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Verification of Routes Using Region Authorization  
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Abstract

BGP routing security is becoming a major issue that affects the normal running of Internet services. Currently, there are many solutions, including ROA authentication and ASPA authentication, to prevent route source hijacking, path hijacking, and route leaking. However, on an actual network, large ISPs with multiple ASes can use carefully constructed routes to bypass ROA and ASPA authentication to attack the target network.

This document defines an region-based authentication method for large ISPs with many ASes to prevent traffic hijacking within ISPs.

Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

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## 1. Introduction

The design of the Border Gateway Protocol (BGP) lacks a mechanism to validate BGP attributes, which is prone to BGP hijacking and BGP route leaks [RFC7908].

[RFC6811] defines a method for verifying the origin of BGP prefixes, which can resolve the most common source AS hijacking. [I-D.ietf-sidrops-aspa-verification] defines an AS-pairs based authentication method to resolve AS-Path hijacking and route leaking.

However, even if these two technologies are deployed on large ISP networks with many ASes, there are still risks of being attacked by carefully constructed path hijacking.

## 2. Terminology

OV: Origin Validation

RPKI: Resource Public Key Infrastructure

RP: Relying Party

RBA: Region Based Authorization

## 3. Problem Statement

Currently, some large ISPs have more than one public ASes to facilitate management. In these ISPs, only one or very few ASes are used to connect to external ISPs. However, the sub-ASes of these ISPs also exchange routes to provide services for different customers. Therefore, the route access between these sub-ASes may still be subjected to a well-crafted attack.

### 3.1. Route hijacking risk within a single ISP

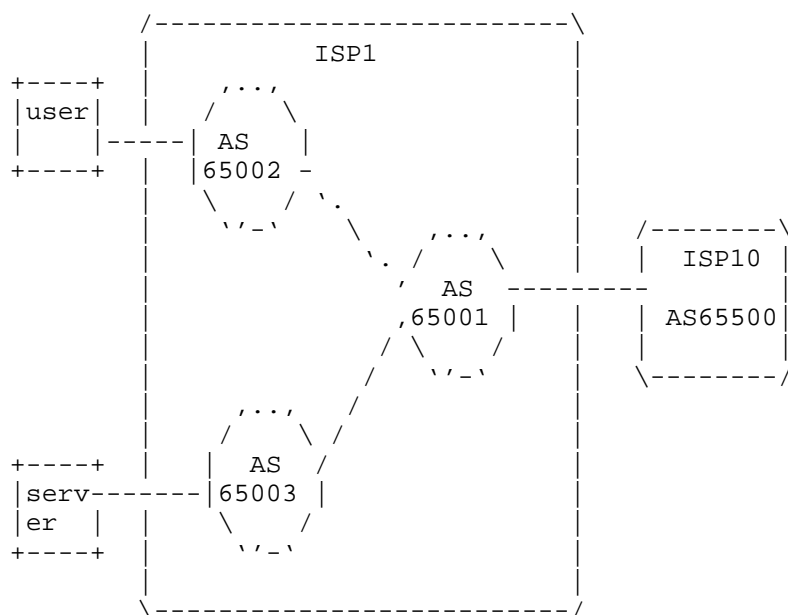


Figure 1 Route hijacking risk within a single ISP

As shown in the Figure 1. ISP1 has AS65001, AS65002, and AS65003 and connects to an external ISP, such as AS65500. There is a server connect to the AS65003, and a user connect to the AS65002. AS65003 advertises the server's route to AS65002, and AS65002 uses the route to provide services for users.

After the AS65500 obtains the route for the server, it can spoof the route and change the source AS to AS65003. In this way, the spoofed route is advertised to AS65001 with AS-Path AS65500 AS65003. AS65001 selects routes between the routes advertised by AS65003 and AS65500. Therefore, AS65001 may preferentially select the forged routes of AS65500. As a result, subsequent traffic from users to the server is hijacked to AS65500.

In actual deployment, to facilitate traffic adjustment, the mask of the address in the ROA database registered by ISP1 may be in a certain range. In this case, the AS65500 can more easily hijack traffic by using more specific prefixes and spoofing the source AS.

The scenario described here can be prevented by ASPA because the AS pair (AS65500,AS65003) does not exist..

### 3.2. Route hijacking risk between multiple ISPs

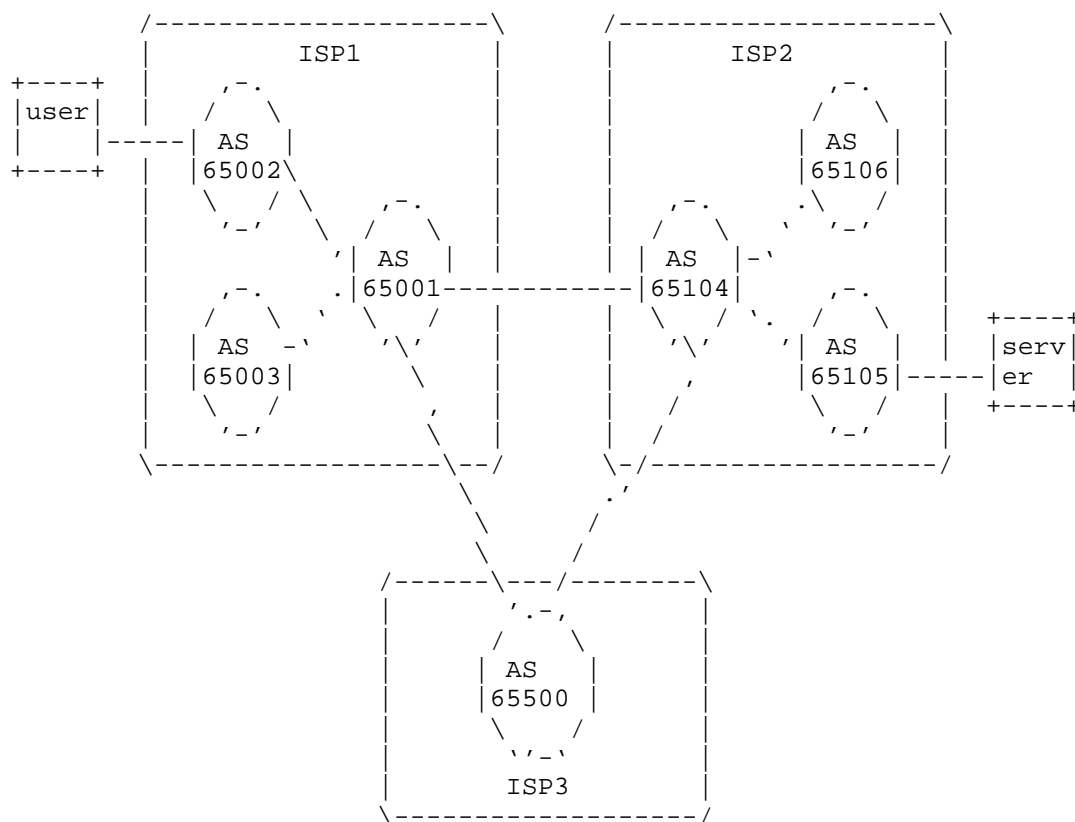


Figure 2 Route hijacking risk between multiple ISPs

As shown in Figure 2. ISP1 has AS65001, AS65002, and AS65003 and connects to external ISPs, such as AS65500 and ISP2's AS65104. ISP2 has AS65104, AS65105, and AS65106, and connects to external ISPs such as AS65500 and ISP1's AS65001. There is a server connect to AS65105, and a user connect to AS65002. AS65105 advertises the server's route to AS65002 through the BGP peer. AS65002 then provides services for users.

The AS65500 can also obtain the route for the server from AS65104. The AS65500 can spoof the route of the server and change the source AS to AS65105. In this way, the AS65500 constructs a more specific prefix, which AS-Path is AS65500 AS65104 AS65105, and advertises the route to AS65001. The traffic from the user to the server will be hijacked to AS65500.

In this scenario it also can't be prevented by ASPA.

#### 4. Region Based Authorization

An RBA is a digital signature object that contains two types of data. One type is to bind multiple ASNs of an ISP to an region ID. The region ID represents the ISP and is signed by the administrator of the ISP. The RBA certifies which ASNs an ISP has. An AS should belongs to only one ISP. The second type is to bind an ISP's region ID to a region confederation ID, which is signed by the ISP's administrator. The region ID and region confederation ID introduced here can be allocated and managed by a unified structure.

#### 5. Region Based Verification Procedure

To solve this problem, a region-based verification is introduced. This method is applicable to large ISPs with multiple ASes. In addition to OV verification, region-based verification is performed to prevent the attack scenarios mentioned in section 3.

##### 5.1. Single region verification

As shown in Figure 1, ISP1 can be set to area 1, including AS65001, AS65002, and AS65003.

When a device learns a route, it will verify whether the route is a local region route based on basic OV verification.

The verification process is as follows:

- 1) Perform OV verification on the route. If the OV verification result is valid, then perform area verification.
- 2) Check whether the route's origin AS is belong to local region.
- 3) If not, it indicates that the route is not a local region route. No additional verification is required in single region scenarios..
- 4) If the route's origin AS is belong to local region, check whether the peer that learns the route is belong to local region.
- 5) If the peer that learns a route is not belong to local region, the route verification result is invalid.

If the route verification result is invalid, the route can be consider as an invalid route and is not involved in route selection. This prevents routes belong to local region from being learned by external ASs and prevents possible route hijacking.

## 5.2. Multiple region verification

For the case of Figure 2, region confederations can be set. ISP1 is set to region 1, including AS65001, AS65002, and AS65003. ISP2 is set to region 2, including AS65104, AS65105, and AS6. In addition, the region of ISP1 and ISP2 form a regional confederation, which is set to regional confederation 1.

The verification process is as follows:

- 1) First, perform the step of region verification. After single region verification step 2, if the route's origin AS is not belong to local region, then check whether the route belongs to the local confederation.
- 2) If the route belongs to the local confederation, check whether the peer that learned the route is belong to the local confederation.
- 3) If the peer is not belong to the local confederation, the route verification result is invalid.
- 4) Optionally, further checking whether the peer is the region to which the route belongs maybe done. If the region to which the route belongs does not match the region to which the learned peer belongs, the route may be considered as the lowest preference.

If the route verification result is invalid, the route can be consider as an invalid route and is not involved in route selection. This prevents routes belong to local region from being learned by external ASs and prevents possible route hijacking.

## 5.3. Obtaining Region Information

The region information and region confederation information can be obtained in either of the following ways:

- 1) Obtained through the RP. When the region information is registered through RPKI, it can be obtained through RP.
- 2) Static configuration. When RP is not ready, this can be achieved through manual configuration.

Generally, the RPKI mode is recommended..

## 5.4. Comparing with routing policy

The verification here can also be implemented through routing policies.

For region verification scenarios, regular expression-based policies, such as denying all routes whose origin AS is the local ISP's ASes, can be configured by the external peers to filter routes.

However, in this mode, complex policies need to be configured based on the AS planning of the ISP. In addition, these policies need to be integrated with existing routing policies, which is complex to use.

The RPKI mechanism can be used to verify the area information obtained from the RP, which simplifies the deployment.

## 6. Security Considerations

NA

## 7. Acknowledgements

NA

## 8. References

### 8.1. Normative References

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