Understand Administrative Distance

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Introduction

This document describes how Cisco routers use Administrative Distance (AD) to choose the most trusted route source.

Prerequisites

Requirements

Cisco recommends that you have knowledge of basic IP Routing.

Components Used

This document is not restricted to specific software and hardware versions.

The information in this document was created from the devices in a specific lab environment. All of the devices used in this document started with a cleared (default) configuration. If your network is live, ensure that you understand the potential impact of any command.

Background Information

AD is a value used to rank the trustworthiness of routing information sources. When the routing table receives candidate routes to the same destination prefix from different route sources, the route with the lowest administrative distance is preferred and installed in the routing table.

Most routing protocols have metric structures and algorithms that are not compatible with other protocols. In a network with multiple routing protocols, the exchange of route information and the capability to select the best path across the multiple protocols are critical. Each routing protocol or source is assigned an AD value, which determines its priority when multiple routes to the same destination are available. Lower values are preferred over higher ones.

Select the Best Path

Before a route can be installed in the routing table, the router performs several checks, such as validating the route, resolving the next hop, and selecting the best route for a given destination prefix. AD is used only when multiple routing sources advertise the same destination prefix.

In general, the Routing Information Base (RIB) installation process has this sequence.

Routing Protocol Best Path Selection

- The routing protocol uses its own metric and path selection algorithm.
- If Equal-Cost Multi-Path (ECMP) is supported, multiple equal cost routes can be selected.

RIB Route Comparison

- Only the protocol(s) best candidate(s) for a given prefix are considered by the routing table.

- If multiple routing sources advertise the same network and prefix length, AD determines which route is installed.
- The route with the lowest AD is preferred.

Route Installation

- Multiple routes can be installed when ECMP is supported and the routes are considered equal by the routing process or RIB.
- During RIB route installation, the router validates that the route is usable, including a reachable next hop or valid exit interface.
- If the route uses a next-hop IP address, the router performs recursive lookup, also called route recursion, to resolve the outgoing interface.
- If the next hop cannot be resolved, the route is not installed in the routing table.

Longest Prefix Match (Forwarding)

- When forwarding a packet, the router searches the forwarding table for all matching routes and selects the most specific prefix (the longest prefix match).
- Longest prefix match is not part of route installation; it is applied later during packet forwarding.
- Longest prefix match comes into play, when a packet arrives and the forwarding plane chooses which of the already installed routes best matches the packet destination IP.



Note: AD and routing metrics are not evaluated during forwarding. Those values have already been used to determine which routes were installed in the RIB, hence AD does not override longest prefix match.



Note: The previous steps describe how routes are selected and installed in the RIB. Once the routes are installed, packet forwarding uses the Forwarding Information Base (FIB), where longest prefix match determines which installed route is used for each packet.

AD is a local value and is not advertised in routing updates. The smaller the administrative distance value, the more preferred the route source.

For example, if a router learns the same prefix from Open Shortest Path First (OSPF) and Enhanced Interior Gateway Routing Protocol (EIGRP), the router prefers the EIGRP route by default because internal EIGRP has an administrative distance of 90, while OSPF has an administrative distance of 110. The RIB installs the EIGRP route because it has the lowest administrative distance for that destination prefix. If the EIGRP route is later withdrawn for example, because the EIGRP neighbor goes down, the router reevaluates the remaining candidate routes. If the OSPF route is still valid and its next hop can be resolved, it is installed in the routing table and becomes the active route for that destination prefix.

In **show ip route** output, the values in brackets use the format [administrative distance/metric]. For example, [90/1] means the route has an administrative distance of 90 and a protocol metric of 1.

After routes have been installed in the routing table, the router uses **longest prefix match** to forward packets. When multiple installed routes match the destination IP address, the router selects the route with the most specific prefix. For example, if the routing table contains 192.168.1.0/24 and 192.168.0.0/16, a packet destined for **192.168.1.10** matches both routes, but the router forwards the packet using **192.168.1.0/24** because it is the longest (more specific) prefix.

Default AD Values

This table lists the administrative distance default values of the protocols that Cisco supports.

Route Source	Default AD Values
Connected	0
Static	1
EIGRP summary route	5
External Border Gateway Protocol (BGP)	20

Internal EIGRP	90
Interior Gateway Routing Protocol (IGRP)	100
OSPF	110
Intermediate System-to-Intermediate System (IS-IS)	115
Routing Information Protocol (RIP)	120
Exterior Gateway Protocol (EGP)	140
On Demand Routing (ODR)	160
External EIGRP	170
Internal BGP	200
Unknown*	255



Note: If the administrative distance is 255, the router does not consider the route reliable and does not install it in the routing table.

When a router learns the same destination prefix from more than one routing source, you can modify administrative distance to influence which route is installed in the routing table.



Note: Use caution if you are planning a change to the AD. AD is local to the router, and inconsistent changes across routers can cause asymmetric routing, suboptimal routing, routing loops, or traffic black holes.

For example, internal EIGRP has a default administrative distance of 90, and OSPF has a default administrative distance of 110. If both protocols advertise the same prefix, the router installs the EIGRP route by default because 90 is lower than 110.

To illustrate this behavior, R1 and R2 are directly connected through GigabitEthernet1 in the 172.16.1.0/24 network.

- R1 advertises 192.168.1.0/24 through EIGRP and OSPF.
- R2 advertises 10.0.0.0/24 through EIGRP and OSPF.
- Both routers learn the remote loopback network through both routing protocols.
- Because EIGRP has the lower default administrative distance, the EIGRP route is installed in the routing table.

On R1, the route to 10.0.0.0/24 is installed as an EIGRP route. The route code D indicates EIGRP. The values in brackets use the format [administrative distance/metric]. In this example, [90/130816] means that the route has an administrative distance of 90 and an EIGRP metric of 130816. On R2, the route to 192.168.1.0/24 is also installed as an EIGRP route:

<#root>

R1#

show ip route

```
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, m - OMP
       n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       H - NHRP, G - NHRP registered, g - NHRP registration summary
       o - ODR, P - periodic downloaded static route, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR
       & - replicated local route overrides by connected

Gateway of last resort is not set


 10.0.0.0/24 is subnetted, 1 subnets D 10.0.0.0 [90/130816] via 172.16.1.200, 00:16:10, GigabitEthernet1


      172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C        172.16.1.0/24 is directly connected, GigabitEthernet1
L        172.16.1.100/32 is directly connected, GigabitEthernet1
      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.1.0/24 is directly connected, Loopback0
L        192.168.1.1/32 is directly connected, Loopback0

R2#
```

show ip route

```
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, m - OMP
       n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       H - NHRP, G - NHRP registered, g - NHRP registration summary
       o - ODR, P - periodic downloaded static route, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR
       & - replicated local route overrides by connected

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        10.0.0.0/24 is directly connected, Loopback0
L        10.0.0.1/32 is directly connected, Loopback0
      172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C        172.16.1.0/24 is directly connected, GigabitEthernet1
L        172.16.1.200/32 is directly connected, GigabitEthernet1
D
```

192.168.1.0/24 [90/130816] via 172.16.1.100, 00:13:42, GigabitEthernet1

Although OSPF also learns the same prefix, the OSPF route is not installed in the routing table because its default administrative distance of 110 is higher than the EIGRP administrative distance of 90.

You can modify the administrative distance of routes learned by a routing process with the **distance <AD-value>** command. In this example, the OSPF administrative distance on R1 is changed to 85:

```
<#root>

R1#

configure terminal

R1(config)#

router ospf 100

R1(config-router)#

distance 85

R1(config-router)#

end
```



Caution: The example shows how to modify the AD of a protocol, however, use extreme caution when you change the AD. An inconsistent AD design can cause asymmetric routing, suboptimal routing, routing loops, or traffic black holes. Validate the routing design before and after the change.

After the AD change, R1 prefers the OSPF route to 10.0.0.0/24 because OSPF now has an administrative distance of 85, which is lower than the EIGRP administrative distance of 90.

The route code changes from D to O, which indicates that the OSPF route is now installed in the routing table. The value [85/2] shows an administrative distance of 85 and an OSPF metric of 2.

The administrative distance change has local significance only. It affects route selection on R1, but it is not advertised to R2. Therefore, R2 continues to prefer the EIGRP route to 192.168.1.0/24:

```
<#root>

R1#

show ip route

Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, m - OMP
       n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
```

```
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       H - NHRP, G - NHRP registered, g - NHRP registration summary
       o - ODR, P - periodic downloaded static route, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR
       & - replicated local route overrides by connected

Gateway of last resort is not set


 10.0.0.0/24 is subnetted, 1 subnets O 10.0.0.0 [85/2] via 172.16.1.200, 00:00:11, GigabitEthernet1


      172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C        172.16.1.0/24 is directly connected, GigabitEthernet1
L        172.16.1.100/32 is directly connected, GigabitEthernet1
      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.1.0/24 is directly connected, Loopback0
L        192.168.1.1/32 is directly connected, Loopback0

R2#
```

show ip route

```
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, m - OMP
       n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       H - NHRP, G - NHRP registered, g - NHRP registration summary
       o - ODR, P - periodic downloaded static route, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR
       & - replicated local route overrides by connected

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        10.0.0.0/24 is directly connected, Loopback0
L        10.0.0.1/32 is directly connected, Loopback0
      172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C        172.16.1.0/24 is directly connected, GigabitEthernet1
L        172.16.1.200/32 is directly connected, GigabitEthernet1
```

D 192.168.1.0/24 [90/130816] via 172.16.1.100, 00:20:15, GigabitEthernet1

There are no general guidelines to assign administrative distances because each network has varied requirements. You must determine a reasonable matrix of administrative distances for the network as a whole.

Additional Uses of AD

A common use of administrative distance is a floating static route. A floating static route is configured with an administrative distance higher than the primary route, so it is used only when the primary route is removed from the routing table.

In this example, R1 uses OSPF as the primary route source to reach 10.0.0.0/24 through R2. The OSPF route has the default administrative distance of 110.

```
<#root>

R1#

show ip route ospf

Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, m - OMP
       n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       H - NHRP, G - NHRP registered, g - NHRP registration summary
       o - ODR, P - periodic downloaded static route, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR
       & - replicated local route overrides by connected

Gateway of last resort is not set


 10.0.0.0/24 is subnetted, 1 subnets O 10.0.0.0 [110/2] via 172.16.1.200, 00:00:09, GigabitEthernet1
```



Note: The Administrative Distance is set to 250.

The route code O indicates that the route was learned through OSPF. The values in brackets use the format [administrative distance/metric]. In this case, [110/2] means that the route has an administrative distance of 110 and an OSPF metric of 2.

To configure a floating static route for the same destination, use an administrative distance higher than the OSPF administrative distance:

```
<#root>

R1#

configure terminal

R1(config)#
```

```
ip route 10.0.0.0 255.255.255.0 172.16.1.200 250

R1(config)#

end
```

In the previous command, 250 is the AD value assigned to the static route. Because 250 is higher than the OSPF AD of 110, the static route is not installed in the routing table while the OSPF route is available.

If the OSPF route is removed from the routing table, the floating static route becomes the best available route to 10.0.0.0/24 and is installed in the routing table:

```
<#root>

R1#

show ip route ospf

Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, m - OMP
       n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       H - NHRP, G - NHRP registered, g - NHRP registration summary
       o - ODR, P - periodic downloaded static route, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR
       & - replicated local route overrides by connected

Gateway of last resort is not set

R1#

show ip route



Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, m - OMP
       n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       H - NHRP, G - NHRP registered, g - NHRP registration summary
       o - ODR, P - periodic downloaded static route, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR
       & - replicated local route overrides by connected

Gateway of last resort is not set
```

```
 10.0.0.0/24 is subnetted, 1 subnets S 10.0.0.0 [250/0] via 172.16.1.200

      172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C        172.16.1.0/24 is directly connected, GigabitEthernet1
L        172.16.1.100/32 is directly connected, GigabitEthernet1
      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.1.0/24 is directly connected, Loopback0
L        192.168.1.1/32 is directly connected, Loopback0
```

The route code changes to S, which indicates that the static route is now installed. The value [250/0] shows an AD of 250 and a static route metric of 0.



Note: The floating static route is installed only when no route with a lower administrative distance exists for the same prefix. The next hop, 172.16.1.200, must also be reachable. If the next hop cannot be resolved, the static route is not installed.



Note: Use floating static routes carefully. An incorrect next hop, an administrative distance that is too low, or inconsistent backup routing can cause traffic to use the backup path unexpectedly or fail during a primary route outage.

For additional examples on the use of Floating Static routes, refer to these documents:

- Sample Configuration: Using Floating Static Routes and Dial-on-Demand Routing

Related Information

- Route Selection in Cisco Routers
- IP Routing Support Page
- Technical Support & Documentation - Cisco Systems