

Technology Overview

Using 4-Byte Autonomous System Numbers in BGP Networks



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Technology Overview Using 4-Byte Autonomous System Numbers in BGP Networks
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Table of Contents

Introduction	1
4-Byte Autonomous System Numbers Overview	1
Juniper Networks Implementation of 4-Byte Autonomous System Numbers	2
Configuring 4-Byte Autonomous System Numbers	3
Establishing a Peer Relationship Between a 4-Byte Capable Router and a 2-Byte Capable Router Using a 2-Byte AS Number	4
Establishing a Peer Relationship Between a 4-Byte Capable Router and a 2-Byte Capable Router Using a 4-Byte AS Number	6
Understanding a 4-Byte Capable Router AS Path Through a 2-Byte Capable Domain	7
Prepending 4-Byte AS Numbers in an AS Path	10
Understanding 4-Byte AS Numbers and Route Distinguishers	11
Configuring 4-Byte AS Numbers and BGP Extended Community Attributes	12
Understanding 4-Byte AS Numbers and Route Loop Detection	13
Disabling Attribute Set Messages on Independent AS Domains for BGP Loop Detection	15

Introduction

This document describes 4-byte autonomous system numbers and the operation of BGP in a network with a mix of 2-byte and 4-byte AS numbers. It also provides configuration examples for establishing a peer relationship, configuring 4-byte AS numbers, prepending 4-byte AS numbers, and disabling attribute set messages.

4-Byte Autonomous System Numbers Overview

This Technology Overview describes 4-byte autonomous system (AS) numbers and the operation of BGP in a network with a mix of 2-byte and 4-byte AS numbers.

The 2-byte AS number, also known as a 16-bit AS number or 2-octet AS number, provides a pool of 65,536 AS numbers. The 2-byte AS number range has been exhausted. 4-byte AS numbers are specified in RFC 4893, *BGP Support for Four-Octet AS Number Space* and provide a pool of 4,294,967,296 AS numbers.

As of January 1, 2009 the Internet Assigned Numbers Authority (IANA) only assigns 4-byte AS numbers, unless a 2-byte AS number is specifically requested. The Internet Engineering Task Force (IETF) RFC 4893 defines a method for smooth transition from 2-byte AS numbers to 4-byte AS numbers and for maintaining backward compatibility.

RFC 4893 introduces two new optional transitive BGP attributes, AS4_PATH and AS4_AGGREGATOR. These new attributes are used to propagate 4-byte AS path information across BGP speakers that do not support 4-byte AS numbers.

RFC 4893 also introduces a reserved, well-known, 2-byte AS number, AS 23456. This reserved AS number is called AS_TRANS in RFC 4893.

This Technology Overview presents the following topics:

- Juniper Networks implementation of 4-byte AS Numbers
- How to configure 4-byte AS numbers
- The impact on BGP peering sessions with a mix of 2-byte and 4-byte AS numbers
- The impact on BGP paths with a mix of 2-byte and 4-byte AS numbers
- How to configure route distinguishers using 4-byte AS numbers
- How to configure extended community attributes using 4-byte AS numbers
- The impact on BGP route loop detection with a mix of 2-byte and 4-byte AS numbers

Related Documentation

- [Juniper Networks Implementation of 4-Byte Autonomous System Numbers on page 2](#)
- [Configuring 4-Byte Autonomous System Numbers on page 3](#)
- [Establishing a Peer Relationship Between a 4-Byte Capable Router and a 2-Byte Capable Router Using a 2-Byte AS Number on page 4](#)
- [Establishing a Peer Relationship Between a 4-Byte Capable Router and a 2-Byte Capable Router Using a 4-Byte AS Number on page 6](#)

- [Understanding a 4-Byte Capable Router AS Path Through a 2-Byte Capable Domain on page 7](#)
- [Prepending 4-Byte AS Numbers in an AS Path on page 10](#)
- [Understanding 4-Byte AS Numbers and Route Distinguishers on page 11](#)
- [Configuring 4-Byte AS Numbers and BGP Extended Community Attributes on page 12](#)
- [Understanding 4-Byte AS Numbers and Route Loop Detection on page 13](#)
- [Disabling Attribute Set Messages on Independent AS Domains for BGP Loop Detection on page 15](#)

Juniper Networks Implementation of 4-Byte Autonomous System Numbers

Junos OS Release 9.1 and later supports 4-byte AS numbers.

If your network is currently using 2-byte AS numbers, you are not required to get new 4-byte AS numbers. The 2-byte AS number range is a subset of the 4-byte AS number range. A Juniper networks router that supports 4-byte AS numbers simply prepends a string of zeros in front of the 2-byte AS number. For example, the 2-byte AS number 65000 becomes the 4-byte AS number 00000.65000.

If your Juniper Networks router supports 4-byte AS numbers and has a peer relationship with a router that does not support 4-byte AS numbers, the following sequence takes place in the adjacent RIB-in routing table after the router that supports 4-byte AS numbers advertises this capability to the new peer:

1. The router that supports 4-byte AS numbers receives an advertisement from the peer that supports only 2-byte AS numbers.
2. On the router that supports 4-byte AS numbers, the 2-byte AS path is converted into the 4-byte AS number by prepending a string of zeros in front of the 2-byte AS number.
3. If a 4-byte AS number is also present in the path, it is merged with the 2-byte AS numbers in the path.
4. If the AGGREGATOR and AS4_AGGREGATOR attributes are present, these attributes are also merged.

If your Juniper Networks router supports 4-byte AS numbers and has a peer relationship with a router that does not support 4-byte AS numbers, the following sequence takes place in the adjacent RIB-out routing table:

1. Update message are reformatted before being sent to the router that does not support 4-byte AS numbers.
2. The router that supports 4-byte AS numbers sends the 4-byte AS number in the AS4_PATH attribute.
3. The AS_PATH attribute is also sent. It is encoded with the 2-byte AS numbers. Mappable 4-byte AS numbers, below 64537, are sent as 2-byte AS numbers.

Non-mappable 4-byte AS numbers, above 64536, are represented by the well-known 2-byte AS number, AS 23456.

4. A single peer group is used for the routers that support 4-byte AS numbers and the routers that support only 2-byte AS numbers.

**Related
Documentation**

- [4-Byte Autonomous System Numbers Overview on page 1](#)
- [Configuring 4-Byte Autonomous System Numbers on page 3](#)
- [Establishing a Peer Relationship Between a 4-Byte Capable Router and a 2-Byte Capable Router Using a 2-Byte AS Number on page 4](#)
- [Establishing a Peer Relationship Between a 4-Byte Capable Router and a 2-Byte Capable Router Using a 4-Byte AS Number on page 6](#)
- [Understanding a 4-Byte Capable Router AS Path Through a 2-Byte Capable Domain on page 7](#)
- [Prepending 4-Byte AS Numbers in an AS Path on page 10](#)
- [Understanding 4-Byte AS Numbers and Route Distinguishers on page 11](#)
- [Configuring 4-Byte AS Numbers and BGP Extended Community Attributes on page 12](#)
- [Understanding 4-Byte AS Numbers and Route Loop Detection on page 13](#)
- [Disabling Attribute Set Messages on Independent AS Domains for BGP Loop Detection on page 15](#)

Configuring 4-Byte Autonomous System Numbers

This section describes how to configure a 4-byte AS number and how to verify if the BGP peer supports 4-byte AS numbers.

The AS number can be specified in plain number format or in AS-dot notation format on routers running Junos OS Release 9.2 and later. For example, the 4-byte AS number of 65,546 is represented in plain-number format as 65546. The same AS number is represented in AS-dot notation format as 1.10 on routers running Junos OS Release 9.2 and later.

- To configure a 4-byte AS number in AS-dot notation format, include the **autonomous-system** statement and specify the 4-byte AS number. In the following example the AS number is set to 1.10.

```
user@host# set routing-options autonomous-system 1.10
```

- To configure a 4-byte AS number in plain number format, include the **autonomous-system** statement and specify the 4-byte AS number. In the following example the AS number is set to 65546.

```
user@host# set routing-options autonomous-system 65546
```

- After a BGP peer session has been negotiated, you can verify whether the peer supports 4-byte AS numbers or not. To verify whether the peer supports 4-byte AS numbers or

not, use the **show bgp neighbor** command. In the following example the peer does not support 4-byte AS numbers.

```
user@host# show bgp neighbor 192.168.1.9 | match "AS"
Peer: 192.168.1.9+179 AS 65056 Local: 192.168.1.3+52616 AS 65000
Peer does not support 4 byte AS extension
```

- In the following example the peer does support 4-byte AS numbers.

```
user@host# show bgp neighbor 192.168.1.9 | match "AS"
Peer: 192.168.1.10+52679 AS 1000000000 Local: 192.168.1.3+179 AS 65000
Peer supports 4 byte AS extension (peer-as 1000000000)
```

Related Documentation

- [4-Byte Autonomous System Numbers Overview on page 1](#)
- [Juniper Networks Implementation of 4-Byte Autonomous System Numbers on page 2](#)
- [Establishing a Peer Relationship Between a 4-Byte Capable Router and a 2-Byte Capable Router Using a 2-Byte AS Number on page 4](#)
- [Establishing a Peer Relationship Between a 4-Byte Capable Router and a 2-Byte Capable Router Using a 4-Byte AS Number on page 6](#)
- [Understanding a 4-Byte Capable Router AS Path Through a 2-Byte Capable Domain on page 7](#)
- [Prepending 4-Byte AS Numbers in an AS Path on page 10](#)
- [Understanding 4-Byte AS Numbers and Route Distinguishers on page 11](#)
- [Configuring 4-Byte AS Numbers and BGP Extended Community Attributes on page 12](#)
- [Understanding 4-Byte AS Numbers and Route Loop Detection on page 13](#)
- [Disabling Attribute Set Messages on Independent AS Domains for BGP Loop Detection on page 15](#)

Establishing a Peer Relationship Between a 4-Byte Capable Router and a 2-Byte Capable Router Using a 2-Byte AS Number

This section describes what happens when a router that supports 4-byte AS numbers establishes a peer relationship with a router that only supports 2-byte AS numbers if both routers are configured with AS numbers in the 2-byte AS number range.

In [Figure 1 on page 4](#), Router 1 is running Junos OS Release 9.2 that supports 4-byte AS numbers. Router 1 is configured to use a 2-byte AS number, AS 12596. Router 2 is running Junos OS Release 8.5 that supports 2-byte AS numbers. Router 2 is configured with a 2-byte AS number, AS 60000.

Figure 1: 4-Byte Capable Router Having a Peer Relationship With a 2-Byte Capable Router Using a 2-Byte AS Number



- The following example shows the relevant portion of the Router 1 configuration.

```
user@Router1# show configuration
...
autonomous-system 12596;
...
local-address 192.168.1.10;
export static-to-bgp;
peer-as 60000;
```

- To verify that the AS path of route 1.2.3.4 contains AS 12596, use the **show route** command on Router 2. The following example shows that the BGP peer session is established in the normal way and that the AS path of route 1.2.3.4 contains AS 12596:

```
user@Router2# show route 1.2.3.4
1.2.3.4/32          *[BGP/170] 00:01:29, localpref 100, from 192.168.1.10
                   AS path: 12596 I
                   > via at-0/1/0.1001
```

- To display the session-establishment messages logged on Router 1, use the **show log messages** command. The following example shows that Router 1 discovers that Router 2 does not support 4-byte AS numbers:

```
user@Router1# show log messages
Nov  7 09:41:39.443493 bgp_4byte_aspath_add_cap():153 AS4-Peer 192.168.1.9
(External AS 60000)(SEND): 4 byte AS capability added, AS 12596
Nov  7 09:41:39.443582 bgp_send: sending 67 bytes to 192.168.1.9 (External AS
60000)
[...]
Nov  7 09:41:39.448055 bgp_4byte_aspath_adjust():1279 AS4-Peer 192.168.1.9
(External AS 60000)(SEND): Adjust BGP update to Old/New BGP speaker format
Nov  7 09:41:39.448132 bgp_4byte_aspath_adjust():1290 AS4-Peer 192.168.1.9
(External AS 60000)(SEND): Cached information of previous update format is not
used
Nov  7 09:41:39.448162 bgp_generate_2byte_aspath():422 AS4-Peer 192.168.1.9
(External AS 60000)(SEND): Generating 2 byte AS path from 4 byte as-path
Nov  7 09:41:39.448198 bgp_send: sending 64 bytes to 192.168.1.9 (External AS
60000)
```

Related Documentation

- [4-Byte Autonomous System Numbers Overview on page 1](#)
- [Juniper Networks Implementation of 4-Byte Autonomous System Numbers on page 2](#)
- [Configuring 4-Byte Autonomous System Numbers on page 3](#)
- [Establishing a Peer Relationship Between a 4-Byte Capable Router and a 2-Byte Capable Router Using a 4-Byte AS Number on page 6](#)
- [Understanding a 4-Byte Capable Router AS Path Through a 2-Byte Capable Domain on page 7](#)
- [Prepending 4-Byte AS Numbers in an AS Path on page 10](#)
- [Understanding 4-Byte AS Numbers and Route Distinguishers on page 11](#)
- [Configuring 4-Byte AS Numbers and BGP Extended Community Attributes on page 12](#)
- [Understanding 4-Byte AS Numbers and Route Loop Detection on page 13](#)
- [Disabling Attribute Set Messages on Independent AS Domains for BGP Loop Detection on page 15](#)

Establishing a Peer Relationship Between a 4-Byte Capable Router and a 2-Byte Capable Router Using a 4-Byte AS Number

This section describes what happens when a router that supports 4-byte AS numbers establishes a peer relationship with a router that only supports 2-byte AS numbers if the first router is configured with an AS number outside the 2-byte AS number range.

In [Figure 2 on page 6](#), Router 2 is running Junos OS Release 9.2 that supports 4-byte AS numbers. Router 2 is configured to use a 4-byte AS number, AS 1000000. Router 3 is running Junos OS Release 8.5 that supports 2-byte AS numbers. Router 3 is configured with a 2-byte AS number, AS 60000.

Figure 2: 4-Byte Capable Router Having a Peer Relationship With a 2-Byte Capable Router Using a 4-Byte AS Number



You can configure a local AS number to be used only during the establishment of the BGP session with a BGP neighbor, but to be hidden in the AS path sent to external BGP peers. To configure the local AS number, include the **local-as** statement, specify the 2-byte AS number to use, 65530, and include the **private** option. With this configuration, only the global AS number, 1000000, is included in the AS path sent to external peers. The following example shows the relevant portion of the Router 1 configuration:

```
user@Router1# show configuration
...
autonomous-system 1000000;
...
local-address 192.168.1.9;
export static-to-bgp;
neighbor 192.168.1.3 {
    peer-as 60000;
    local-as 65530 private;
}
```

The peer AS number on Router 3 should equal the local AS number on Router 1. The following example shows the relevant portion of the Router 3 configuration:

```
user@Router3# show configuration
...
autonomous-system 60000;
...
local-address 192.168.1.3;
neighbor 192.168.1.9 {
    peer-as 65530;
}
```

To verify that the AS path of route 22.1.2.3 contains AS 65530, use the **show route** command on Router 3. The following example shows that the BGP peer session is established and that the AS path of route 22.1.2.3 contains AS 65530:

```
user@Router3# show route 22.1.2.3
```

```

...
22.1.2.3/32      *[BGP/170] 01:39:55, localpref 100, from 192.168.1.9
                  AS path: 65530 I
                  > via so-1/0/3.0

```

Related Documentation

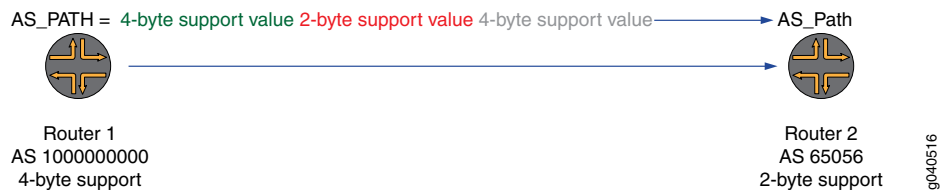
- [4-Byte Autonomous System Numbers Overview on page 1](#)
- [Juniper Networks Implementation of 4-Byte Autonomous System Numbers on page 2](#)
- [Configuring 4-Byte Autonomous System Numbers on page 3](#)
- [Establishing a Peer Relationship Between a 4-Byte Capable Router and a 2-Byte Capable Router Using a 2-Byte AS Number on page 4](#)
- [Understanding a 4-Byte Capable Router AS Path Through a 2-Byte Capable Domain on page 7](#)
- [Prepending 4-Byte AS Numbers in an AS Path on page 10](#)
- [Understanding 4-Byte AS Numbers and Route Distinguishers on page 11](#)
- [Configuring 4-Byte AS Numbers and BGP Extended Community Attributes on page 12](#)
- [Understanding 4-Byte AS Numbers and Route Loop Detection on page 13](#)
- [Disabling Attribute Set Messages on Independent AS Domains for BGP Loop Detection on page 15](#)

Understanding a 4-Byte Capable Router AS Path Through a 2-Byte Capable Domain

This section describes what happens when a router that supports 4-byte AS numbers sends the AS path statement to a router that only supports 2-byte AS numbers if the first router is configured with an AS number outside the 2-byte AS number range.

In [Figure 3 on page 7](#) Router 1 supports 4-byte AS numbers. Router 1 is configured to use a 4-byte AS number, AS 1000000000. Router 2 supports 2-byte AS numbers. Router 2 is configured with a 2-byte AS number, AS 65056.

Figure 3: 4-Byte Capable Router AS Path to a 2-Byte Capable Router



- Router 2 does not accept 4-byte AS numbers in the AS_PATH attribute. You can verify this using the `show bgp neighbor` command on Router 1.

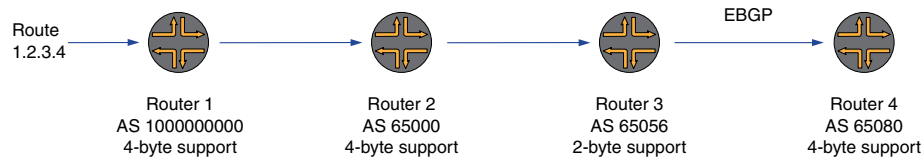
```

user@Router1# show bgp neighbor 192.168.1.9 | match "AS"
Peer: 192.168.1.9+179 AS 65056 Local: 192.168.1.2+64053 AS 65080
Peer does not support 4 byte AS extension

```

[Figure 4 on page 8](#) shows four routers running EBGP. Router 1, Router 2, and Router 4 support 4-byte AS numbers. Router 3 does not support 4-byte AS numbers.

Figure 4: EBGP 4-Byte AS Path Through a 2-Byte AS Domain



9040519

In this case:

- Router 1 sends the 4-byte AS number, AS 1000000000, in the AS_PATH attribute to Router 2.
- Router 2 knows that Router 3 does not support 4-byte AS numbers.
- Router 2 sends the AS_TRANS number, AS 23456, in the AS_PATH attribute in place of the 4-byte AS number to Router 3.
- Router 2 sends the 4-byte AS number, AS 1000000000 in the AS4_PATH attribute to Router 3.
- Because the AS4_PATH attribute is transitive, Router 3 sends both the AS_PATH attribute and the AS4_PATH attribute to Router 4.
- When Router 4 receives the AS_PATH and AS4_PATH attributes, it merges the path statements to create an accurate AS path.

You can display the AS path using the **show route** command on Router 3. In the following example, notice that the AS number 23456 appears in the AS path and that the AS4_PATH attribute is **Unrecognized**. Because the AS4_PATH attribute is a transitive attribute, it is forwarded to the next router.

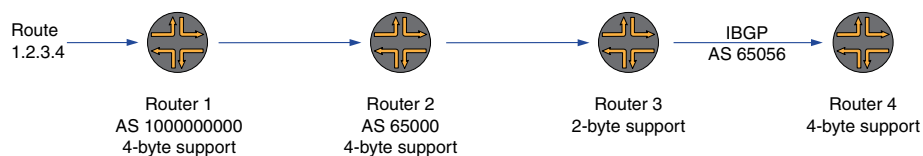
```
user@Router3# show route 1.2.3.4 detail
AS path: 65000 23456 I Unrecognized Attributes: 13 bytes
```

You can display the route details using the **show route** command on Router 4. In the following example, notice that as the AS path transitions Router 3, as shown in the AS2 (2-byte AS) path, the AS number is displayed as AS_TRANS. This means that Router 3 sees the AS number as 23456. In the AS4 (4-byte AS) path the AS number is displayed as 1000000000. In the merged AS path the correct AS path numbers are displayed for AS 65056, AS 65000, and AS 1000000000.

```
user@Router4# show route 1.2.3.4 detail
...
AS path: AS2 PA[3]:65056 65000 AS_TRANS
AS path: AS4 PA[2]:65056 1000000000
AS path: Merged[3]:65056 65000 1000000000 I
```

[Figure 5 on page 9](#) shows 4 routers running IBGP. Router 1, Router 2, and Router 4 support 4-byte AS numbers. Router 3 does not support 4-byte AS numbers.

Figure 5: IBGP 4-Byte AS Path Through a 2-Byte AS Domain



9040518

In this case:

- Router 1 sends the 4-byte AS number, AS 1000000000, in the AS_PATH attribute to Router 2.
- Router 2 knows that Router 3 does not support 4-byte AS numbers.
- Router 2 sends the AS_TRANS number, AS 23456, in the AS_PATH attribute in place of the 4-byte AS number to Router 3.
- Router 3 sends both the AS_PATH attribute and the AS4_PATH attribute to Router 4.
- When Router 4 receives the AS_PATH and AS4_PATH attributes, it merges the path statements to create an accurate AS path.

You can display the route details using the **show route** command on Router 2. In the following example, notice that the AS path is displayed as 1000000000.

```
user@Router2# show route 1.2.3.4 detail
...
AS path: 1000000000
```

You can display the route details using the **show route** command on Router 3. In the following example, notice that the AS path is displayed as 65000 23456.

```
user@Router3# show route 1.2.3.4 detail
...
AS path: 65000 23456 I
```

You can display the route details using the **show route** command on Router 4. In the following example, notice that the merged AS path is displayed as 65000 1000000000.

```
user@Router4# show route 1.2.3.4 detail
...
AS path: 65000 1000000000 I
```

Related Documentation

- [4-Byte Autonomous System Numbers Overview on page 1](#)
- [Juniper Networks Implementation of 4-Byte Autonomous System Numbers on page 2](#)
- [Configuring 4-Byte Autonomous System Numbers on page 3](#)
- [Establishing a Peer Relationship Between a 4-Byte Capable Router and a 2-Byte Capable Router Using a 2-Byte AS Number on page 4](#)
- [Establishing a Peer Relationship Between a 4-Byte Capable Router and a 2-Byte Capable Router Using a 4-Byte AS Number on page 6](#)
- [Prepending 4-Byte AS Numbers in an AS Path on page 10](#)
- [Understanding 4-Byte AS Numbers and Route Distinguishers on page 11](#)

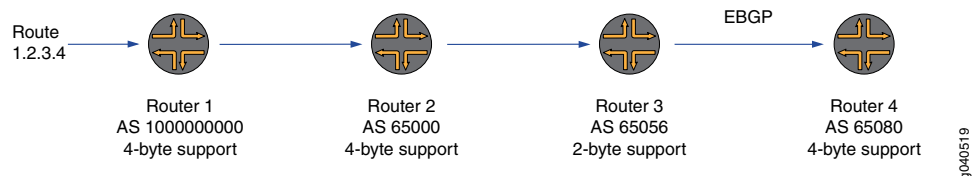
- [Configuring 4-Byte AS Numbers and BGP Extended Community Attributes on page 12](#)
- [Understanding 4-Byte AS Numbers and Route Loop Detection on page 13](#)
- [Disabling Attribute Set Messages on Independent AS Domains for BGP Loop Detection on page 15](#)

Prepending 4-Byte AS Numbers in an AS Path

This section describes how to prepend one or more AS numbers at the beginning of an AS path. The AS numbers are added at the beginning of the path after the actual AS number from which the route originates has been added to the path. Prepending an AS path makes a shorter AS path look longer and therefore less preferable to BGP.

In [Figure 6 on page 10](#), Router 2 is configured to prepend AS 1000000000 4 times in front of AS number 65000.

Figure 6: EBGP With 4-Byte AS Numbers Prepend to the AS Path



You can display the route details using the `show route` command on Router 3. In the following example, notice that the prepended AS number displayed in the AS path on Router 3 is the AS_TRANS number, AS 23456. This is because Router 3 does not support 4-byte AS numbers.

```
user@Router3# show route 1.2.3.4 detail
...
1.2.3.4/32          *[BGP/170] 01:39:55, localpref 100, from 192.168.1.3
                   AS path: 65000 23456 23456 23456 23456 I
```

You can display the route details using the `show route` command on Router 4. In the following example, notice that the prepended AS number displayed in the AS path on Router 4 is AS 1000000000. This is because Router 4 supports 4-byte AS numbers and merges the AS_PATH and AS4_PATH attributes.

```
user@Router4# show route 1.2.3.4 detail
...
1.2.3.4/32          *[BGP/170] 01:39:55, localpref 100, from 192.168.1.9
                   AS path: 65056 65000 1000000000 1000000000 1000000000 1000000000 I
```

Related Documentation

- [4-Byte Autonomous System Numbers Overview on page 1](#)
- [Juniper Networks Implementation of 4-Byte Autonomous System Numbers on page 2](#)
- [Configuring 4-Byte Autonomous System Numbers on page 3](#)
- [Establishing a Peer Relationship Between a 4-Byte Capable Router and a 2-Byte Capable Router Using a 2-Byte AS Number on page 4](#)

-
- [Establishing a Peer Relationship Between a 4-Byte Capable Router and a 2-Byte Capable Router Using a 4-Byte AS Number on page 6](#)
 - [Understanding a 4-Byte Capable Router AS Path Through a 2-Byte Capable Domain on page 7](#)
 - [Understanding 4-Byte AS Numbers and Route Distinguishers on page 11](#)
 - [Configuring 4-Byte AS Numbers and BGP Extended Community Attributes on page 12](#)
 - [Understanding 4-Byte AS Numbers and Route Loop Detection on page 13](#)
 - [Disabling Attribute Set Messages on Independent AS Domains for BGP Loop Detection on page 15](#)

Understanding 4-Byte AS Numbers and Route Distinguishers

A route distinguisher (RD) is an 8-byte field prefixed to a service provider customer's IPv4 address. The resulting 12-byte field is a unique VPN-IPv4 address. The RD in BGP messages consists of two major fields, the type field (2 bytes) and value field (6 bytes). The type field determines how the value field should be interpreted.

The route distinguisher is configured as a 6-byte value that you can specify as **as-number:number**, where **as-number** is your assigned AS number and **number** (also known as an administrative number or assigned number subfield) is any 2-byte or 4-byte value. The AS number can be in the range from 1 through 4,294,967,295. If the AS number is a 2-byte value, the administrative number is a 4-byte value. If the AS number is 4-byte value, the administrative number is a 2-byte value.

An RD consisting of a 4-byte AS number and a 2-byte administrative number is defined as a type 2 route distinguisher in RFC 4364, *BGP/MPLS IP Virtual Private Networks*.

To configure an RD using a 4-byte AS number, append the letter "L" to the end of the number. In the following example, the 4-byte AS number is 7765000 and the administrative number is 1000:

```
user@Router1# set routing-instances 4B route-distinguisher 7765000L:1000
```

If the router you are configuring is a BGP peer of a router that does not support 4-byte AS numbers, you also need to configure a local AS number as discussed in ["Establishing a Peer Relationship Between a 4-Byte Capable Router and a 2-Byte Capable Router Using a 4-Byte AS Number" on page 6](#). To configure the local AS number, include the **local-as** statement, specify the 2-byte AS number to use (65001), and include the **private** option.

```
user@Router1# set routing-instances 4B protocols bgp group 4B2Bpeers local-as 65001 private
```

Related Documentation

- [4-Byte Autonomous System Numbers Overview on page 1](#)
- [Juniper Networks Implementation of 4-Byte Autonomous System Numbers on page 2](#)
- [Configuring 4-Byte Autonomous System Numbers on page 3](#)

- [Establishing a Peer Relationship Between a 4-Byte Capable Router and a 2-Byte Capable Router Using a 2-Byte AS Number on page 4](#)
- [Establishing a Peer Relationship Between a 4-Byte Capable Router and a 2-Byte Capable Router Using a 4-Byte AS Number on page 6](#)
- [Understanding a 4-Byte Capable Router AS Path Through a 2-Byte Capable Domain on page 7](#)
- [Prepending 4-Byte AS Numbers in an AS Path on page 10](#)
- [Configuring 4-Byte AS Numbers and BGP Extended Community Attributes on page 12](#)
- [Understanding 4-Byte AS Numbers and Route Loop Detection on page 13](#)
- [Disabling Attribute Set Messages on Independent AS Domains for BGP Loop Detection on page 15](#)

Configuring 4-Byte AS Numbers and BGP Extended Community Attributes

A BGP community is a group of destinations that share a common property. You can configure the standard community attribute and extended community attributes for inclusion in BGP update messages.

For example, when configuring a VPN routing and forwarding (VRF) instance, you need to configure a route target. A route target is one type of BGP extended community attribute. To create a named BGP extended community attribute, include the **community** statement and specify the community members:

```
community name {  
    members [ community-ids ];  
}
```

To specify the community members, you must specify the community ID. The community ID consists of three components that you specify in the following format:

```
type:administrator:assigned-number
```

The **administrator** field of some BGP extended community attributes is an AS number. To configure a **target** extended community, which includes a 4-byte AS number in the plain-number format, append the letter “L” to the end of the number.

In the following example, a **target** community with the 4-byte AS number **334324** and an assigned number of **132** is represented as **target:334324L:132**.

```
[edit policy-options]  
community vpn_blue members [ target:334324L:132 ];
```



NOTE: If you display the target extended community information on a peer router that does not support 4-byte AS numbers, the router displays **target:unknown** format.

Related Documentation

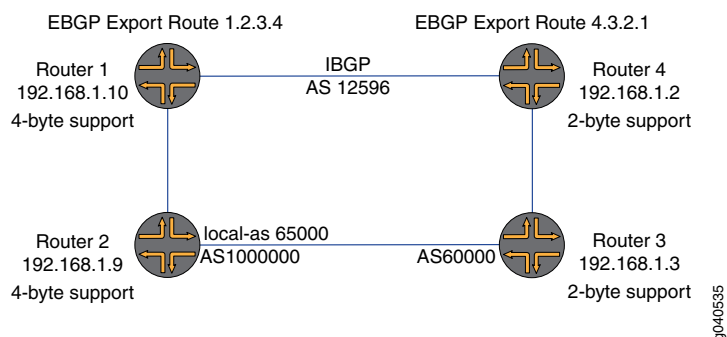
- [4-Byte Autonomous System Numbers Overview on page 1](#)
- [Juniper Networks Implementation of 4-Byte Autonomous System Numbers on page 2](#)
- [Configuring 4-Byte Autonomous System Numbers on page 3](#)
- [Establishing a Peer Relationship Between a 4-Byte Capable Router and a 2-Byte Capable Router Using a 2-Byte AS Number on page 4](#)
- [Establishing a Peer Relationship Between a 4-Byte Capable Router and a 2-Byte Capable Router Using a 4-Byte AS Number on page 6](#)
- [Understanding a 4-Byte Capable Router AS Path Through a 2-Byte Capable Domain on page 7](#)
- [Prepending 4-Byte AS Numbers in an AS Path on page 10](#)
- [Understanding 4-Byte AS Numbers and Route Distinguishers on page 11](#)
- [Understanding 4-Byte AS Numbers and Route Loop Detection on page 13](#)
- [Disabling Attribute Set Messages on Independent AS Domains for BGP Loop Detection on page 15](#)

Understanding 4-Byte AS Numbers and Route Loop Detection

One of the most important functions in BGP is route loop detection at the autonomous system level using the AS_PATH attribute. A simple way of thinking of the AS_PATH is that it is the list of autonomous systems that a route goes through to reach its destination. Loops are detected and avoided by the router checking for its own AS number in the AS_PATH received from a neighboring AS.

This section describes how route loop detection works with a mix of routers that support and do not support 4-byte AS numbers. [Figure 7 on page 13](#) shows a small network with the potential for BGP loops.

Figure 7: 4-Byte AS Numbers and Loop Detection



In the first example, an EBGP route, route 1.2.3.4, is first advertised by Router 1. The first AS in the path is AS 12596 as configured on Router 1. The second AS that is in the path is AS 1000000 as configured on Router 2. AS 1000000 is sent in the AS4_path attribute and the AS_TRANS number, AS 23456, is sent in the AS_PATH attribute to Router 3. The third AS that is in the path is AS 60000, as configured on Router 3.

The **show route** command output shows the AS path for route 1.2.3.4 as advertised by Router 3 to Router 4. In the **show route** command output, you see AS 12596 first. Because Router 3 does not support 4-byte AS numbers, you see AS 23456 second. Because Router 2 used a local AS of 65000 to establish a peer relationship with Router 3, you see AS 65000 third. AS 60000 is not in the **show route** command output because the command was entered on the router configured with AS 60000.

```
user@Router3# show route advertising-protocol bgp 192.168.1.2
...
Prefix Nexthop MED Lc1pref AS path
10.255.14.172/32 Self 65000 23456 12596 I
```

In this case, when Router 4 sees its own AS number, AS 12596, in the path, it detects a routing loop.

In the second example, an EBGP route, route 4.3.2.1, is first advertised by Router 4. The first AS in the path is AS 12596 as configured on Router 4. The second AS in the path is AS 60000 as configured on Router 3. The third AS in the path is AS 1000000 as configured on Router 2.

The **show route** command output shows the AS path for route 4.3.2.1 as advertised by Router 2 to Router 1. In the **show route** command output, you see AS 12596 first and AS 60000 second. AS 1000000 is not in the **show route** command output because the command was entered on the router configured with AS 1000000.

```
user@Router2# show route advertising-protocol bgp 192.168.1.10
...
Prefix Nexthop MED Lc1pref AS path
10.255.14.172/32 Self 60000 12596 I
```

When Router 1 sees its own AS number, AS 12596, in the path, it detects a routing loop.

Related Documentation

- [4-Byte Autonomous System Numbers Overview on page 1](#)
- [Juniper Networks Implementation of 4-Byte Autonomous System Numbers on page 2](#)
- [Configuring 4-Byte Autonomous System Numbers on page 3](#)
- [Establishing a Peer Relationship Between a 4-Byte Capable Router and a 2-Byte Capable Router Using a 2-Byte AS Number on page 4](#)
- [Establishing a Peer Relationship Between a 4-Byte Capable Router and a 2-Byte Capable Router Using a 4-Byte AS Number on page 6](#)
- [Understanding a 4-Byte Capable Router AS Path Through a 2-Byte Capable Domain on page 7](#)
- [Prepending 4-Byte AS Numbers in an AS Path on page 10](#)
- [Understanding 4-Byte AS Numbers and Route Distinguishers on page 11](#)
- [Configuring 4-Byte AS Numbers and BGP Extended Community Attributes on page 12](#)
- [Disabling Attribute Set Messages on Independent AS Domains for BGP Loop Detection on page 15](#)

Disabling Attribute Set Messages on Independent AS Domains for BGP Loop Detection

BGP loop detection for a specific route uses the local autonomous system (AS) domain for the routing instance. By default, all routing instances belong to a single primary routing instance domain. Therefore, BGP loop detection uses the local ASs configured on all of the routing instances. Depending on your network configuration, this default behavior can cause routes to be looped and hidden.

To limit the local ASs in the primary routing instance, you can configure an independent AS domain for a routing instance. The independent domain is separate from the primary routing instance and keeps the AS paths of the independent domain from being shared with the AS path and the AS path attributes of other domains.

By default, independent domains use transitive path attribute 128 (attribute set) messages to tunnel the independent domain's BGP attributes through the internal BGP (IBGP) core. However, the attribute set message behavior for independent domains is undesired in many cases. If you only want to configure independent domains to maintain the independence of local ASs in the routing instance, and perform BGP loop detection only for the specified local ASs in the routing instance, you can disable the attribute set messages.

To disable attribute set messages on an independent domain, include the **independent-domain no-attrset** statement:

1. Select the routing instance that contains the independent domain you want to modify. You can select the routing instance from the following hierarchy levels:
 - [edit routing-instances *routing-instance-name*]
 - [edit logical-systems *logical-system-name* routing-instances *routing-instance-name*]
2. Disable attribute set messages on the independent domain.

```
[edit routing-instances instance-name]  
user@host# set routing-options autonomous-system as-number independent-domain  
no-attrset
```



TIP: When you disable attribute set messages, we recommend that you specify the AS number of the primary routing instance. This ensures that the primary routing instance AS is treated as a local AS in the routing instance and is used for BGP loop detection.

After you specify a routing instance for an independent domain, the local ASs are only associated with that routing instance. That means BGP loop detection uses only the local ASs defined in the routing instance.

Related Documentation

- [4-Byte Autonomous System Numbers Overview on page 1](#)
- [Juniper Networks Implementation of 4-Byte Autonomous System Numbers on page 2](#)
- [Configuring 4-Byte Autonomous System Numbers on page 3](#)

- [Establishing a Peer Relationship Between a 4-Byte Capable Router and a 2-Byte Capable Router Using a 2-Byte AS Number on page 4](#)
- [Establishing a Peer Relationship Between a 4-Byte Capable Router and a 2-Byte Capable Router Using a 4-Byte AS Number on page 6](#)
- [Understanding a 4-Byte Capable Router AS Path Through a 2-Byte Capable Domain on page 7](#)
- [Prepending 4-Byte AS Numbers in an AS Path on page 10](#)
- [Understanding 4-Byte AS Numbers and Route Distinguishers on page 11](#)
- [Configuring 4-Byte AS Numbers and BGP Extended Community Attributes on page 12](#)
- [Understanding 4-Byte AS Numbers and Route Loop Detection on page 13](#)