



Routing

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+ How does this support my pentesting career?

- Understanding routing protocol attacks
- Performing network traffic inspection



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2.3 Routing

- + Addressing devices is just half of the work needed to reach a host. Your packets need to follow a valid **path** to reach it.
- + **Routers** are devices connected to different networks at the same time. They are able to forward IP datagrams from one network to another. The forwarding policy is based on **routing protocols**.



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2.3 Routing

- + Routing protocols are used to determine the best path to reach a network. They behave like a postman who tries to use the shortest path possible to deliver a letter.
- + A router inspects the destination address of every incoming packet and then forwards it through one of its interfaces.



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2.3.1 Routing Table

- + To choose the right forwarding interface, a router performs a lookup in the **routing table**, where it finds an IP-to-interface binding.
- + The table can also contain an entry with the **default address** (0.0.0.0). This entry is used when the router receives a packet whose destination is an *unknown network*.



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▼ 2.3.1 Routing Table

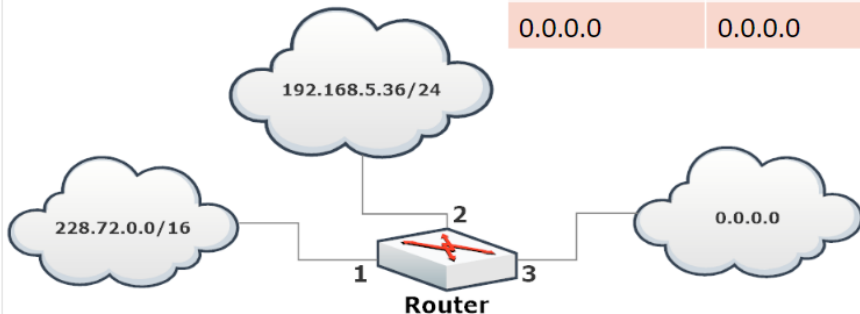
▶ 2.3.1.1 Routing Table Example

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2.3.1.1 Routing Table Example



IP	Netmask	Interface
228.72.0.0	255.255.0.0	1
192.168.5.0	255.255.255.0	2
0.0.0.0	0.0.0.0	3



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2.3.1.1 Routing Table Example

- + In this example, the routing table is made of three entries.
 - Interface 1 is used to forward the packets to 228.72.0.0/16.
 - Interface 2 is used to forward the packets to 192.168.5.0/24.
 - Interface 3 is used as the default route for packets whose destination does not match any other entry in the table.



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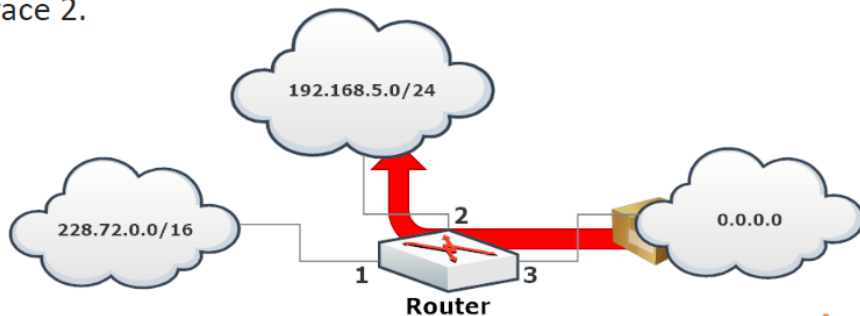
▶ 2.3.1.2 Default Route Example

▶ 2.3.2 Routing Metrics

2.3.1.1 Routing Table Example

EXAMPLE

- + A packet arriving on interface 3 for 192.168.5.3 is forwarded on interface 2.



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► 2.3.1.2 Default Route Example

► 2.3.2 Routing Metrics

2.3.1.1 Routing Table Example

- + In fact, the first entry in the routing table does not match the destination network.


To: 192.168.5.3



IP	Netmask	Interface
228.72.0.0	255.255.0.0	1
192.168.5.0	255.255.255.0	2
0.0.0.0	0.0.0.0	3



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► 2.3.1.2 Default Route Example

► 2.3.2 Routing Metrics

2.3.1.1 Routing Table Example

- While the second does: 192.168.5.3 sits in the 192.168.5.0/24 network.


To: 192.168.5.3



IP	Netmask	Interface
228.72.0.0	255.255.0.0	1
192.168.5.0	255.255.255.0	2
0.0.0.0	0.0.0.0	3



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2.3.1.1 Routing Table Example

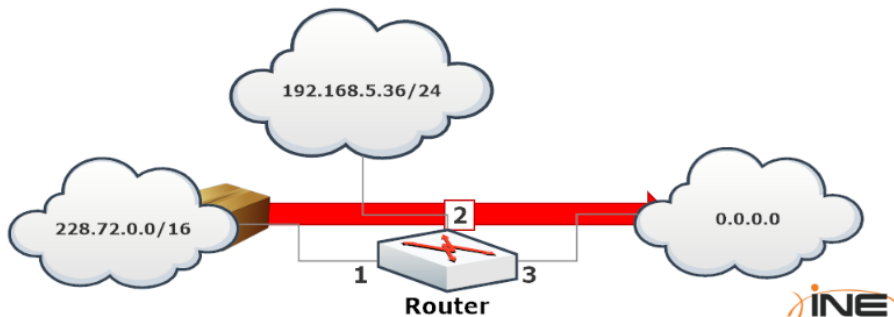
► 2.3.1.2 Default Route Example

► 2.3.2 Routing Metrics

2.3.1.2 Default Route Example

EXAMPLE

- + A packet arriving on interface 1 for 72.13.37.2 is routed through interface 3, the default route.



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2.3.1.1 Routing Table Example

▼ 2.3.1.2 Default Route Example

2.3.1.2 Default Route Example

2.3.1.2 Default Route Example

- + There is no matching entry, so the router forwards the packet through interface 3.


To: 72.13.37.2



IP	Netmask	Interface
228.72.0.0	255.255.0.0	1
192.168.5.0	255.255.255.0	2
0.0.0.0	0.0.0.0	3



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2.3.1.1 Routing Table Example

▼ 2.3.1.2 Default Route Example

2.3.1.2 Default Route Example

2.3.2 Routing Metrics

- + As in the real world, there could be more than a way to reach a destination.
- + So, during path discovery, routing protocols also assign a **metric to each link**.



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▼ 2.3.1.2 Default Route Example

2.3.1.2 Default Route
Example

▼ 2.3.2 Routing Metrics

2.3.2 Routing Metrics

- + This ensures that, if two paths have the same number of hops, the fastest route is selected.
- + The metric is selected according to the channel's estimated bandwidth and congestion.



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▼ 2.3.1.2 Default Route Example

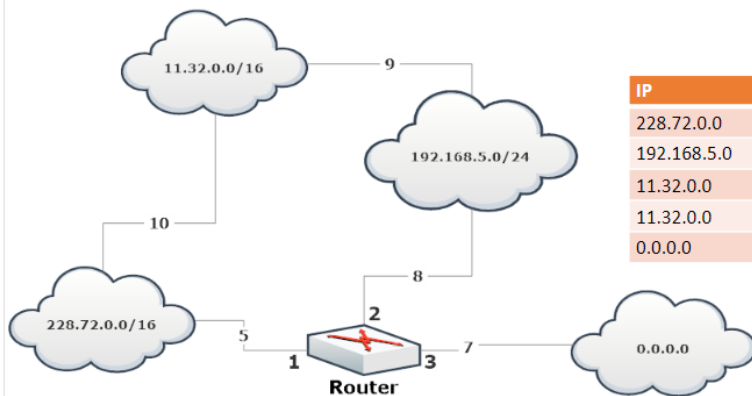
2.3.1.2 Default Route
Example

▼ 2.3.2 Routing Metrics

▼ 2.3.2 Routing Metrics

2.3.2.1 Routing Metrics Example

+ Let's look at how routing decisions are made according to metrics.



IP	Netmask	Interface	Metric
228.72.0.0	255.255.0.0	1	5
192.168.5.0	255.255.255.0	2	8
11.32.0.0	255.255.0.0	2	17
11.32.0.0	255.255.0.0	1	15
0.0.0.0	0.0.0.0	3	7



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▼ 2.3.1.2 Default Route Example

2.3.1.2 Default Route Example

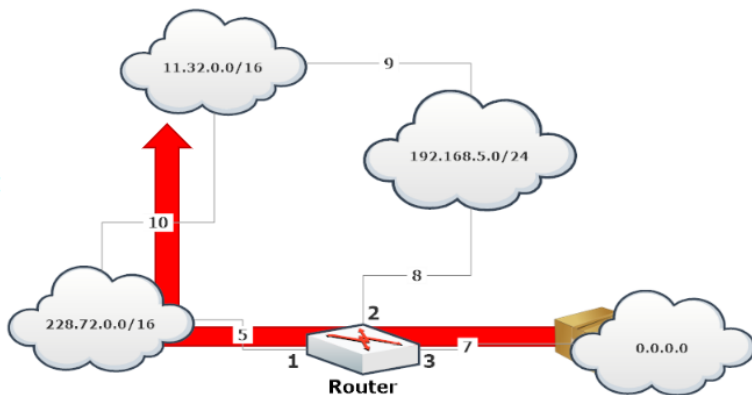
▼ 2.3.2 Routing Metrics

▼ 2.3.2 Routing Metrics

▼ 2.3.2.1 Routing Metrics Example

2.3.2.1 Routing Metrics Example

- + A packet arriving on interface 3 for 11.32.3.118 is routed through interface 1, as the metric for that route is 15.
- + Routing through interface 2 would have a metric of 17.



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▼ 2.3.1.2 Default Route Example

2.3.1.2 Default Route Example

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▼ 2.3.2 Routing Metrics

▼ 2.3.2.1 Routing Metrics Example

2.3.2.1 Routing Metrics Example

2.3.3 Checking the Routing Table

- + Routing tables are not only kept by routers; every host stores its own table.
- + To check what they look like, you can use:
 - + `ip route` on Linux
 - + `route print` on Windows
 - + `netstat -r` on OSX



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2.3.1.2 Default Route
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▼ 2.3.2 Routing Metrics

▼ 2.3.2.1 Routing Metrics Example

2.3.2.1 Routing Metrics
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EXAMPLE

+ Checking the routing table on a Linux box:

```
root@host:~# ip route
default via 192.168.51.1 dev eth0 proto static
192.168.51.0/24 dev wlan0 proto kernel scope link src 192.168.51.123
```



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EXAMPLE

- + Checking the routing table on Microsoft Windows:

```
C:\Users\User>route print

=====
Interface List
11...08 00 27 bf ac c8 .....Intel(R) PRO/1000 MT Desktop Adapter
1.....Software Loopback Interface 1
=====

IPv4 Route Table
=====

Active Routes:
Network Destination        Netmask          Gateway           Interface        Metric
0.0.0.0                    0.0.0.0          10.0.2.2          10.0.2.15        10
10.0.2.0                   255.255.255.0    On-link           10.0.2.15        266
```



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2.3.3 Checking the Routing Table

EXAMPLE

+ Checking the routing table on Mac OSX:

```
User:~ user$ netstat -r
Routing tables

Internet:

Destination      Gateway           Flags             Refs      Use    Netif Expire
default          192.168.51.1     UGSc              13        0      en1
127              127.0.0.1        UCS               0         0      lo0
127.0.0.1        127.0.0.1        UH                1        16      lo0
169.254          link#4            UCS               0         0      en1
192.168.51       link#4            UCS               4         0      en1
192.168.51.1     58:6d:8f:e5:e:d2 UHLWIir          14        24      en1 1200
192.168.51.109   2:f:b5:4b:76:cf  UHLWii           0         0      en1 1148
```



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