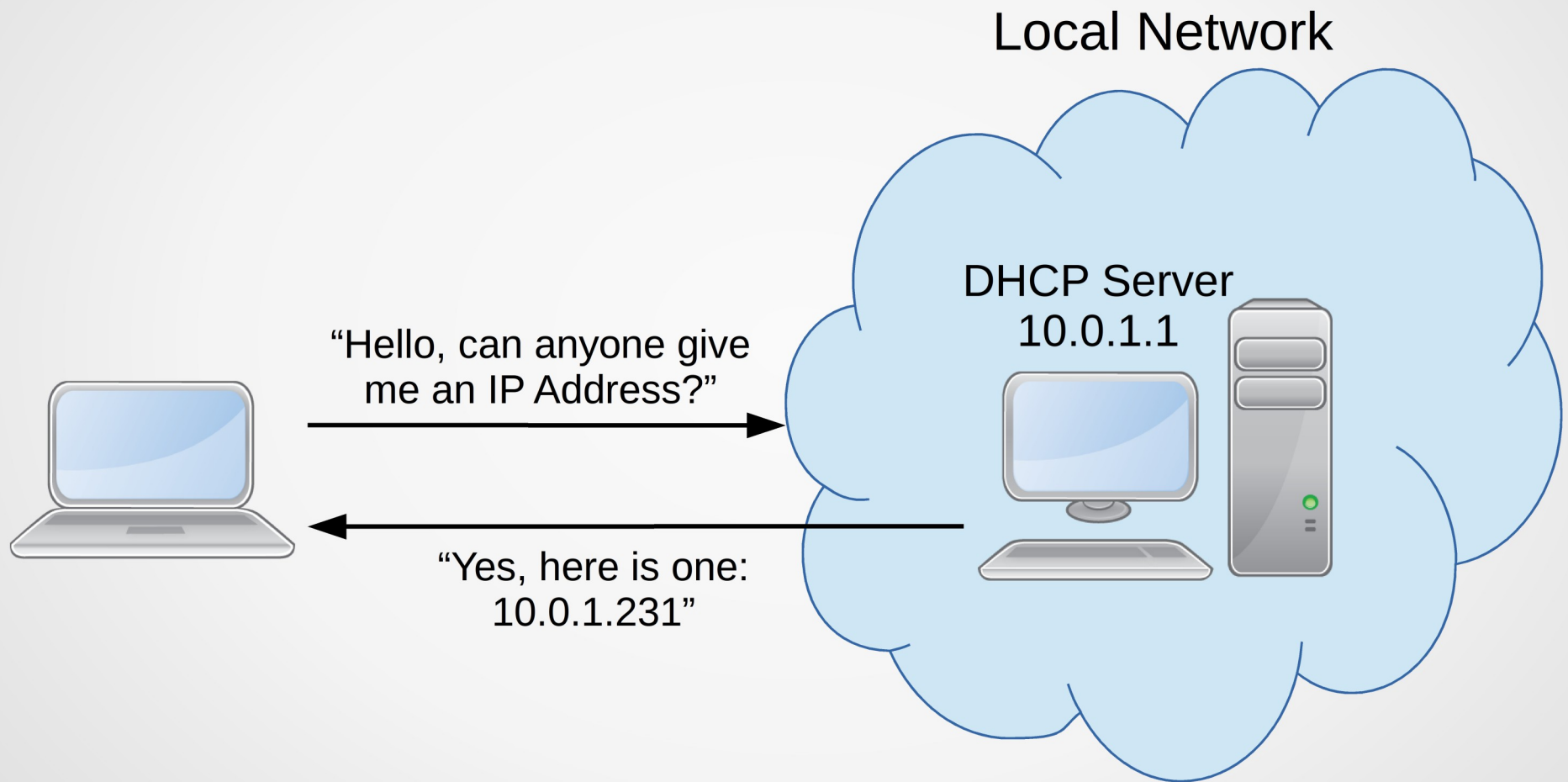
DHCP

Local Network

DHCP Server
10.0.1.1

"Hello, can anyone give
me an IP Address?"
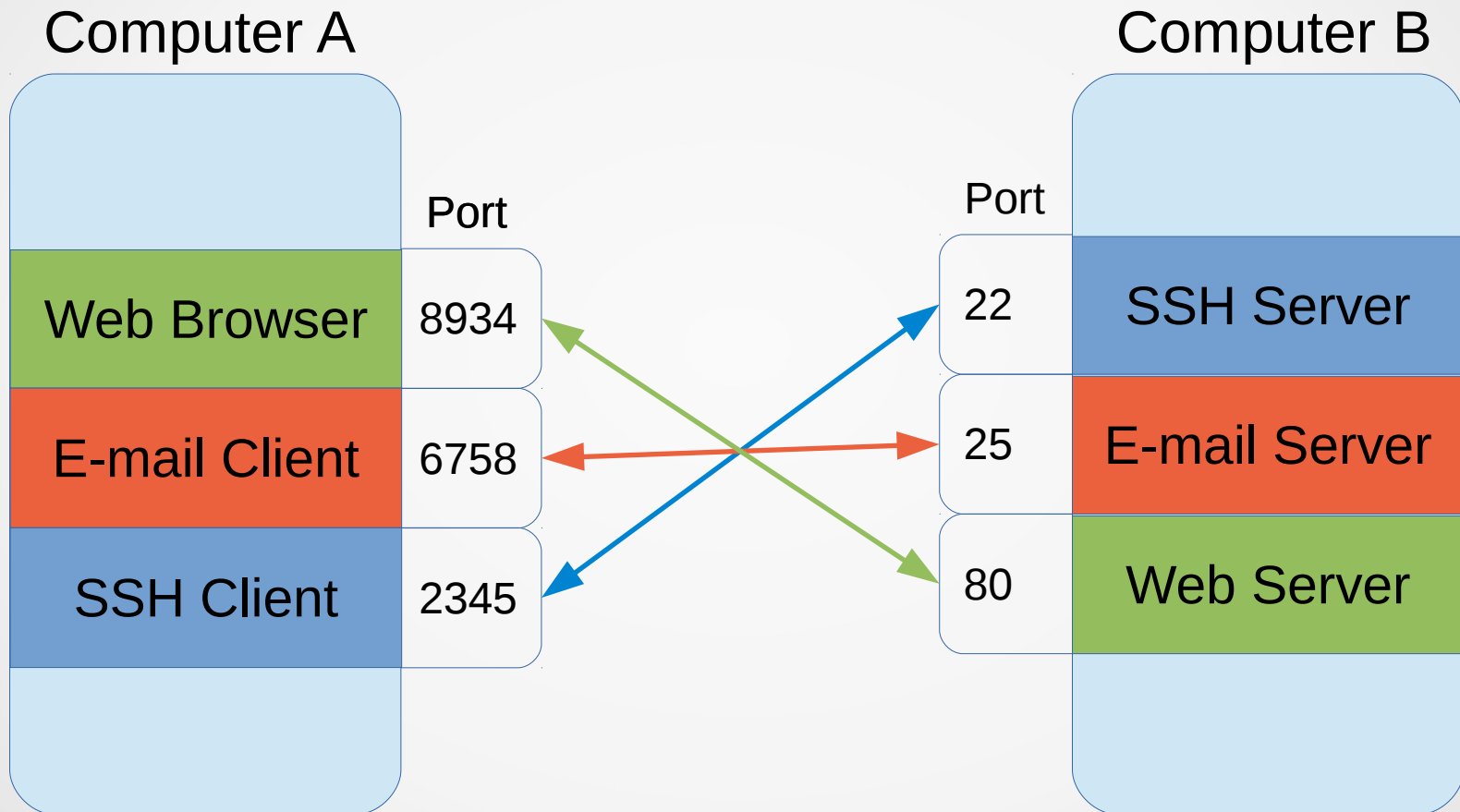
"Yes, here is one:
10.0.1.231"

Ports

- Multiple applications on a computer can access network

- Port is a unique number identifying a networking application/process

Ports

Ports

- Servers *listen* on pre-defined, well known ports
  - 22 – SSH (Secure Shell)
  - 25 – SMTP (Mail delivery)
  - 80 – HTTP (World Wide Web)
  - 443 – HTTPS (World Wide Web, secure)
- Clients use a random port on connection
- Up to 64k ports are available on a machine

Checking Current Connections

```
kirk@ent:~$ netstat -np

Active Internet connections (w/o servers)

Proto Local Address        Foreign Address  State        PID/...

tcp    192.168.0.10:38123 192.168.0.12:22   ESTABLISHED 4531/ssh
```

Checking Listening Ports

```
kirk@ent:~$ netstat -nlp

Proto Local Address      Foreign Address    State      PID/Program name

tcp   0.0.0.0:22          0.0.0.0:*          LISTEN     1932/sshd

tcp6  :::22               :::*               LISTEN     1932/sshd

tcp6  :::80               :::*               LISTEN     2704/apache2
```

MAC Address

- Unique address given to every network device

- Given during device manufacturing

- At the data link layer (lower level than IP address)

- ip addr list output contains MAC address also

Route

- Sending data to a machine that can't be reached directly
- Machine A route: reach machines in Network 2 via Machine B
- Machine C route: reach machines in Network 1 via Machine B
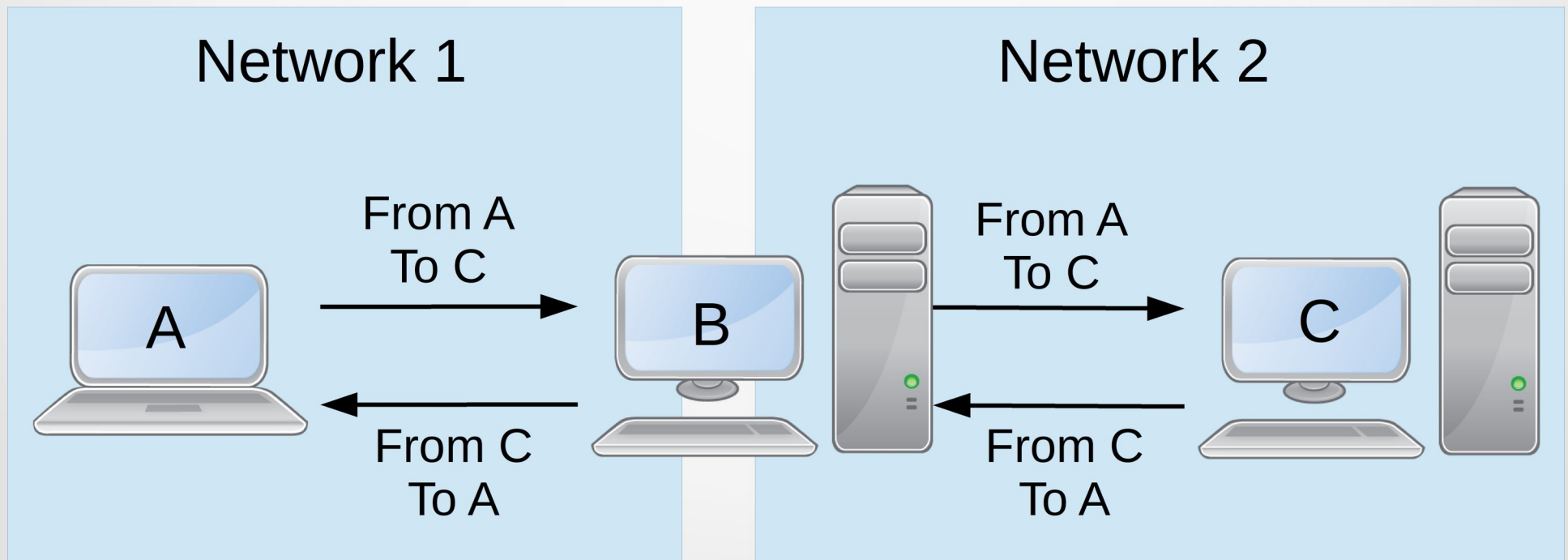
Route
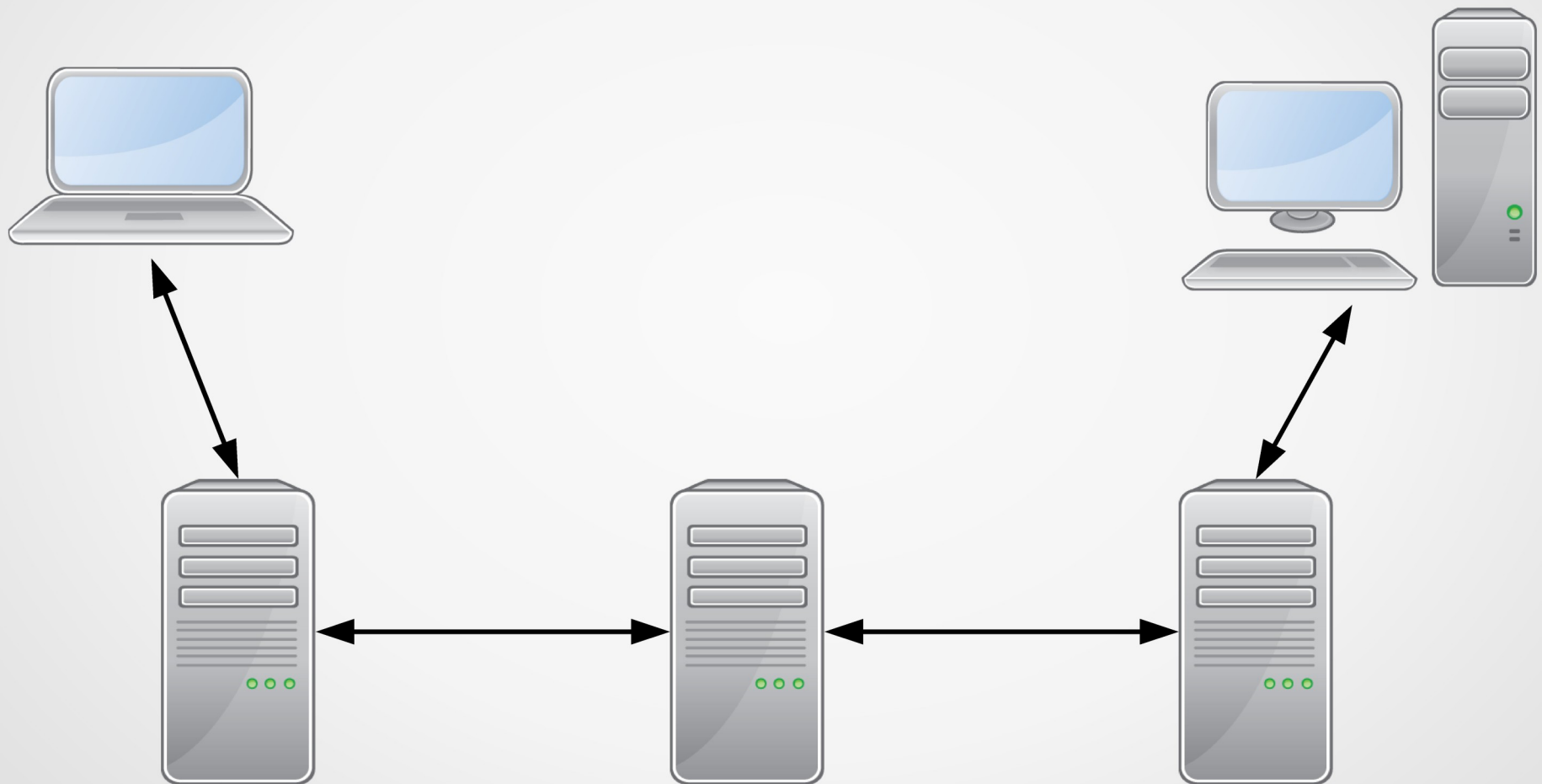
Route

- Route is the description of how to a reach a particular destination

- Multiple hops are possible

- Default route is a target network machine where all packets are sent if

  - They are not immediate peers

  - They don't have any other explicit route

Listing Routes

```
kirk@ent:~$ ip route list

default via 192.168.0.1 dev wlan0  proto
static   metric 1024


169.254.0.0/16 dev wlan0   scope link   metric
1000


192.168.0.0/24 dev wlan0   proto kernel   scope
link   src 192.168.0.2
```

Tracing Routes

```
kirk@ent:~$ traceroute google.com

traceroute to google.com (74.125.236.36), 30 hops
max, 60 byte packets
 1  192.168.0.1 (192.168.0.1)  1.632 ms  3.299 ms
4.004 ms

 2  ras.beamtele.net (183.83.0.1)  23.812 ms
24.089 ms  24.399 ms

...

 7  209.85.241.33 (209.85.241.33)  22.634 ms
21.521 ms  25.409 ms

 8  maa03s04-in-f4.1e100.net (74.125.236.36)
24.431 ms  27.817 ms  29.621 ms
```
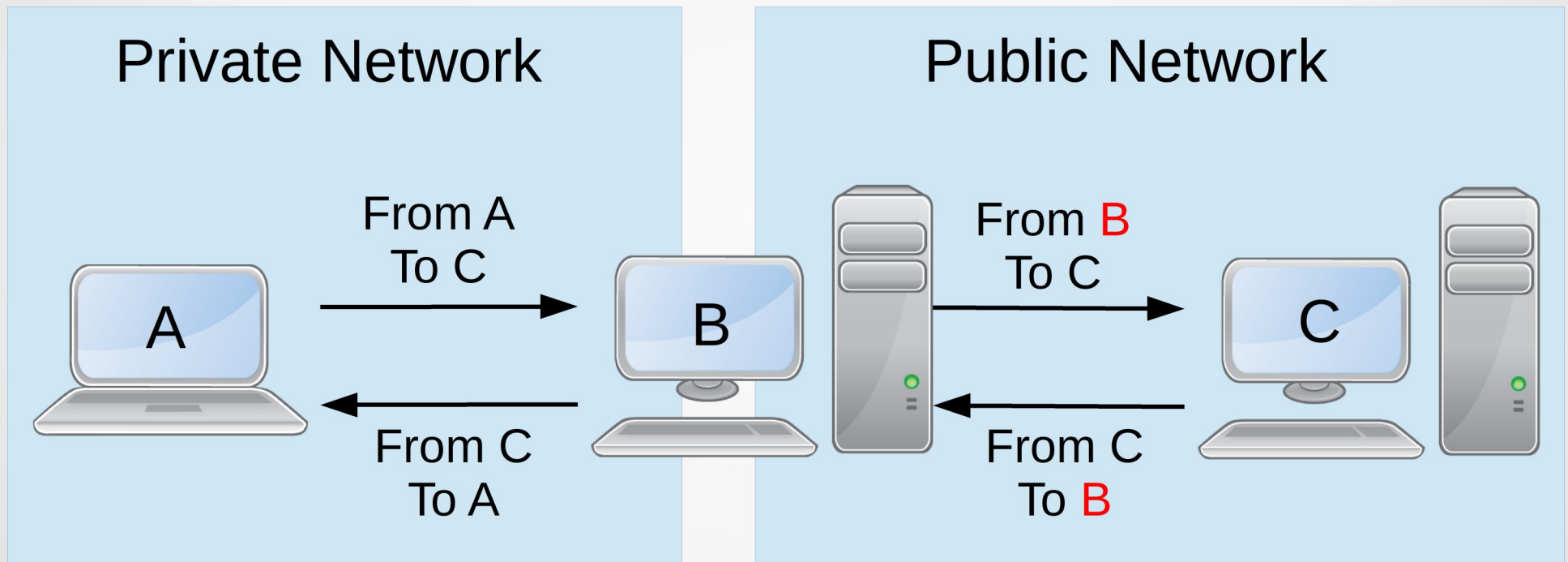
Network Address Translation

- Private computers can contact public computers

- Via intermediary which is connected to private network and public network

- Similar to routing but IP address translation is involved

Network Address Translation

Private Network

Public Network

From A
To C
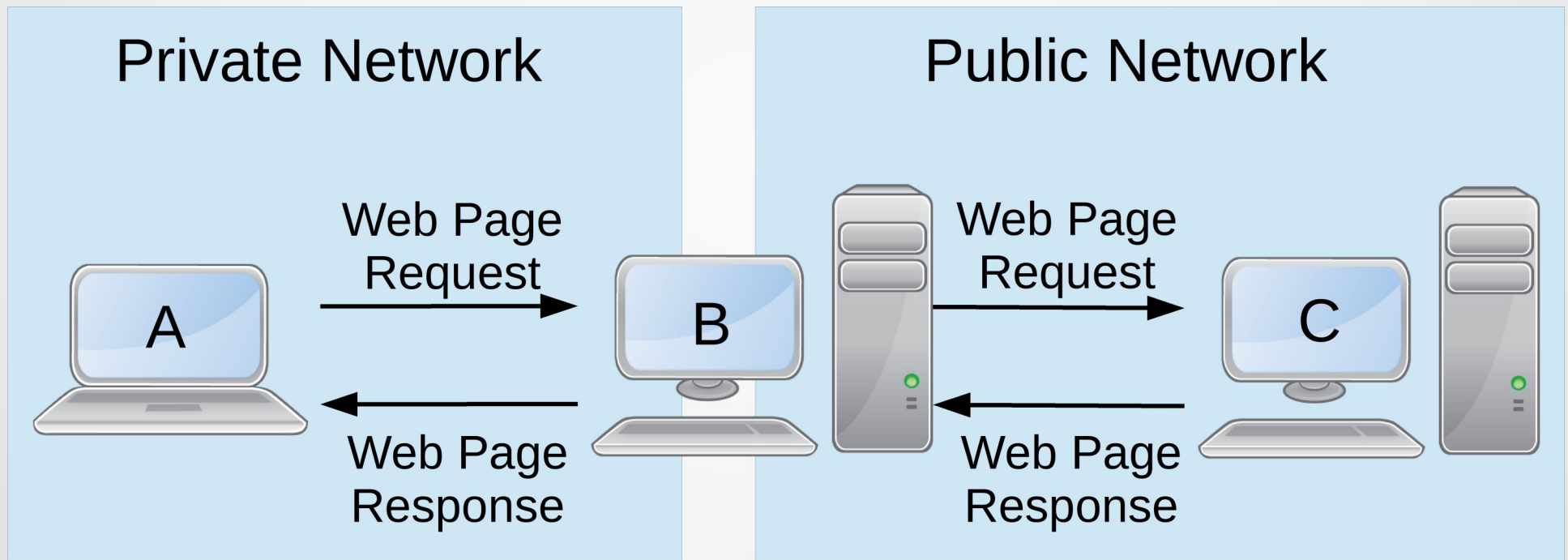
From C
To A

From B
To C

From C
To B

Proxy Server

- Typically HTTP
- Forwards requests from a client to destination
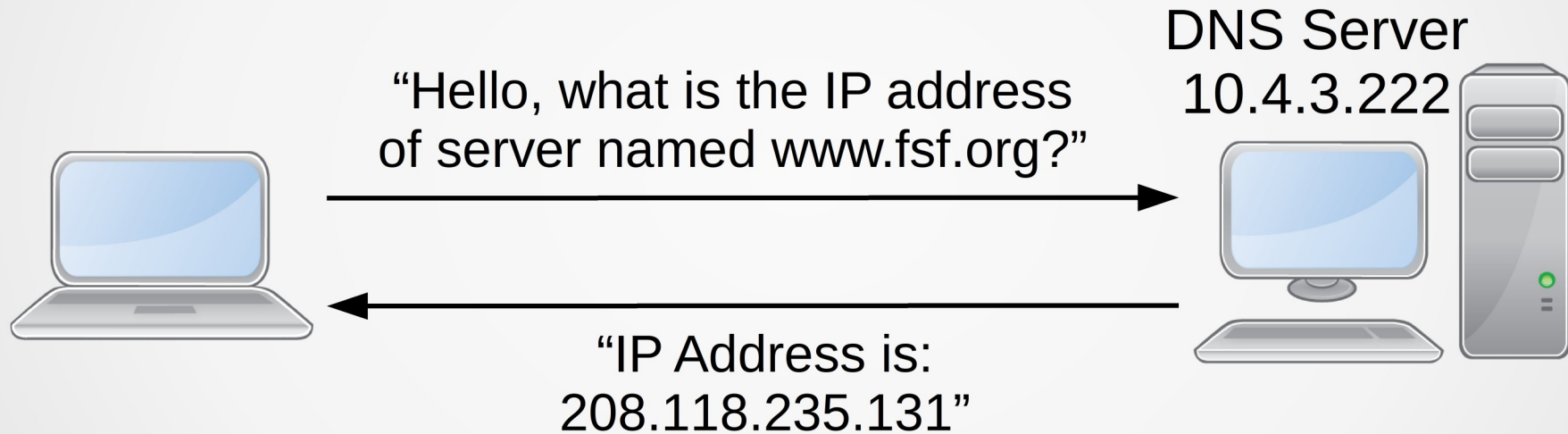- Caches content
- SOCKS proxy can forward any TCP protocol

Proxy Server

- Proxy server is B

DNS Server

- Resolve names into IP addresses

DNS Server
10.4.3.222

"Hello, what is the IP address
of server named www.fsf.org?"

"IP Address is:
208.118.235.131"

Resolving Domain Names

```
kirk@ent:~$ host -a www.fsf.org

Trying "www.fsf.org"

;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 9940

;; flags: qr rd ra; QUERY: 1, ANSWER: 2, AUTHORITY: 0,
ADDITIONAL: 0

;; QUESTION SECTION:

;www.fsf.org.    IN ANY

;; ANSWER SECTION:

www.fsf.org.  299  IN  AAAA  2001:4830:134:4::a

www.fsf.org.  299  IN  A     208.118.235.131

Received 73 bytes from 192.168.0.1#53 in 4 ms
```

References

- Computer Networks (4th Edition) by Andrew S. Tanenbaum (ISBN-13: 007-6092022473)

- Wikipedia Book on Computer Networking: https://en.wikipedia.org/wiki/Book:Computer_Networking