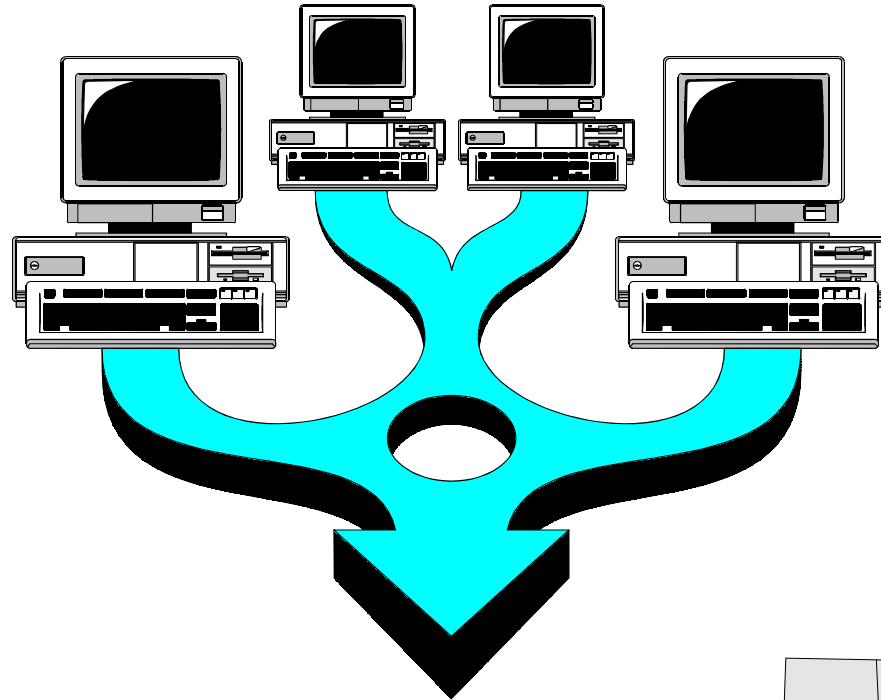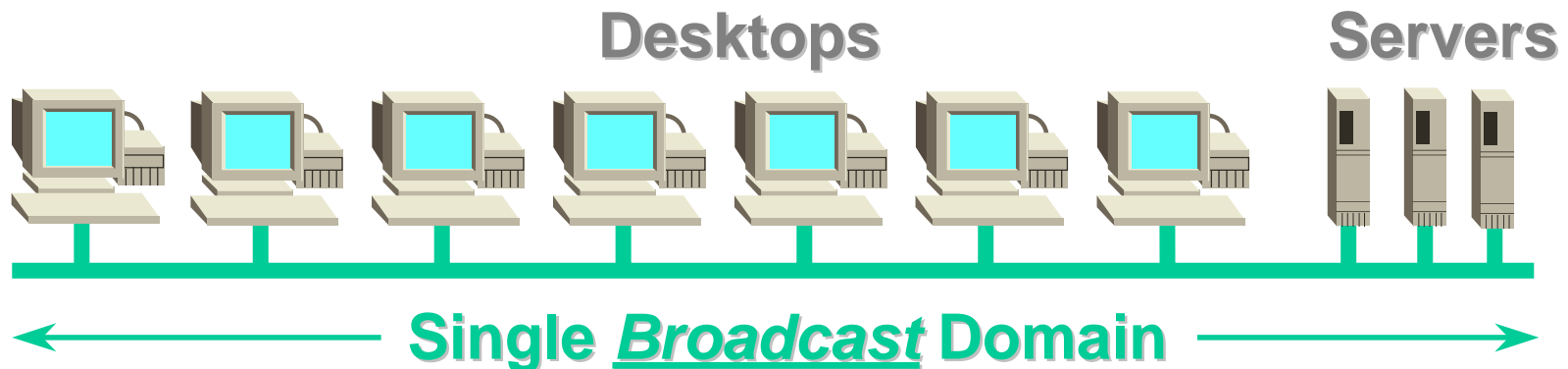# Routing

Ethernet LAN

A shared medium network that interconnects attached nodes by broadcasting a frame transmitted by one attached node to all other attached nodes. Each node individually decides whether to receive or discard the frame.

Desktops   Servers
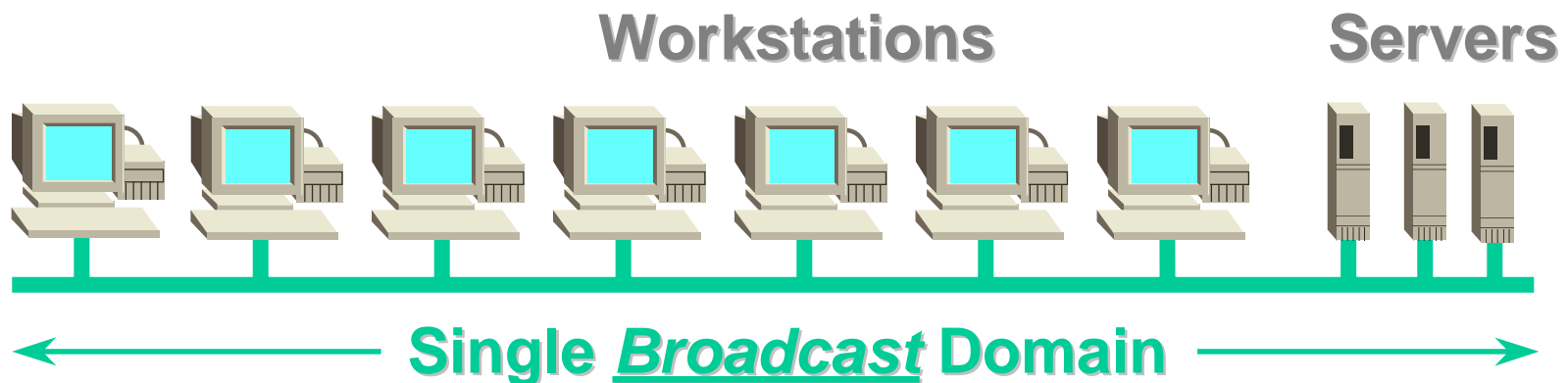
Single *Broadcast* Domain

Ethernet LAN Problems

A shared medium network requires all nodes to share the bandwidth of the physical link

A shared medium network limits effective utilization of the physical link. Ethernets traditionally achieved only 30%- 40% efficiency because all nodes were in a single collision domain.

Workstations   **Servers**
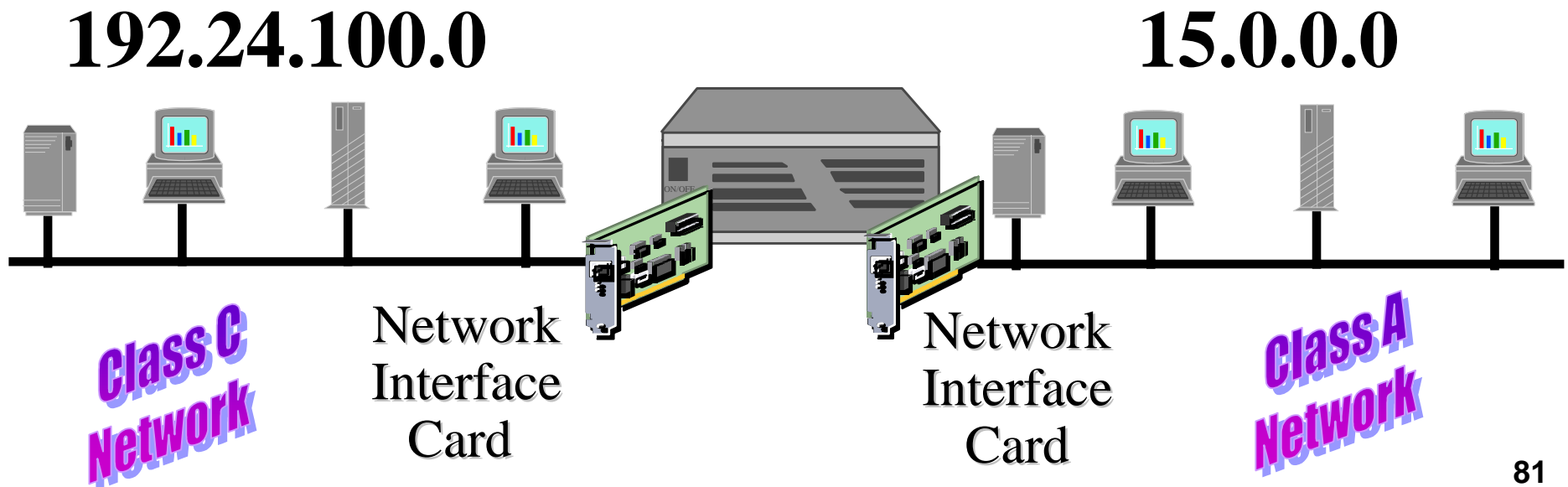
Single *Broadcast* Domain

Hub Definition

- **Hub sends packets out of all ports**
- **Single collision domain**
- **Single broadcast domain**
- **Appears as a single wire**

Network Interface Card

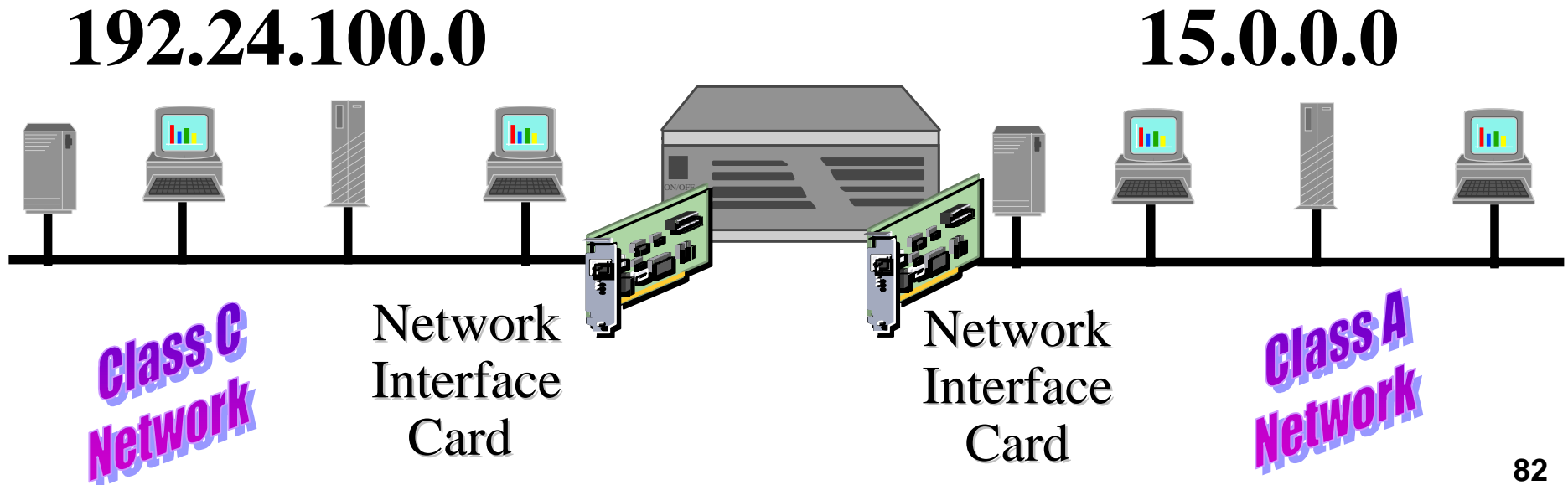Network Interface Card
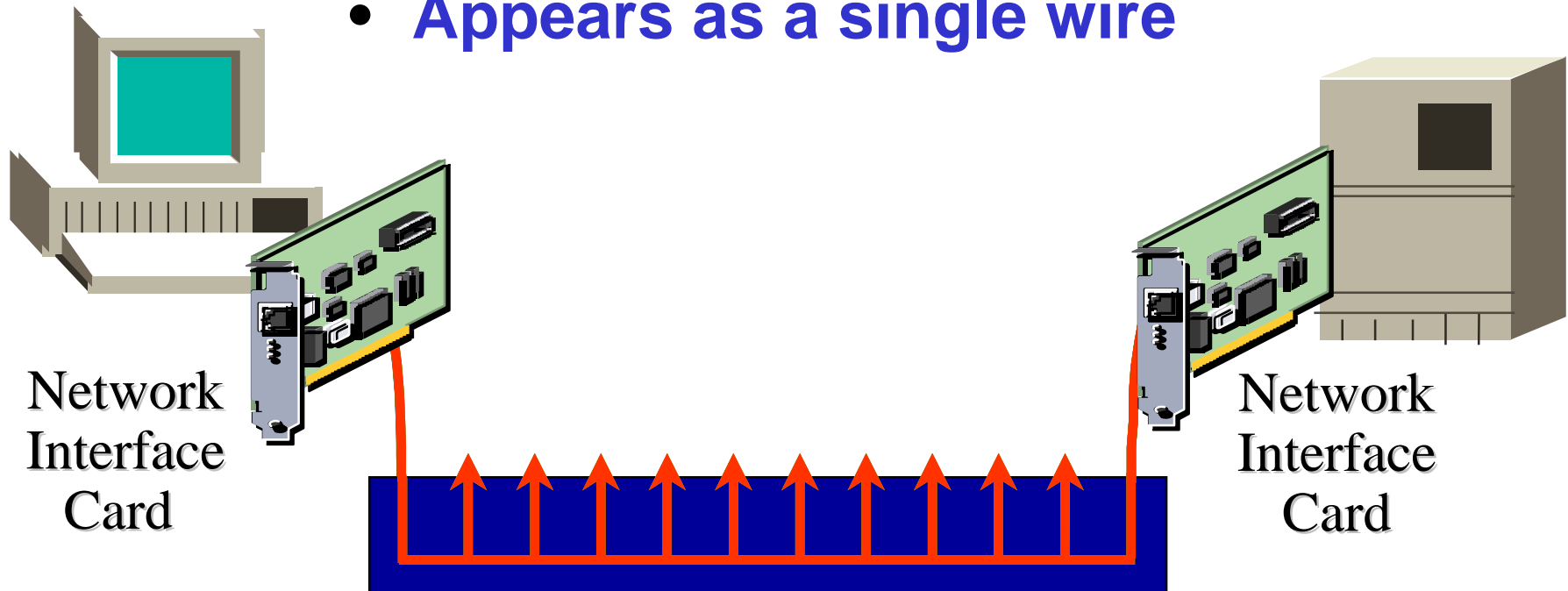
Implementing Subnetting

- **Use router to implement subnetworks**
- **Illustrated router subnetting example is an outdated implementation**
- **Router contains multiple LAN cards**

192.24.100.0

15.0.0.0

Class C Network

Network Interface Card

Network Interface Card

Class A Network

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Routing Concepts

- **Process of choosing a path over which to send a packet**
- **Only static routes presented**
- **Configure route to a host or network**

192.24.100.0   15.0.0.0

Class C Network   Network Interface Card   Network Interface Card   *Class A Network*
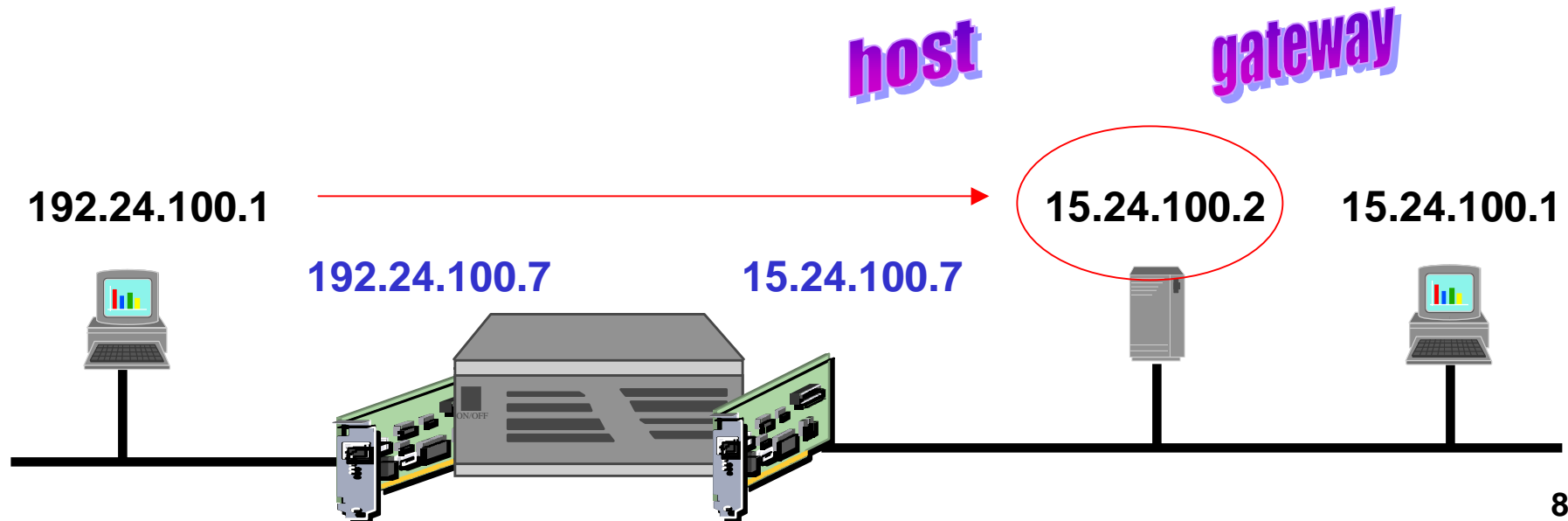
Routing By Host

- **Route packages from 192.24.100.1 to host 15.24.100.2**

- **Low usage since routing is generally based on networks**

/usr/sbin/route   add   host   15.24.100.2   192.24.100.7   1

host   gateway

192.24.100.1   15.24.100.2   15.24.100.1
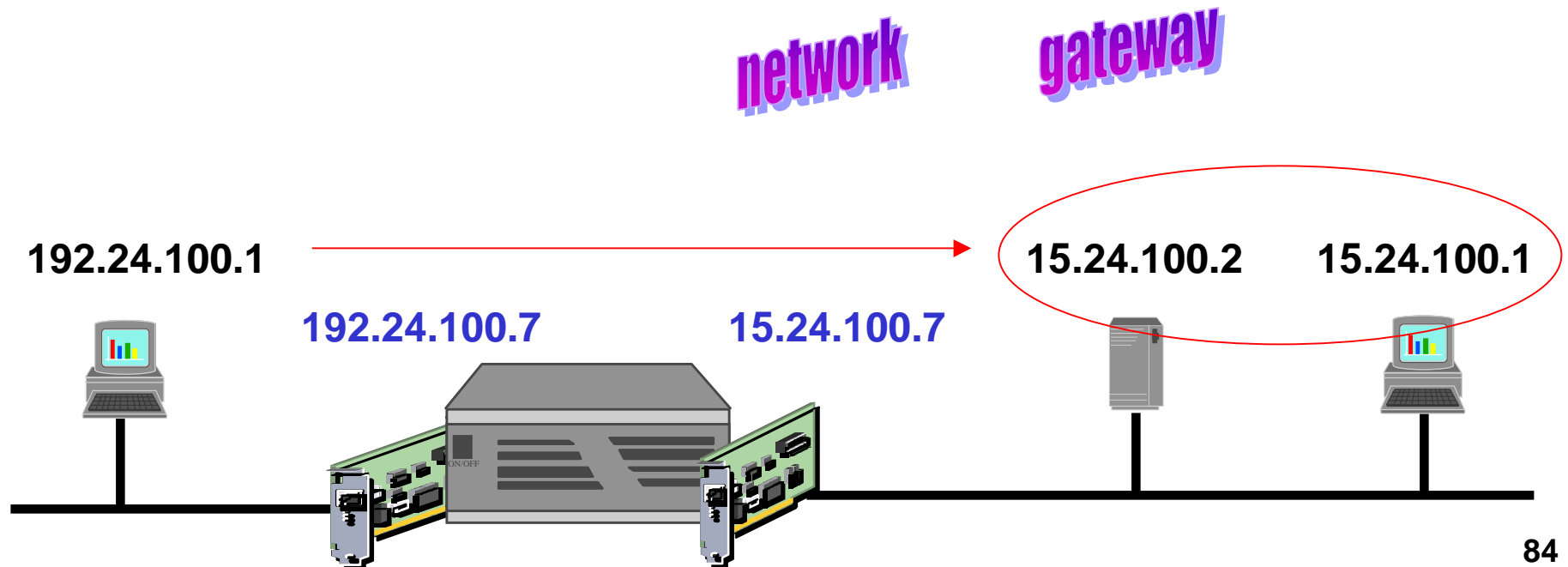
192.24.100.7   15.24.100.7

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Routing By Network

- **Route packages from 192.24.100.1 to network 15.0.0.0**

/usr/sbin/route   add   net   15   192.24.100.7   1

network   gateway

192.24.100.1   15.24.100.2   15.24.100.1
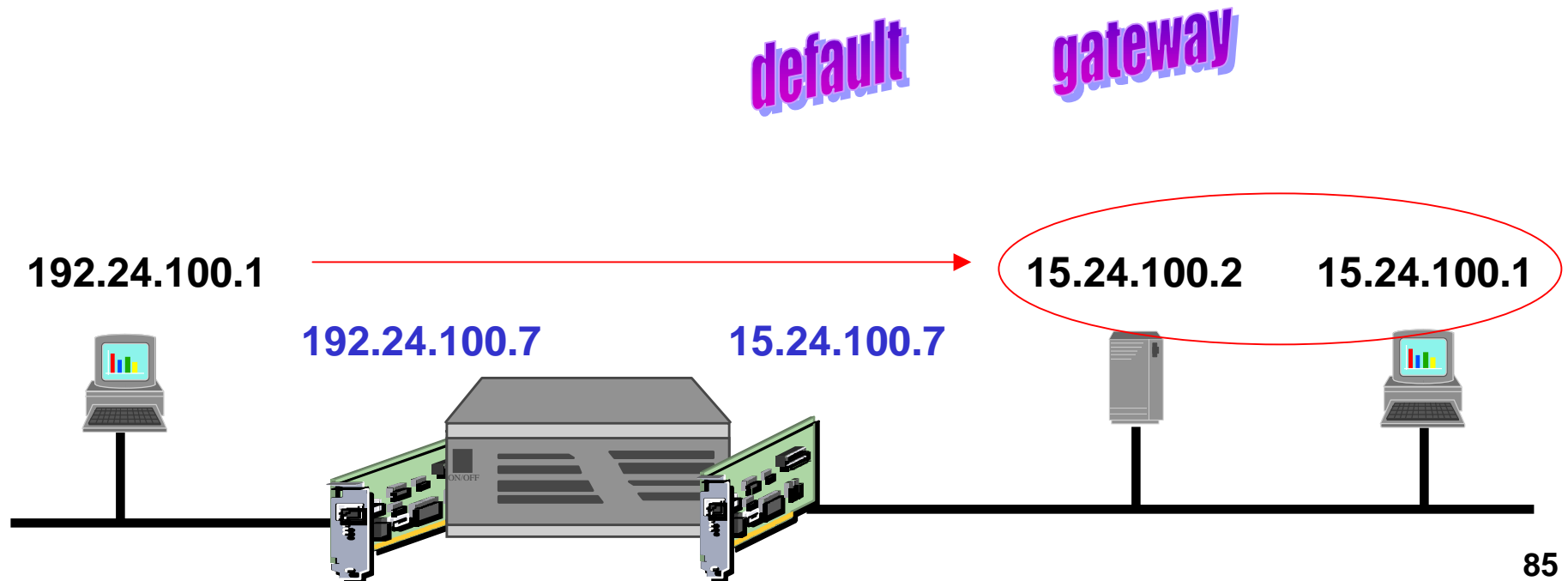
192.24.100.7   15.24.100.7

Routing By Default

- **Route all packages from 192.24.100.1 through a default address**

/usr/sbin/route   add   default   192.24.100.7   1

default   gateway

192.24.100.1 →   15.24.100.2   15.24.100.1

192.24.100.7   15.24.100.7

Display Routes

- **Display all the routes in the local routing table**

/usr/bin/netstat -rn

```
                                              dtterm
 Window   Edit   Options                                                    Help
 # ifconfig lan0
 lan0: flags=863<UP,BROADCAST,NOTRAILERS,RUNNING,MULTICAST>
         inet 192.24.100.1 netmask ffffff00 broadcast 192.24.100.255
 # netstat -rn
 Routing tables
 Destination        Gateway           Flags    Refs       Use  Interface  Pmtu PmtuTime
 127.0.0.1          127.0.0.1          UH          0       122  lo0        4608
 192.24.100.1       127.0.0.1          UH         45     40141  lo0        4608
 192.24.100         192.24.100.1       U           0        13  lan0       1500
 #
```

Display Routes

- **The Flags field may contain any or all of U,G, or H**

  - **U**   **The router is up and running**
  - **G**   **The router entry is a gateway**
  - **H**   **The destination is a host, not a network**

- **The Refs field gives the current number of active uses of the route**

- **The Use count (number of packets) is cumulative since the last activation of the network interface**

- **Pmtu field applies only to host routes - see man page for definitions**

Display Routes

```
                                    dtterm
 Window   Edit  Options                                              Help

 # ifconfig lan0
 lan0: flags=863<UP,BROADCAST,NOTRAILERS,RUNNING,MULTICAST>
         inet 192.24.100.1 netmask ffffff00 broadcast 192.24.100.255
 # netstat -rn
 Routing tables
 Destination        Gateway          Flags     Refs      Use   Interface   Pmtu PmtuTime
 127.0.0.1          127.0.0.1        UH           0      122   lo0         4608
 192.24.100.1       127.0.0.1        UH          45    40141   lo0         4608
 192.24.100         192.24.100.1     U            0       13   lan0        1500
 #
```

The lo0 interface refers to the loopback interface on the network interface card. This loopback interface allows the host to address itself the same way as it addresses other hosts on the network. There is one difference, however, is that packets are looped back and prevented from contributing to network traffic.

```
                                     dtterm

 Window   Edit   Options                                              Help

# ifconfig lan0
lan0: flags=863<UP,BROADCAST,NOTRAILERS,RUNNING,MULTICAST>
         inet 192.24.100.1 netmask ffffff00 broadcast 192.24.100.255
# netstat -rn
Routing tables
Destination        Gateway          Flags    Refs      Use  Interface   Pmtu PmtuTime
127.0.0.1          127.0.0.1        UH          0      122  lo0         4608
192.24.100.1       127.0.0.1        UH         45    40141  lo0         4608
192.24.100         192.24.100.1     U           0       13  lan0        1500
#
```
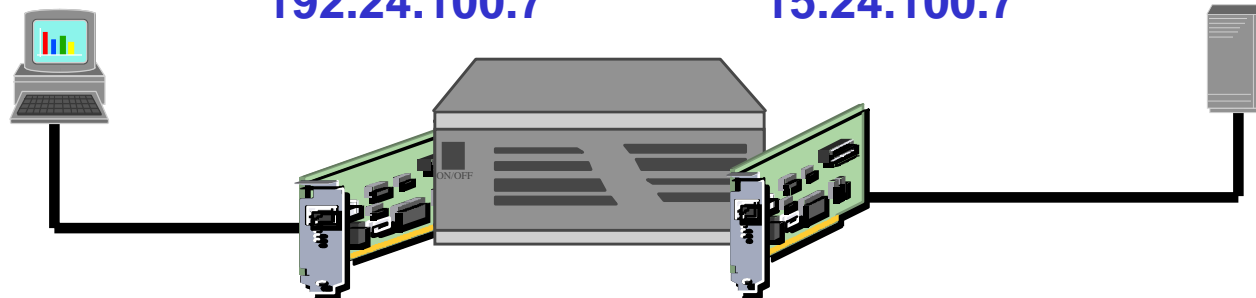
192.24.100.1   **15.24.100.2**

192.24.100.7   **15.24.100.7**

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```
                              dtterm

 Window   Edit   Options                                    Help

 # ifconfig lan0
 lan0: flags=863<UP,BROADCAST,NOTRAILERS,RUNNING,MULTICAST>
         inet 192.24.100.1 netmask ffffff00 broadcast 192.24.100.255
 # ping 192.24.100.7 -n 2
 PING 192.24.100.7: 64 byte packets
 64 bytes from 192.24.100.7: icmp_seq=0. time=7. ms
 64 bytes from 192.24.100.7: icmp_seq=1. time=3. ms

 ----192.24.100.7 PING Statistics----
 2 packets transmitted, 2 packets received, 0% packet loss
 round-trip (ms)  min/avg/max = 3/5/7
 #
```
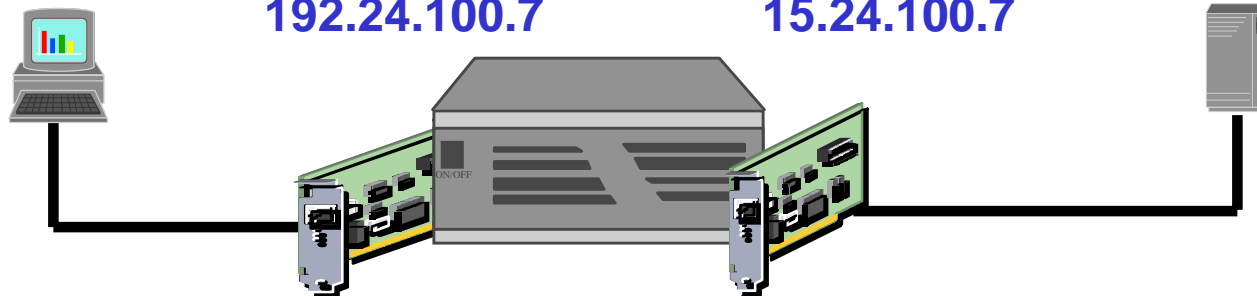
192.24.100.1   **15.24.100.2**

192.24.100.7   **15.24.100.7**

```
                                    dtterm

 Window    Edit   Options                                            Help

 # ifconfig lan0
 lan0: flags=863<UP,BROADCAST,NOTRAILERS,RUNNING,MULTICAST>
         inet 192.24.100.1 netmask ffffff00 broadcast 192.24.100.255
 # ping 15.24.100.7 -n 2
 PING 15.24.100.7: 64 byte packets
 ping: sendto: Network is unreachable
 ping: wrote 15.24.100.7 64 chars, ret=-1
 ping: sendto: Network is unreachable
 ping: wrote 15.24.100.7 64 chars, ret=-1

 ----15.24.100.7 PING Statistics----
 2 packets transmitted, 0 packets received, 100% packet loss
 #
```
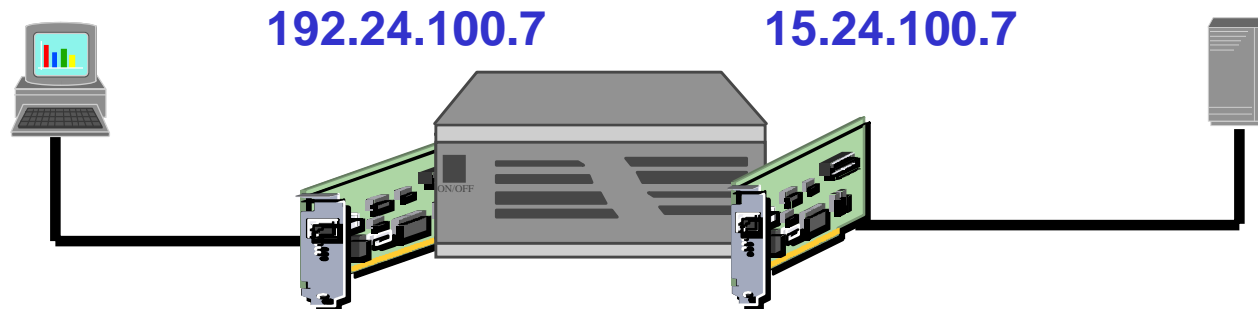
192.24.100.1   **15.24.100.2**

192.24.100.7   **15.24.100.7**

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```
                                    dtterm
  Window    Edit    Options                                        Help

  # ifconfig lan0
  lan0: flags=863<UP,BROADCAST,NOTRAILERS,RUNNING,MULTICAST>
          inet 192.24.100.1 netmask ffffff00 broadcast 192.24.100.255
  # ping 15.24.100.2 -n 2
  PING 15.24.100.2: 64 byte packets
  ping: sendto: Network is unreachable
  ping: wrote 15.24.100.2 64 chars, ret=-1
  ping: sendto: Network is unreachable
  ping: wrote 15.24.100.2 64 chars, ret=-1

  ----15.24.100.2 PING Statistics----
  2 packets transmitted, 0 packets received, 100% packet loss
  #
```
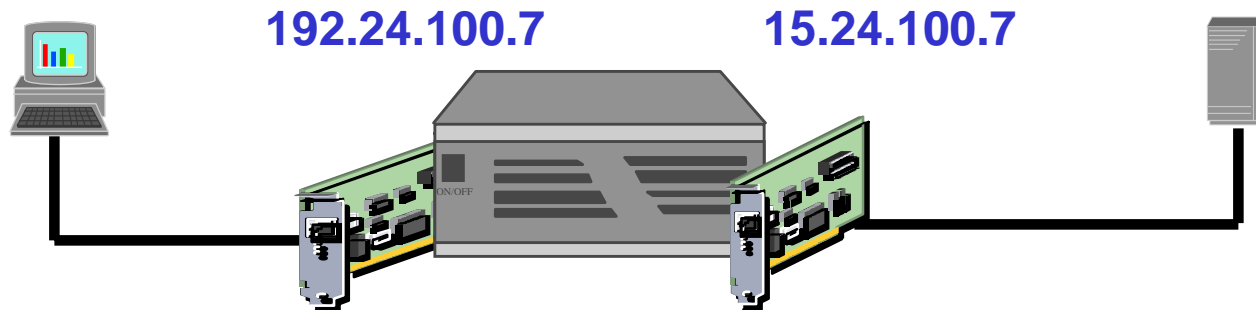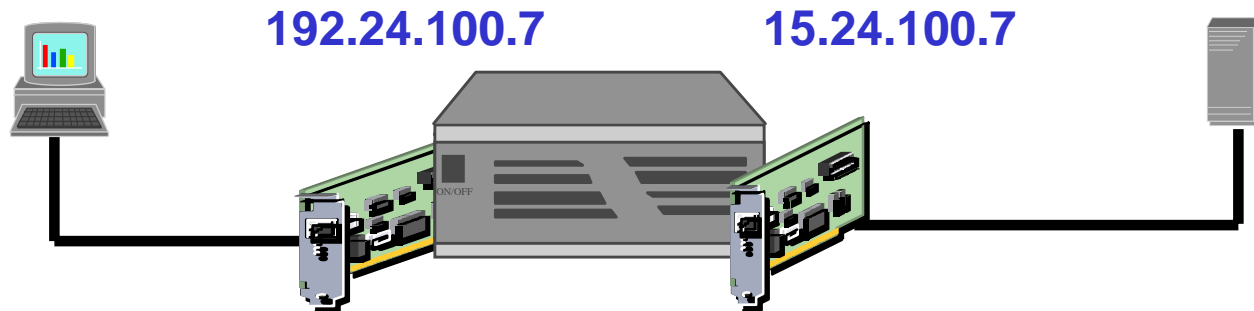
192.24.100.1   **15.24.100.2**

192.24.100.7   **15.24.100.7**

```
# ifconfig lan0
lan0: flags=863<UP,BROADCAST,NOTRAILERS,RUNNING,MULTICAST>
        inet 192.24.100.1 netmask ffffff00 broadcast 192.24.100.255
# route add net 15 192.24.100.7 1
add net 15: gateway 192.24.100.7
# netstat -rn
Routing tables
Destination      Gateway          Flags   Refs      Use   Interface   Pmtu PmtuTime
127.0.0.1        127.0.0.1        UH         0      122   lo0         4608
192.24.100.1     127.0.0.1        UH        45    42629   lo0         4608
15               192.24.100.7     UG         0        0   lan0        1500
192.24.100       192.24.100.1     U          0       13   lan0        1500
#
```

192.24.100.1   **15.24.100.2**

192.24.100.7   **15.24.100.7**

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```
                                      dtterm

 Window   Edit   Options                                              Help

 # ifconfig lan0
 lan0: flags=863<UP,BROADCAST,NOTRAILERS,RUNNING,MULTICAST>
         inet 192.24.100.1 netmask ffffff00 broadcast 192.24.100.255
 # ping 15.24.100.7 -n 2
 PING 15.24.100.7: 64 byte packets
 64 bytes from 15.24.100.7: icmp_seq=0. time=7. ms
 64 bytes from 15.24.100.7: icmp_seq=1. time=3. ms

 ----15.24.100.7 PING Statistics----
 2 packets transmitted, 2 packets received, 0% packet loss
 round-trip (ms)  min/avg/max = 3/5/7
 #
```
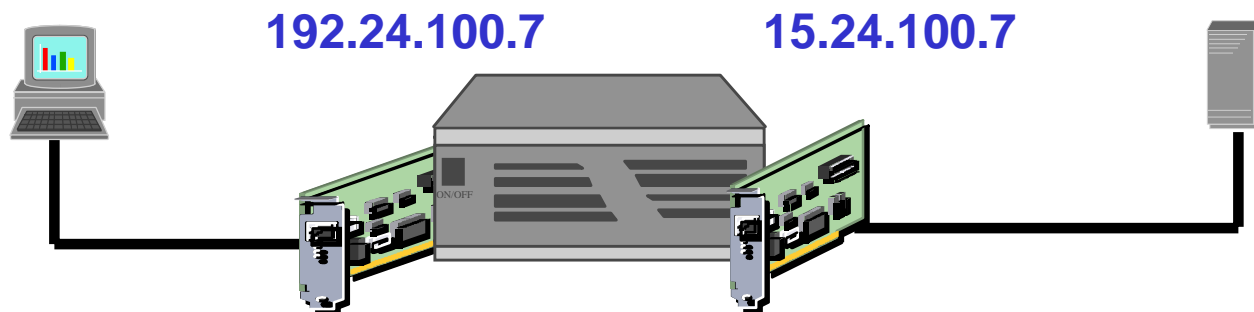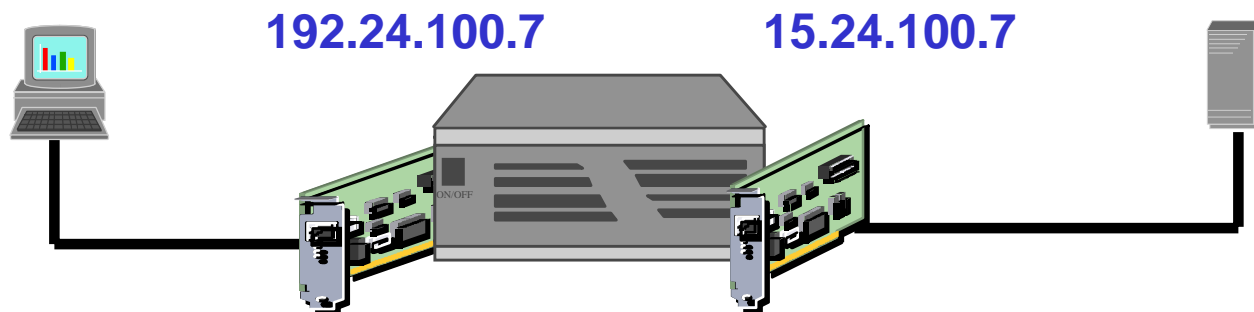
192.24.100.1   **15.24.100.2**

192.24.100.7   **15.24.100.7**

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```
# ifconfig lan0
lan0: flags=863<UP,BROADCAST,NOTRAILERS,RUNNING,MULTICAST>
        inet 192.24.100.1 netmask ffffff00 broadcast 192.24.100.255
# ping 15.24.100.2 -n 2
PING 15.24.100.2: 64 byte packets

----15.24.100.2 PING Statistics----
2 packets transmitted, 0 packets received, 100% packet loss
#
```

192.24.100.1

15.24.100.2

192.24.100.7

15.24.100.7

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```
                                    dtterm

 Window   Edit   Options                                          Help

 # ifconfig lan0
 lan0: flags=863<UP,BROADCAST,NOTRAILERS,RUNNING,MULTICAST>
        inet 15.24.100.2 netmask ff000000 broadcast 15.255.255.255
 # netstat -rn
 Routing tables
 Destination      Gateway         Flags   Refs      Use   Interface   Pmtu PmtuTime
 15.24.100.2      127.0.0.1       UH        51    11688   lo0         4608
 127.0.0.1        127.0.0.1       UH         0      122   lo0         4608
 15               15.24.100.2     U          0        0   lan0        1500
 #
```
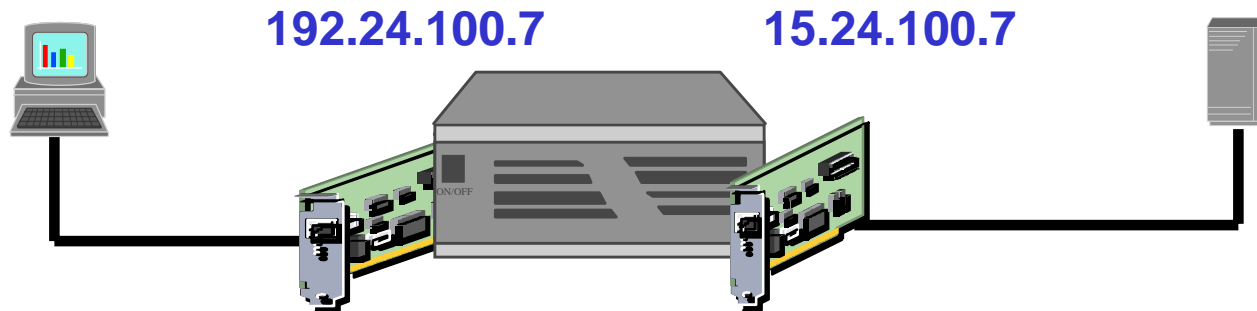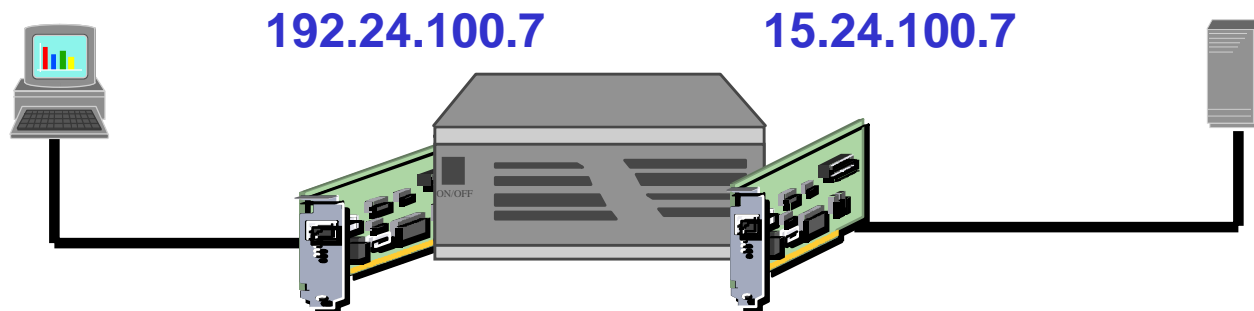
192.24.100.1   **15.24.100.2**

192.24.100.7   **15.24.100.7**

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```
# ifconfig lan0
lan0: flags=863<UP,BROADCAST,NOTRAILERS,RUNNING,MULTICAST>
        inet 15.24.100.2 netmask ff000000 broadcast 15.255.255.255
# route add default 15.24.100.7 1
add net default: gateway 15.24.100.7
# netstat -rn
Routing tables
Destination       Gateway         Flags   Refs      Use   Interface   Pmtu PmtuTime
15.24.100.2       127.0.0.1       UH        51    14318   lo0         4608
127.0.0.1         127.0.0.1       UH         0      122   lo0         4608
default           15.24.100.7     UG         0        9   lan0        1500
15                15.24.100.2     U          0        0   lan0        1500
#
```
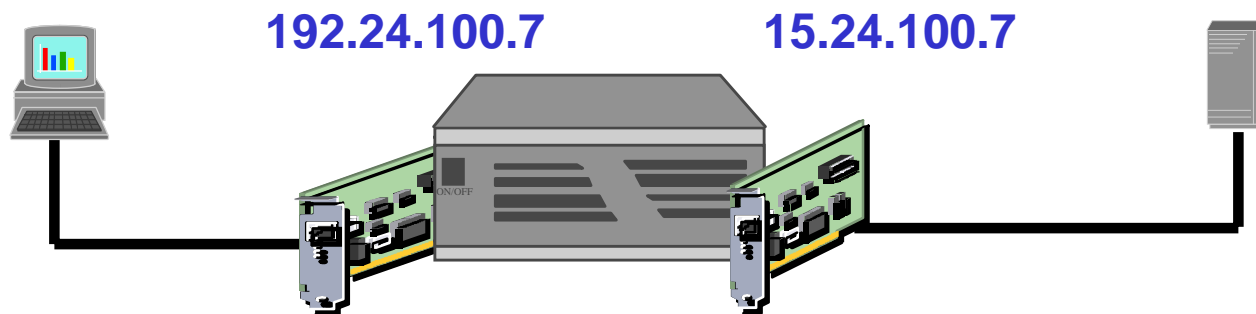
192.24.100.1

15.24.100.2

192.24.100.7

15.24.100.7

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```
# ifconfig lan0
lan0: flags=863<UP,BROADCAST,NOTRAILERS,RUNNING,MULTICAST>
        inet 15.24.100.2 netmask ff000000 broadcast 15.255.255.255
# ping 192.24.100.1 -n 2
PING 192.24.100.1: 64 byte packets
64 bytes from 192.24.100.1: icmp_seq=0. time=6. ms
64 bytes from 192.24.100.1: icmp_seq=1. time=3. ms

----192.24.100.1 PING Statistics----
2 packets transmitted, 2 packets received, 0% packet loss
round-trip (ms)  min/avg/max = 3/4/6
#
```

dtterm

Window   Edit   Options   Help

192.24.100.1

192.24.100.7   **15.24.100.7**

15.24.100.2

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```
# ifconfig lan0
lan0: flags=863<UP,BROADCAST,NOTRAILERS,RUNNING,MULTICAST>
        inet 192.24.100.1 netmask ffffff00 broadcast 192.24.100.255
# ping 15.24.100.2 -n 2
PING 15.24.100.2: 64 byte packets
64 bytes from 15.24.100.2: icmp_seq=0. time=8. ms
64 bytes from 15.24.100.2: icmp_seq=1. time=3. ms

----15.24.100.2 PING Statistics----
2 packets transmitted, 2 packets received, 0% packet loss
round-trip (ms)  min/avg/max = 3/5/8
#
```

192.24.100.1

15.24.100.2

192.24.100.7

15.24.100.7
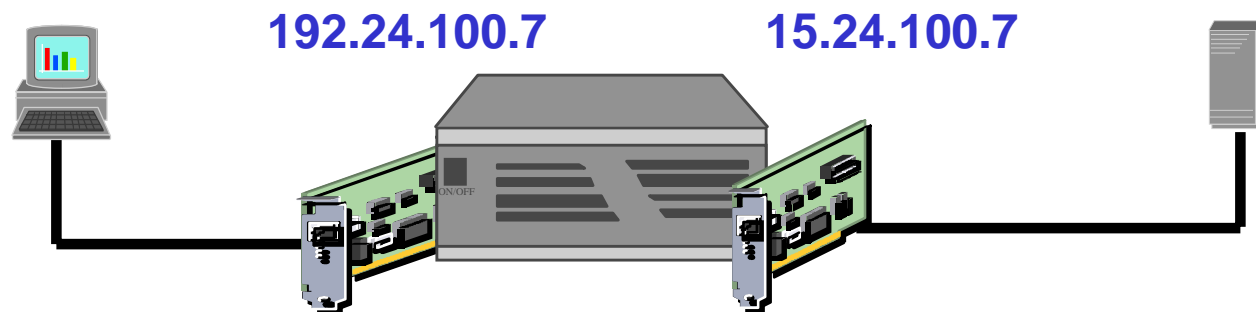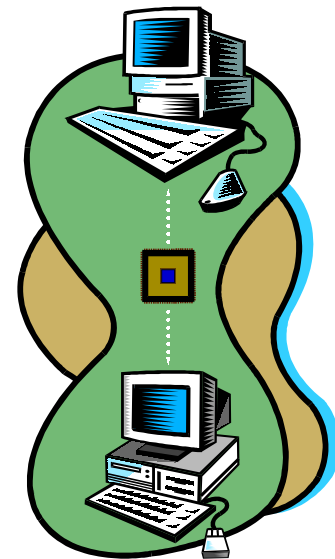
Configure Routes

Warning ...

Configuring the LAN card routes via the route command is not permanent. A reboot will cause the LAN card routes to be set to its default configuration.

Configure Routes: /etc/rc.config.d/netconf

- Contains configuration values for the network subsystems:
  - Route

Configure Routes:
/etc/rc.config.d/netconf

```
# Internet routing configuration.  See route(1m), routing(7)
#
# ROUTE_DESTINATION:     Destination host or network IP address in
#                        decimal-dot notation, preceded by the word
#                        "host" or "net"; or simply the word "default".
#
# ROUTE_MASK:            Subnetwork mask in decimal-dot notation, or C language
#                        hexadecimal notation.  This is an optional field.
#                        A IP address, subnet mask pair uniquely identifies
#                        a subnet to be reached. If a subnet mask is not given,
#                        then the system will assign the longest subnet mask
#                        of the configured network interfaces to this route.
#                        If there is no matching subnet mask, then the system
#                        will assign the default network mask as the route's
#                        subnet mask.
#
# ROUTE_GATEWAY:         Gateway IP address in decimal-dot notation.
#                        If local interface, must use the same form
#                        as used for IP_ADDRESS above.
#
# ROUTE_COUNT:           An integer that indicates whether the gateway is a
#                        remote interface (one) or the local interface (zero).
#
# ROUTE_ARGS:            Route command arguments and options.  This variable
#                        may contain a combination of the following arguments:
#                        "-f", "-n" and "-p pmtu".
#
# For each additional route, add a set of variable assignments like the ones
# below, changing the index to "[1]", "[2]" et cetera.
#
# IMPORTANT:  for 9.x-to-10.0 transition, do not put blank lines between
```

Configure Routes:
/etc/rc.config.d/netconf

```
#
# For each additional route, add a set of variable assignments like the ones
# below, changing the index to "[1]", "[2]" et cetera.
#
# IMPORTANT:  for 9.x-to-10.0 transition, do not put blank lines between
# the next set of statements

ROUTE_DESTINATION[0]=default
ROUTE_MASK[0]=""
ROUTE_GATEWAY[0]=15.47.72.1
ROUTE_COUNT[0]=1
ROUTE_ARGS[0]=""
```