

Network Configuration Example

Configuring BGP Route Authentication

Release
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Juniper Networks, Inc.
1194 North Mathilda Avenue
Sunnyvale, California 94089
USA
408-745-2000
www.juniper.net

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Introduction

This document provides an overview and describes how to configure route authentication for BGP by using a hashed key and keychain for authentication. This method can be used to mitigate the risk of being attacked by a device that is configured to share incorrect routing information with another router.

Understanding Route Authentication

The use of router and route authentication and route integrity greatly mitigates the risk of being attacked by a machine or router that has been configured to share incorrect routing information with another router. In this kind of attack, the attacked router can be tricked into creating a routing loop, or the attacked router's routing table can be greatly increased thus impacting performance, or routing information can be redirected to a place in the network for the attacker to analyze it. Bogus route advertisements can be sent out on a segment. These updates can be accepted into the routing tables of neighbor routers unless an authentication mechanism is in place to verify the source of the routes.

Router and route authentication enables routers to share information only if they can verify that they are talking to a trusted source, based on a password (key). In this method, a hashed key is sent along with the route being sent to another router. The receiving router compares the sent key to its own configured key. If they are the same, it accepts the route. By using a hashing algorithm, the key is not sent over the wire in plain text. Instead, a hash is calculated using the configured key. The routing update is used as the input text, along with the key, into the hashing function. This hash is sent along with the route update to the receiving router. The receiving router compares the received hash with a hash it generates on the route update using the preshared key configured on it. If the two hashes are the same, the route is assumed to be from a trusted source. The key is known only to the sending and receiving routers.

To further strengthen security, you can configure a series of authentication keys (a *keychain*). Each key has a unique start time within the keychain. Keychain authentication allows you to change the password information periodically without bringing down peering sessions. This keychain authentication method is referred to as *hitless* because the keys roll over from one to the next without resetting any peering sessions or interrupting the routing protocol.

The sending peer uses the following rules to identify the active authentication key:

- The start time is less than or equal to the current time (in other words, not in the future).
- The start time is greater than that of all other keys in the chain whose start time is less than the current time (in other words, closest to the current time).

The receiving peer determines the key with which it authenticates based on the incoming key identifier.

The sending peer identifies the current authentication key based on a configured start time and then generates a hash value using the current key. The sending peer then inserts a TCP-enhanced authentication option object into the BGP update message. The object

contains an object ID (assigned by IANA), the object length, the current key, and a hash value.

The receiving peer examines the incoming TCP-enhanced authentication option, looks up the received authentication key, and determines whether the key is acceptable based on the start time, the system time, and the tolerance parameter. If the key is accepted, the receiving peer calculates a hash and authenticates the update message.

Initial application of a keychain to a TCP session causes the session to reset. However, once the keychain is applied, the addition or removal of a password from the keychain does not cause the TCP session to reset. Also, the TCP session does not reset when the keychain changes from one authentication algorithm to another.

Related Documentation

- Example: Configuring Hitless Authentication Key Rollover for IS-IS
- [Example: Configuring Route Authentication for BGP on page 2](#)
- Example: Configuring MD5 Authentication for OSPFv2 Exchanges

Example: Configuring Route Authentication for BGP

All BGP protocol exchanges can be authenticated to guarantee that only trusted routing devices participate in autonomous system (AS) routing updates. By default, authentication is disabled.

- [Requirements on page 2](#)
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Requirements

Before you begin:

- Configure the router interfaces.
- Configure an interior gateway protocol (IGP).

Overview

When you configure authentication, the algorithm creates an encoded checksum that is included in the transmitted packet. The receiving routing device uses an authentication key (password) to verify the packet's checksum.

This example includes the following statements for configuring and applying the keychain:

- **key**—A keychain can have multiple keys. Each key within a keychain must be identified by a unique integer value. The range of valid identifier values is from 0 through 63.

The key can be up to 126 characters long. Characters can include any ASCII strings. If you include spaces, enclose all characters in quotation marks (" ").

- **tolerance**—(Optional) For each keychain, you can configure a clock-skew tolerance value in seconds. The clock-skew tolerance is applicable to the receiver accepting keys for BGP updates. The configurable range is 0 through 999,999,999 seconds. During the tolerance period, either the current or previous password is acceptable.
- **key-chain**—For each keychain, you must specify a name. This example defines one keychain: **bgp-auth**. You can have multiple keychains on a routing device. For example, you can have a keychain for BGP, a keychain for OSPF, and a keychain for LDP.
- **secret**—For each key in the keychain, you must set a secret password. This password can be entered in either encrypted or plain text format in the **secret** statement. It is always displayed in encrypted format.
- **start-time**—Each key must specify a start time in UTC format. Control gets passed from one key to the next. When a configured start time arrives (based on the routing device's clock), the key with that start time becomes active. Start times are specified in the local time zone for a routing device and must be unique within the keychain.
- **authentication-key-chain**—Enables you to apply a keychain at the global BGP level for all peers, for a group, or for a neighbor. This example applies the keychain to the peers defined in the external BGP (EBGP) group called **ext**.
- **authentication-algorithm**—For each keychain, you can specify a hashing algorithm. The algorithm can be AES-128, MD5, or SHA-1.

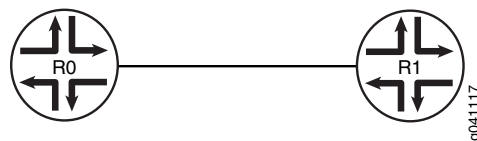
You associate a keychain and an authentication algorithm with a BGP neighboring session.

This example configures a keychain named **bgp-auth**. Key 0 will be sent and accepted starting at 2011-6-23.20:19:33 -0700, and will stop being sent and accepted when the next key in the keychain (key 1) becomes active. Key 1 becomes active one year later at 2012-6-23.20:19:33 -0700, and will not stop being sent and accepted unless another key is configured with a start time that is later than the start time of key 1. A clock-skew tolerance of 30 seconds applies to the receiver accepting the keys. During the tolerance period, either the current or previous key is acceptable. The keys are shared-secret passwords. This means that the neighbors receiving the authenticated routing updates must have the same authentication keychain configuration, including the same keys (passwords). So Router R0 and Router R1 must have the same authentication-key-chain configuration if they are configured as peers. This example shows the configuration on only one of the routing devices.

Topology Diagram

Figure 1 on page 4 shows the topology used in this example.

Figure 1: Authentication for BGP



Configuration

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set protocols bgp group ext type external
set protocols bgp group ext peer-as 65530
set protocols bgp group ext neighbor 172.16.2.1
set routing-options autonomous-system 65533
set protocols bgp group ext authentication-key-chain bgp-auth
set protocols bgp group ext authentication-algorithm md5
set security authentication-key-chains key-chain bgp-auth tolerance 30
set security authentication-key-chains key-chain bgp-auth key 0 secret
  this-is-the-secret-password
set security authentication-key-chains key-chain bgp-auth key 0 start-time
  2011-6-23.20:19:33-0700
set security authentication-key-chains key-chain bgp-auth key 1 secret
  this-is-another-secret-password
set security authentication-key-chains key-chain bgp-auth key 1 start-time
  2012-6-23.20:19:33-0700
```

Step-by-Step Procedure

The following example requires that you navigate various levels in the configuration hierarchy. For information about navigating the CLI, see Using the CLI Editor in Configuration Mode in the CLI User Guide.

To configure Router R1 to accept route filters from Device CE1 and perform outbound route filtering using the received filters:

1. Configure the local autonomous system.

```
[edit routing-options]
user@R1# set autonomous-system 65533
```

2. Configure one or more BGP groups.

```
[edit protocols bgp group ext]
user@R1# set type external
user@R1# set peer-as 65530
user@R1# set neighbor 172.16.2.1
```

3. Configure authentication with multiple keys.

```
[edit security authentication-key-chains key-chain bgp-auth]
user@R1# set key 0 secret this-is-the-secret-password
user@R1# set key 0 start-time 2011-6-23.20:19:33-0700
user@R1# set key 1 secret this-is-another-secret-password
user@R1# set key 1 start-time 2012-6-23.20:19:33-0700
```

The start time of each key must be unique within the keychain.

4. Apply the authentication keychain to BGP, and set the hashing algorithm.

```
[edit protocols bgp group ext]
user@R1# set authentication-key-chain bgp-auth
user@R1# set authentication-algorithm md5
```

5. (Optional) Apply a clock-skew tolerance value in seconds.

```
[edit security authentication-key-chains key-chain bgp-auth]
user@R1# set tolerance 30
```

Results From configuration mode, confirm your configuration by entering the **show protocols**, **show routing-options**, and **show security** commands. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

```
user@R1# show protocols
bgp {
  group ext {
    type external;
    peer-as 65530;
    neighbor 172.16.2.1;
    authentication-key-chain bgp-auth;
    authentication-algorithm md5;
  }
}

user@R1# show routing-options
autonomous-system 65533;

user@R1# show security
authentication-key-chains {
  key-chain bgp-auth {
    tolerance 30;
    key 0 {
      secret
        "$9$5T6AREylK8RhXNdwaJn/CtO1cykWx9AyIMWdVgoJDjqP5FCA0z3IEhcMWLxNbgDlF6A";
      ## SECRET-DATA
      start-time "2011-6-23.20:19:33 -0700";
    }
    key 1 {
      secret "$9$UyD.59CuO1h9AylKW-dqmfT369CuRhSP5hrvMN-JGDiqfu0lleWpuh.";
      ## SECRET-DATA
      start-time "2012-6-23.20:19:33 -0700";
    }
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

Repeat the procedure for every BGP-enabled device in the network, using the appropriate interface names and addresses for each BGP-enabled device.

Verification

Confirm that the configuration is working properly.

- [Verifying Authentication for the Neighbor on page 6](#)
- [Verifying That Authorization Messages Are Sent on page 6](#)
- [Checking Authentication Errors on page 7](#)
- [Verifying the Operation of the Keychain on page 7](#)

Verifying Authentication for the Neighbor

Purpose Make sure that the **AutheKeyChain** option appears in the output of the **show bgp neighbor** command.

Action From operational mode, enter the **show bgp neighbor** command.

```
user@R1> show bgp neighbor
Peer: 172.16.2.1+179 AS 65530 Local: 172.16.2.2+1222 AS 65533
  Type: External State: Established Flags: <Sync>
  Last State: OpenConfirm Last Event: RecvKeepAlive
  Last Error: None
  Export: [ direct-lo0 ]
  Options: <Preference PeerAS Refresh>
  Options: <AutheKeyChain>
  Authentication key is configured
  Authentication key chain: jni
  Holdtime: 90 Preference: 170
  Number of flaps: 0
  Peer ID: 172.16.2.1 Local ID: 10.255.124.35 Active Holdtime: 90
  Keepalive Interval: 30 Peer index: 0
  Local Interface: fe-0/0/1.0
  NLRI advertised by peer: inet-unicast
  NLRI for this session: inet-unicast
  Peer supports Refresh capability (2)
  Table inet.0 Bit: 10000
    RIB State: BGP restart is complete
    Send state: in sync
    Active prefixes: 2
    Received prefixes: 2
    Suppressed due to damping: 0
    Advertised prefixes: 1
  Last traffic (seconds): Received 2 Sent 2 Checked 2
  Input messages: Total 21 Updates 2 Refreshes 0 Octets 477
  Output messages: Total 22 Updates 1 Refreshes 0 Octets 471
  Output Queue[0]: 0
```

Verifying That Authorization Messages Are Sent

Purpose Confirm that BGP has the enhanced authorization option.

Action From operational mode, enter the **monitor traffic interface fe-0/0/1** command.

```
user@R1> monitor traffic interface fe-0/0/1
verbose output suppressed, use <detail> or <extensive> for full protocol decode
Listening on fe-0/0/1, capture size 96 bytes
```

```

13:08:00.618402 In arp who-has 172.16.2.66 tell 172.16.2.69
13:08:02.408249 Out IP 172.16.2.2.1122 > 172.16.2.1.646: P
1889289217:1889289235(18) ack 2215740969 win 58486 <nop,nop,timestamp 167557
1465469,nop,Enhanced Auth keyid 0 diglen 12 digest: fe3366001f45767165f17037>:
13:08:02.418396 In IP 172.16.2.1.646 > 172.16.2.2.1122: P 1:19(18) ack 18 win
57100 <nop,nop,timestamp 1466460 167557,nop,Enhanced Auth keyid 0 diglen 12
digest: a18c31eda1b14b2900921675>:
13:08:02.518146 Out IP 172.16.2.2.1122 > 172.16.2.1.646: . ack 19 win 58468
<nop,nop,timestamp 167568 1466460,nop,Enhanced Auth keyid 0 diglen 12 digest:
c3b6422eb6bd3fd9cf79742b>
13:08:28.199557 Out IP 172.16.2.2.nerv > 172.16.2.1.bgp: P
286842489:286842508(19) ack 931203976 win 57200 <nop,Enhanced Auth keyid 0
diglen 12 digest: fc0e42900a73736bcc07c1a4>: BGP, length: 19
13:08:28.209661 In IP 172.16.2.1.bgp > 172.16.2.2.nerv: P 1:20(19) ack 19 win
56835 <nop,Enhanced Auth keyid 0 diglen 12 digest: 0fc8578c489fabce63aeb2c3>:
BGP, length: 19
13:08:28.309525 Out IP 172.16.2.2.nerv > 172.16.2.1.bgp: . ack 20 win 57181
<nop,Enhanced Auth keyid 0 diglen 12 digest: ef03f282fb2ece0039491df8>
13:08:32.439708 Out IP 172.16.2.2.1122 > 172.16.2.1.646: P 54:72(18) ack 55 win
58432 <nop,nop,timestamp 170560 1468472,nop,Enhanced Auth keyid 0 diglen 12
digest: 76e0cf926f348b726c631944>:
13:08:32.449795 In IP 172.16.2.1.646 > 172.16.2.2.1122: P 55:73(18) ack 72 win
57046 <nop,nop,timestamp 1469463 170560,nop,Enhanced Auth keyid 0 diglen 12
digest: dae3eec390d18a114431f4d8>:
13:08:32.549726 Out IP 172.16.2.2.1122 > 172.16.2.1.646: . ack 73 win 58414
<nop,nop,timestamp 170571 1469463,nop,Enhanced Auth keyid 0 diglen 12 digest:
851df771aee2ea7a43a0c46c>
13:08:33.719880 In arp who-has 172.16.2.66 tell 172.16.2.69
^C
35 packets received by filter
0 packets dropped by kernel

```

Checking Authentication Errors

Purpose Check the number of packets dropped by TCP because of authentication errors.

Action From operational mode, enter the **show system statistics tcp | match auth** command.

```

user@R1> show system statistics tcp | match auth
      0 send packets dropped by TCP due to auth errors
      58 rcv packets dropped by TCP due to auth errors

```

Verifying the Operation of the Keychain

Purpose Check the number of packets dropped by TCP because of authentication errors.

Action From operational mode, enter the **show security keychain detail** command.

```

user@R1> show security keychain detail
keychain          Active-ID      Next-ID      Transition  Tolerance
                  Send Receive   Send Receive
bgp-auth          3      3      1      1      1d 23:58      30
Id 3, Algorithm hmac-md5, State send-receive, Option basic
Start-time Wed Aug 11 16:28:00 2010, Mode send-receive
Id 1, Algorithm hmac-md5, State inactive, Option basic
Start-time Fri Aug 20 11:30:57 2010, Mode send-receive

```

- Related Documentation**
- [Understanding External BGP Peering Sessions](#)
 - [BGP Configuration Overview](#)