



# Routing

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The system uses a routing table to determine the egress interface for packets entering the system. The following topics explain routing basics and how to configure routing on the device.

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## Routing Overview

The following topics describe how routing behaves within the FTD device. Routing is the act of moving information across a network from a source to a destination. Along the way, at least one intermediate node is typically encountered. Routing involves two basic activities: determining optimal routing paths and transporting packets through a network.

## Route Types

There are two main types of route: static or dynamic.

Static routes are those that you define explicitly. These are stable, normally high-priority routes, that you would use to ensure traffic to the route destination is always sent out the correct interface. For example, you would create a default static route to cover all traffic not already covered by any other route, that is, 0.0.0.0/0 for IPv4 or ::/0 for IPv6. Another example would be a static route to an internal syslog server that you always want to use.

Dynamic routes are those learned through the operation of a routing protocol, such as OSPF, BGP, EIGRP, IS-IS, or RIP. You do not define the routes directly. Instead, you configure the routing protocol, and the system then communicates with neighbor routers, transmitting routing updates to them and receiving routing updates in turn.

Dynamic routing protocols adjust the routing table to changing network circumstances by analyzing incoming routing update messages. If the message indicates that a network change has occurred, the system recalculates routes and sends out new routing update messages. These messages permeate the network, stimulating routers to rerun their algorithms and change their routing tables accordingly.

Static routing is simple and serves the purpose of basic routing. It works well in environments where network traffic is relatively predictable and where network design is relatively simple. However, because static routes cannot change unless you edit them, they cannot react to changes in the network.

Unless you have a small network, you would typically combine static routes with one or more dynamic routing protocol. You would define at least one static route, as the default route for any traffic that does not match an explicit route.



**Note** You can use Smart CLI to configure the following routing protocols: OSPF. Use FlexConfig to configure other routing protocols that are supported in ASA software.

## The Routing Table and Route Selection

When NAT translations (xlates) and rules do not determine the egress interface, the system uses the routing table to determine the path for a packet.

Routes in the routing table include a metric called “administrative distance” that provides a relative priority to a given route. If a packet matches more than one route entry, the one with the lowest distance is used. Directly connected networks (those defined on an interface) have the distance 0, so they are always preferred. Static routes have a default distance of 1, but you can create them with any distance between 1-254.

Routes that identify a specific destination take precedence over the default route (the route whose destination is 0.0.0.0/0 or ::/0).

### How the Routing Table Is Populated

The FTD routing table can be populated by statically defined routes, directly connected routes, and routes discovered by the dynamic routing protocols. Because the FTD device can run multiple routing protocols in addition to having static and connected routes in the routing table, it is possible that the same route is discovered or entered in more than one manner. When two routes to the same destination are put into the routing table, the one that remains in the routing table is determined as follows:

- If the two routes have different network prefix lengths (network masks), then both routes are considered unique and are entered into the routing table. The packet forwarding logic then determines which of the two to use.

For example, if the RIP and OSPF processes discovered the following routes:

- RIP: 192.168.32.0/24
- OSPF: 192.168.32.0/19

Even though OSPF routes have the better administrative distance, both routes are installed in the routing table because each of these routes has a different prefix length (subnet mask). They are considered different destinations and the packet forwarding logic determines which route to use.

- If the FTD device learns about multiple paths to the same destination from a single routing protocol, such as RIP, the route with the better metric (as determined by the routing protocol) is entered into the routing table.

Metrics are values associated with specific routes, ranking them from most preferred to least preferred. The parameters used to determine the metrics differ for different routing protocols. The path with the lowest metric is selected as the optimal path and installed in the routing table. If there are multiple paths to the same destination with equal metrics, load balancing is done on these equal cost paths.

- If the FTD device learns about a destination from more than one routing protocol, the administrative distances of the routes are compared, and the routes with lower administrative distance are entered into the routing table.

## Administrative Distances for Routes

You can change the administrative distances for routes discovered by or redistributed into a routing protocol. If two routes from two different routing protocols have the same administrative distance, then the route with the lower *default* administrative distance is entered into the routing table. In the case of EIGRP and OSPF routes, if the EIGRP route and the OSPF route have the same administrative distance, then the EIGRP route is chosen by default.

Administrative distance is a route parameter that the FTD device uses to select the best path when there are two or more different routes to the same destination from two different routing protocols. Because the routing protocols have metrics based on algorithms that are different from the other protocols, it is not always possible to determine the best path for two routes to the same destination that were generated by different routing protocols.

Each routing protocol is prioritized using an administrative distance value. The following table shows the default administrative distance values for the routing protocols supported by the FTD device.

**Table 1: Default Administrative Distance for Supported Routing Protocols**

Route Source	Default Administrative Distance
Connected interface	0
VPN route	1
Static route	1
EIGRP Summary Route	5
External BGP	20
Internal EIGRP	90
OSPF	110
IS-IS	115
RIP	120
EIGRP external route	170
Internal and local BGP	200
Unknown	255

The smaller the administrative distance value, the more preference is given to the protocol. For example, if the FTD device receives a route to a certain network from both an OSPF routing process (default administrative distance - 110) and a RIP routing process (default administrative distance - 120), the FTD device chooses the OSPF route because OSPF has a higher preference. In this case, the router adds the OSPF version of the route to the routing table.

A VPN advertised route (V-Route/RRI) is equivalent to a static route with the default administrative distance 1. But it has a higher preference as with the network mask 255.255.255.255.

In this example, if the source of the OSPF-derived route was lost (for example, due to a power shutdown), the FTD device would then use the RIP-derived route until the OSPF-derived route reappears.

The administrative distance is a local setting. For example, if you change the administrative distance of routes obtained through OSPF, that change would only affect the routing table for the FTD device on which the command was entered. The administrative distance is not advertised in routing updates.

Administrative distance does not affect the routing process. The routing processes only advertise the routes that have been discovered by the routing process or redistributed into the routing process. For example, the RIP routing process advertises RIP routes, even if routes discovered by the OSPF routing process are used in the routing table.

### Backup Dynamic and Floating Static Routes

A backup route is registered when the initial attempt to install the route in the routing table fails because another route was installed instead. If the route that was installed in the routing table fails, the routing table maintenance process calls each routing protocol process that has registered a backup route and requests them to reinstall the route in the routing table. If there are multiple protocols with registered backup routes for the failed route, the preferred route is chosen based on administrative distance.

Because of this process, you can create floating static routes that are installed in the routing table when the route discovered by a dynamic routing protocol fails. A floating static route is simply a static route configured with a greater administrative distance than the dynamic routing protocols running on the FTD device. When the corresponding route discovered by a dynamic routing process fails, the static route is installed in the routing table.

## How Forwarding Decisions Are Made

Forwarding decisions are made as follows:

- If the destination does not match an entry in the routing table, the packet is forwarded through the interface specified for the default route. If a default route has not been configured, the packet is discarded.
- If the destination matches a single entry in the routing table, the packet is forwarded through the interface associated with that route.
- If the destination matches more than one entry in the routing table, then the packet is forwarded out of the interface associated with the route that has the longer network prefix length.

For example, a packet destined for 192.168.32.1 arrives on an interface with the following routes in the routing table:

- 192.168.32.0/24 gateway 10.1.1.2
- 192.168.32.0/19 gateway 10.1.1.3

In this case, a packet destined to 192.168.32.1 is directed toward 10.1.1.2, because 192.168.32.1 falls within the 192.168.32.0/24 network. It also falls within the other route in the routing table, but 192.168.32.0/24 has the longest prefix within the routing table (24 bits verses 19 bits). Longer prefixes are always preferred over shorter ones when forwarding a packet.



**Note** Existing connections continue to use their established interfaces even if a new similar connection would result in different behavior due to a change in routes.

## Routing Table for Management Traffic

As a standard security practice, it is often necessary to segregate and isolate management (from-the-device) traffic from data traffic. To achieve this isolation, the FTD device uses a separate routing table for management-only traffic vs. data traffic. Separate routing tables means that you can create separate default routes for data and management as well.

### Types of Traffic for Each Routing Table

Through-the-device traffic always uses the data routing table.

From-the-device traffic, depending on the type, uses either the management-only routing table or the data routing table by default. If a match is not found in the default routing table, it checks the other routing table.

- Management-only table from-the-device traffic includes AAA server communications.
- Data table from-the-device traffic includes DNS server lookups and DDNS. An exception is if you only specify the Diagnostic interface for DNS, then the FTD device will only use the management-only table.

### Interfaces Included in the Management-Only Routing Table

Management-only interfaces include any the Management x/x interfaces as well as any interfaces that you have configured to be management-only.



**Note** The Management virtual interface uses its own Linux routing table that is not part of the FTD route lookup. Traffic originating on the Management interface includes the FDM management sessions, licensing communication, and database updates. The Diagnostic logical interface, on the other hand, uses the management-only routing table described in this section.

### Fallback to the Other Routing Table

If a match is not found in the default routing table, it checks the other routing table.

### Using the Non-Default Routing Table

If you need from-the-box traffic to go out an interface that isn't in its default routing table, then you might need to specify that interface when you configure it, rather than relying on the fall back to the other table. The FTD will only check routes for the specified interface. For example, if you need to communicate with a RADIUS server on a data interface, then specify that interface in the RADIUS configuration. Otherwise, if there is a default route in the management-only routing table, then it will match the default route and never fall back to the data routing table.

## Equal-Cost Multi-Path (ECMP) Routing

The FTD device supports Equal-Cost Multi-Path (ECMP) routing.

You can have up to 8 equal cost static or dynamic routes per interface. For example, you can configure multiple default routes on the outside interface that specify different gateways.

```
route for 0.0.0.0 0.0.0.0 through outside to 10.1.1.2
route for 0.0.0.0 0.0.0.0 through outside to 10.1.1.3
route for 0.0.0.0 0.0.0.0 through outside to 10.1.1.4
```

In this case, traffic is load-balanced on the outside interface between 10.1.1.2, 10.1.1.3, and 10.1.1.4. Traffic is distributed among the specified gateways based on an algorithm that hashes the source and destination IP addresses, incoming interface, protocol, source and destination ports.

## Static Routes

You can create static routes to provide basic routing for your network.

### About Static and Default Routes

To route traffic to a non-connected host or network, you must define a route to the host or network, either using static or dynamic routing. Generally, you must configure at least one static route: a default route for all traffic that is not routed by other means to a default network gateway, typically the next hop router.

#### Default Route

The simplest option is to configure a default static route to send all traffic to an upstream router, relying on the router to route the traffic for you. A default route identifies the gateway IP address to which the FTD device sends all IP packets for which it does not have a learned or static route. A default static route is simply a static route with 0.0.0.0/0 (IPv4) or ::/0 (IPv6) as the destination IP address.

You should always define a default route.

Because the FTD device uses separate routing tables for data traffic and for management traffic, you can optionally configure a default route for data traffic and another default route for management traffic. Note that from-the-device traffic uses either the management-only or data routing table by default depending on the type, but will fall back to the other routing table if a route is not found. Default routes will always match traffic, and will prevent a fall back to the other routing table. In this case, you must specify the interface you want to use for egress traffic if that interface is not in the default routing table. The Diagnostic interface is included in the management-only table. The special Management interface uses a separate Linux routing table, and has its own default route.

### Static Routes

You might want to use static routes in the following cases:

- Your networks use an unsupported router discovery protocol.
- Your network is small and you can easily manage static routes.
- You do not want the traffic or CPU overhead associated with routing protocols.
- In some cases, a default route is not enough. The default gateway might not be able to reach the destination network, so you must also configure more specific static routes. For example, if the default gateway is outside, then the default route cannot direct traffic to any inside networks that are not directly connected to the FTD device.

- You are using a feature that does not support dynamic routing protocols.

## Guidelines for Static Routing

### Bridge Groups

- In routed mode, you must specify the BVI as the gateway; you cannot specify the member interface.
- For traffic that originates on the FTD device (such as syslog or SNMP) that is destined through a bridge group member interface for a non-directly connected network, you need to configure either a default route or static routes so the FTD device knows out of which bridge group member interface to send traffic. If you have servers that cannot all be reached through a single default route, then you must configure static routes.

## Configuring Static Routes

Define static routes to tell the system where to send packets that are not bound for networks that are directly connected to the interfaces on the system.

You need at least one static route, the default route, for network 0.0.0.0/0. This route defines where to send packets whose egress interface cannot be determined by existing NAT xlates (translations) or static NAT rules, or other static routes.

You might need other static routes if the default gateway cannot be used to get to all networks. For example, the default route is usually an upstream router on the outside interface. If there are additional inside networks that are not directly connected to the device, and they cannot be accessed through the default gateway, you need static routes for each of those inside networks.

You cannot define static routes for the networks that are directly connected to system interfaces. The system automatically creates these routes.

### Procedure

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**Step 1** Click **Device**, then click the link in the **Routing** summary.

**Step 2** On the **Static Routing** page, do one of the following:

- To add a new route, click +.
- Click the edit icon (✎) for the route you want to edit.

If you no longer need a route, click the trash can icon for the route to delete it.

**Step 3** Configure the route properties

- **Name**—A display name for the route.
- **Description**—An optional description of the purpose for the route.
- **Interface**—Select the interface through which you want to send traffic. The gateway address needs to be accessible through this interface.

For bridge groups, you configure the route for the bridge group interface (BVI), not for the member interfaces.

- **Protocol**—Select whether the route is for an **IPv4** or **IPv6** address.

- **Networks**—Select the network objects that identify the destination networks or hosts that should use the gateway in this route.

To define a default route, use the pre-defined any-ipv4 or any-ipv6 network objects, or create an object for the 0.0.0.0/0 (IPv4) or ::/0 (IPv6) network.

- **Gateway**—Select the host network object that identifies the IP address for the gateway. Traffic is sent to this address. You cannot use the same gateway for routes on more than one interface.
- **Metric**—The administrative distance for the route, between 1 and 254. The default for static routes is 1. If there are additional routers between the interface and the gateway, enter the number of hops as the administrative distance.

Administrative distance is a parameter used to compare routes. The lower the number, the higher precedence the route is given. Connected routes (networks directly connected to an interface on the device) always take precedence over static routes.

**Step 4** Click **OK**.

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## Monitoring Routing

To monitor and troubleshoot routing, open the CLI console or log into the device CLI and use the following commands.

- **show route** displays the routing table for the data interfaces, including routes for directly-connected networks.
- **show ipv6 route** displays the IPv6 routing table for the data interfaces, including routes for directly-connected networks.
- **show network** displays the configuration for the virtual Management interface, including the management gateway. Routing through the virtual Management interface is not handled by the data interface routing table, unless you specify data-interfaces as the management gateway.
- **show network-static-routes** displays static routes configured for the virtual Management interface using the **configure network static-routes** command. Normally, there will not be any static routes, as the management gateway suffices for management routing in most cases. These routes are not available to traffic on the data interfaces. This command is not available in the CLI console.