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MANRS Lab

Students' Guide

Version 1 – 22 December 2018

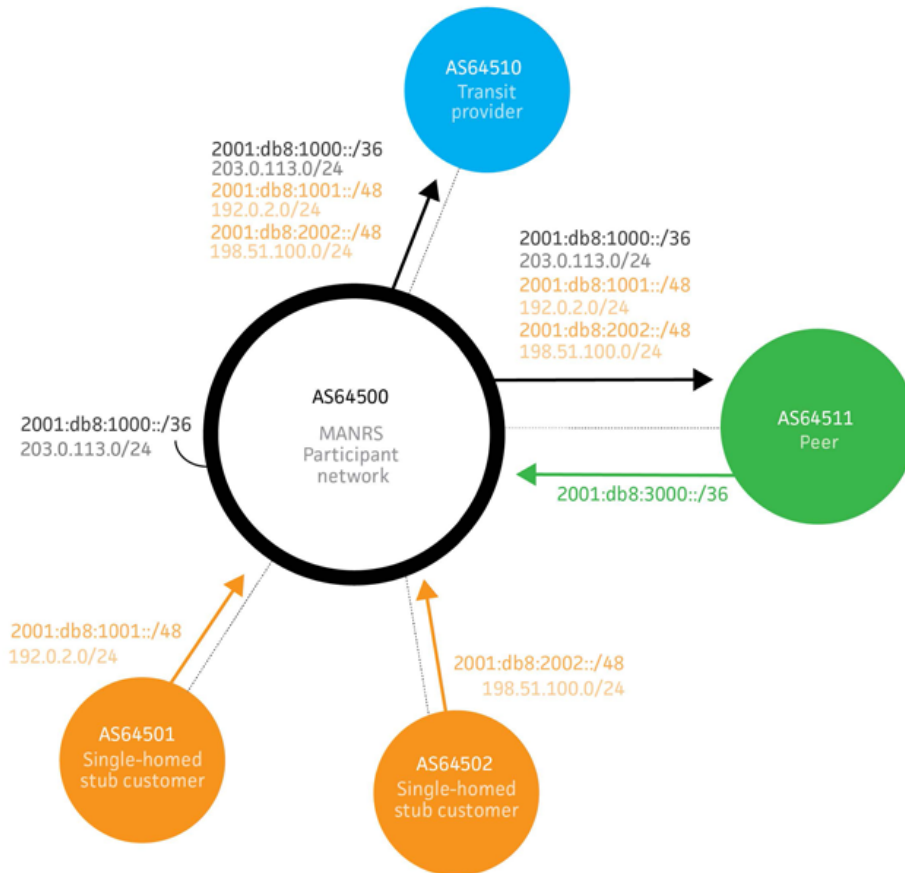
www.steffann.nl

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Introduction

This MANRS Lab is designed to let you gain experience with implementing MANRS on a router. The exercises will follow the MANRS Implementation guide at <https://www.manrs.org/isps/guide/> very closely, including the network topology:



Exercises are provided for Cisco IOS, Juniper JunOS and Mikrotik.

In these exercises the neighbours around you are not behaved properly. They announce routes that don't belong to them. They even try to hijack your address space! They also send traffic with spoofed source addresses and traffic for destinations that you don't announce to them. It is your task to implement MANRS by documenting your network in the IRR, properly filtering route announcements en to stop traffic with spoofed source addresses.

The goals of the exercise are:

- to publish routing information about AS64500 in the IRR
- to filter incoming routes announced by your customers AS64501 and AS64502
- to filter incoming routes announced by your transit provider AS64510
- to filter incoming routes announced by your peer AS64511
- to filter outgoing routes as you announce them to your customers, peer and transit
- to filter traffic with spoofed source addresses from your customers

User interface

The lab is web-based and can be used with any modern browser. You do not need any other tools for doing the exercises. Configuring the routers is done through a browser based terminal window, and interaction with the IRR database is web based as well.

Your main interface to the lab environment is through the exercise dashboard:

MANRS Lab Manager
Dashboard: MANRS-Cisco for Sander Steffann

Logged in as Sander Steffann (sander@steffann.nl)
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MANRS for Cisco

Welcome to the MANRS for Cisco lab. This lab consists of a transit, a peer, two customers, and your very own Cisco router in the middle. The goal is to implement MANRS on your router so that the other routers cannot send you hijacked routes or traffic with spoofed source addresses. And they will try!

The layout of this lab is based on the [MANRS Implementation Guide](#). The addresses and prefixes used in this lab correspond to those used in that document.

Background information

At the start of the lab all links are configured and BGP sessions exist for both IPv4 and IPv6. There is no filtering in place. That is your task.

Your router (AS64500)

You have full console access to your router. Configure it so it has MANRS.

You should announce the following prefixes from your own router:

- 2001:db8:1000::/36
- 203.0.113.0/24

The transit (AS64510)

The transit will send you the most routes. But it isn't behaving completely correct. Some of its routes are your own! Make sure you don't accept them, or someone on the internet might hijack you. There is also traffic coming from the transit with source addresses that don't exist in the routing table. Those should also be blocked.


For testing purposes you can ping the transit on addresses 2001:db8::1 and 10.0.0.1.

The peer (AS64511)

The peer will do the same as the transit, except that of course it's only allowed to attract traffic for itself. So make sure that you filter what they announce to you, and also make sure they don't use you as a free transit!

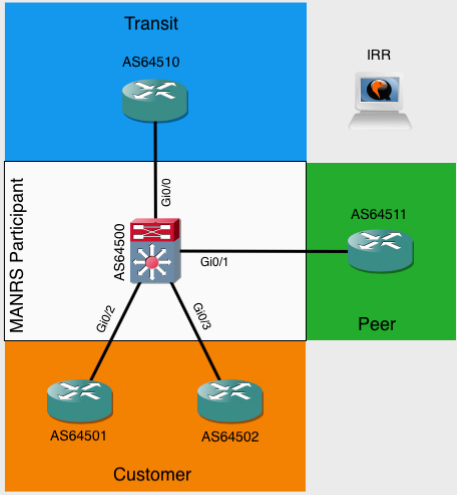
The peer should announce the following prefixes to you:

- 2001:db8:3000::/36



MANRS

for Cisco



The dashboard contains several tabs, each representing a different part of the exercise. Some of the tabs are coloured. The colour shows you whether what is seen on that tab is correct according to the exercise goals or whether there is still work to be done.

Instructions

This tab contains basic instructions about the exercise. It is the tab you see in the screenshot above. The exercises are all based on the instructions in the MANRS Implementation guide. Follow that guide to complete the exercises!

AS64500

This tab contains the interface to the router you'll be working on. It contains basic information about your router and a terminal window for the router's console:

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Your router (AS64500)

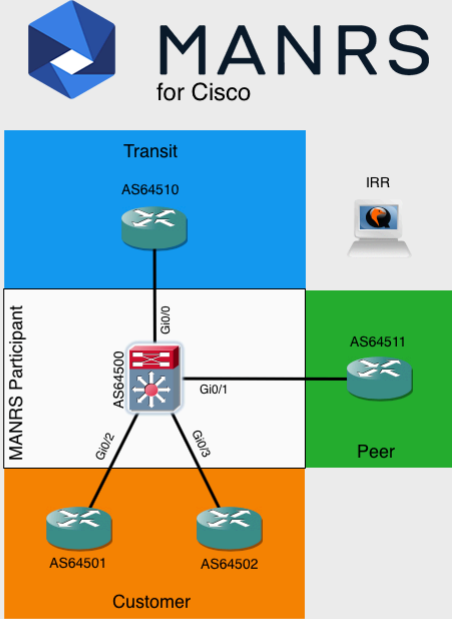
The goal of this lab is to teach your router MANRS.

You should announce the following prefixes from your own router:

- 2001:db8:1000::/36
- 203.0.113.0/24

Username: manrs
Password: manrs

```
Log in with username 'manrs' and password 'manrs':
User Access Verification
Username:
```



The diagram illustrates the MANRS for Cisco network topology. It features a central 'MANRS Participant' router (AS64500) connected to three other routers: AS64510 (Transit), AS64511 (Peer), and a 'Customer' block containing AS64501 and AS64502. The connections are labeled with interface names: Gi0/0 for the link to AS64510, Gi0/1 for the link to AS64511, Gi0/2 for the link to AS64501, and Gi0/3 for the link to AS64502. An 'IRR' (Internet Routing Registry) icon is also shown near AS64510. The background is divided into colored regions: blue for Transit, green for Peer, and orange for Customer.

This is where you will do most of your work.

AS64501, AS64502, AS64510 and AS64511

These tabs contain information as seen from your neighbours points of view. It will show you which routes they receive from you and which traffic they receive through you:

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The customer (AS64501)

Customer 64501 should announce the following prefixes to you:

- 2001:db8:1001::/48
- 192.0.2.0/24

For testing purposes you can ping them on addresses 2001:db8:1001::1 and 192.0.2.1.

Looking glass from this router's viewpoint

Received traffic (last change at 3:36:18)

Expected	Currently seen
10.0.0.1 to 192.0.2.1	10.0.0.1 to 192.0.2.1
These packets shouldn't be received	192.0.2.3 to 192.0.2.1
These packets shouldn't be received	192.88.99.2 to 192.0.2.1
These packets shouldn't be received	192.88.99.10 to 192.0.2.1
198.51.100.1 to 192.0.2.1	198.51.100.1 to 192.0.2.1
These packets shouldn't be received	198.51.100.3 to 192.0.2.1
2001:db8::1 to 2001:db8:1001::1	2001:db8::1 to 2001:db8:1001::1
These packets shouldn't be received	2001:db8:1000::3 to 2001:db8:1001::1
These packets shouldn't be received	2001:db8:1001::3 to 2001:db8:1001::1
2001:db8:2002::1 to 2001:db8:1001::1	2001:db8:2002::1 to 2001:db8:1001::1
2001:db8:3000::1 to 2001:db8:1001::1	These packets are missing
These packets shouldn't be received	3ffe::2 to 2001:db8:1001::1
These packets shouldn't be received	3ffe::10 to 2001:db8:1001::1

IPv4 routes (last change at 3:38:29)

Expected	Currently seen
10.0.0.0/8	10.0.0.0/8
AS-Path: 64500 64510 65000 65000 65001	AS-Path: 64500 64510 65000 65000 65001
172.16.0.0/12	172.16.0.0/12

MANRS Participant

Transit

AS64510

IRR

AS64511

Peer

Customer

AS64501

AS64502

AS64500

G10/2

G10/3

G10/0

G10/1

The main part of these tabs is the looking glass that lets you see what is happening from the neighbour's point of view. We will now explain the different sections of information contained in the looking glass.

Received traffic

This section shows you the source and destination addresses of packets being received by this neighbour's router:

Received traffic (last change at 3:36:18)

Expected	Currently seen
10.0.0.1 to 192.0.2.1	10.0.0.1 to 192.0.2.1
These packets shouldn't be received	192.0.2.3 to 192.0.2.1
These packets shouldn't be received	192.88.99.2 to 192.0.2.1
These packets shouldn't be received	192.88.99.10 to 192.0.2.1
198.51.100.1 to 192.0.2.1	198.51.100.1 to 192.0.2.1
These packets shouldn't be received	198.51.100.3 to 192.0.2.1
2001:db8::1 to 2001:db8:1001::1	2001:db8::1 to 2001:db8:1001::1
These packets shouldn't be received	2001:db8:1000::3 to 2001:db8:1001::1
These packets shouldn't be received	2001:db8:1001::3 to 2001:db8:1001::1
2001:db8:2002::1 to 2001:db8:1001::1	2001:db8:2002::1 to 2001:db8:1001::1
2001:db8:3000::1 to 2001:db8:1001::1	These packets are missing
These packets shouldn't be received	3ffe::2 to 2001:db8:1001::1
These packets shouldn't be received	3ffe::10 to 2001:db8:1001::1

As you can see in the screenshot above there are packets being received that shouldn't be received. This is probably because they are sent with spoofed source addresses. There are also packets that should have been received but aren't. Could it be that someone is hijacking traffic? Of course there is also legitimate traffic. Make sure that you don't filter that out!

IPv4 routes

This part of the looking glass shows you the IPv4 routes that are received by your neighbour:

IPv4 routes (last change at 3:38:29)

Expected	Currently seen
10.0.0.0/8 AS-Path: 64500 64510 65000 65000 65001	10.0.0.0/8 AS-Path: 64500 64510 65000 65000 65001
172.16.0.0/12 AS-Path: 64500 64510 65002 65001	172.16.0.0/12 AS-Path: 64500 64510 65002 65001
This route shouldn't be received	192.0.2.64/26 AS-Path: 64500 64502
This route shouldn't be received	192.0.2.128/25 AS-Path: 64500 64502
192.168.0.0/16 AS-Path: 64500 64510 65002 65003	192.168.0.0/16 AS-Path: 64500 64510 65002 65003
198.51.100.0/24 AS-Path: 64500 64502	198.51.100.0/24 AS-Path: 64500 64502
203.0.113.0/24 AS-Path: 64500	203.0.113.0/24 AS-Path: 64500
This route shouldn't be received	203.0.113.64/26 AS-Path: 64500 64510

In the example above some routes are received that shouldn't be. Make sure that you announce exactly the right routes to your neighbours! That is usually done with both filtering which routes you accept and which routes you announce.

IPv6 routes

This part shows the same information as the IPv4 routes section but for IPv6 routes:

IPv6 routes (last change at 3:39:05)

Expected	Currently seen
2001:db8::/36 AS-Path: 64500 64510 65000 65000 65001	2001:db8::/36 AS-Path: 64500 64510 65000 65000 65001
2001:db8:1000::/36 AS-Path: 64500	2001:db8:1000::/36 AS-Path: 64500
This route shouldn't be received	2001:db8:1001:1000::/52 AS-Path: 64500 64502
This route shouldn't be received	2001:db8:1200::/40 AS-Path: 64500 64510
2001:db8:2002::/48 AS-Path: 64500 64502	2001:db8:2002::/48 AS-Path: 64500 64502
2001:db8:3000::/36 AS-Path: 64500 64511	This route is missing
2001:db8:4000::/36 AS-Path: 64500 64510 65002 65001	2001:db8:4000::/36 AS-Path: 64500 64510 65002 65001
2001:db8:5000::/36 AS-Path: 64500 64510 65002 65003	2001:db8:5000::/36 AS-Path: 64500 64510 65002 65003
2001:db8:6000::/36 AS-Path: 64500 64510 65002 65002 65003	2001:db8:6000::/36 AS-Path: 64500 64510 65002 65002 65003

IRR

This tab contains your interface to the IRR database. It allows you to query and update the database. It also shows you information about your ASN and the routes associated with it:

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Documenting your routing policy

Your task is to update your AUT-NUM object, to create ROUTE and ROUTE6 objects for your own address space, and to create an AS-SET called AS64500:AS-ALL that contains your own network and those for your customers.

Query the IRR database

You can search the IRR database here using whois queries. You can search for example on IP address, AS Number, AS-Set or contact handle.

Query:

Updating the IRR

Maintainer object: STUDENT-MNT
Maintainer password: manrs


Type your IRR objects here

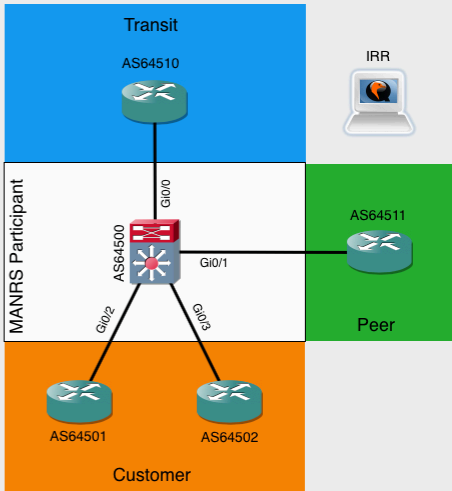
Currently in the IRR

IPv4 from ASN (last change at 0:36:13)

Expected	Currently seen
203.0.113.0/120	This prefix is missing

IPv6 from ASN (last change at 0:36:13)

**MANRS**
for Cisco



These exercises contain a fully functional IRR system. To keep things simple it only contains data relevant to the exercise, such as AUT-NUM objects for the used ASNs, route and route6 objects for your neighbours and some minimal contact information.

Query the IRR database

At the top of this tab you can query the IRR. If you would query your own ASN you would see something like this:

Query the IRR database

You can search the IRR database here using `whois` queries. You can search for example on IP address, AS Number, AS-Set or contact handle.

Query:

```
aut-num:      AS64500
as-name:      STUDENT-AS
descr:        Student's ASN
admin-c:      STUDENT-MANRS
tech-c:       STUDENT-MANRS
mnt-by:       ROOT-MNT
mnt-by:       STUDENT-MNT
changed:      sander@steffann.nl 20181117
source:       MANRS

role:         Student
address:      Nowhere
phone:        +1-703-439-2120
e-mail:       student@example.com
nic-hdl:      STUDENT-MANRS
mnt-by:       STUDENT-MNT
changed:      student@example.com 20181117
source:       MANRS
```

You can also do inverse queries, for example to see which routes should be announced from an ASN:

Query the IRR database

You can search the IRR database here using `whois` queries. You can search for example on IP address, AS Number, AS-Set or contact handle.

Query:

```
route:        192.0.2.0/24
origin:        AS64501
descr:         IPv4 announced from AS64501
mnt-by:        ROOT-MNT
changed:       sander@steffann.nl 20181117
source:        MANRS

route6:        2001:db8:1001::/48
origin:        AS64501
descr:         IPv6 announced from AS64501
mnt-by:        ROOT-MNT
changed:       sander@steffann.nl 20181117
source:        MANRS
```

You can use all the common query options. For a full overview of the available query options see appendix B1 of <https://raw.githubusercontent.com/irrdnet/irrd/master/irrd-user.pdf>.

Updating the IRR

You can modify objects in the IRR using the update function:

Updating the IRR

Maintainer object: STUDENT-MNT

Maintainer password: manrs

```
aut-num: AS64500
as-name: STUDENT-AS
descr: Student's ASN
admin-c: STUDENT-MANRS
tech-c: STUDENT-MANRS
mnt-by: ROOT-MNT
mnt-by: STUDENT-MNT
changed: sander@steffann.nl
source: MANRS
password: manrs
```

REPLACE OK: [aut-num] AS64500

Submit update to IRR

In the box on the left you type (or easier: copy&paste) the IRR object you want to modify. Put in the version of the object that you want to save, make sure you have added the appropriate password line, and click the submit button. The response from the IRR database will appear on the right.

When you submit an object with errors, the error messages from the IRR database will be shown on the right:

Updating the IRR

Maintainer object: STUDENT-MNT

Maintainer password: manrs

```
aut-num: AS64599
as-name: STUDENT-AS
descr: Student's ASN
mnt-by: STUDENT-MNT
changed: sander@steffann.nl
source: MANRS
password: manrs
```

```
UPDATE FAILED: [aut-num] AS64599
aut-num: AS64599
as-name: STUDENT-AS
descr: Student's ASN
mnt-by: STUDENT-MNT
changed: sander@steffann.nl 20181222
source: MANRS
#ERROR: Mandatory field "admin-c" missing
#ERROR: Mandatory field "tech-c" missing
```

Submit update to IRR

The error messages are usually self-explanatory. If you want to see the template for an IRR object type you can query the database for that too:

Query:

aut-num:	[mandatory]	[single]	[primary/look-up key]
as-name:	[mandatory]	[single]	[]
descr:	[mandatory]	[single]	[]
member-of:	[optional]	[multiple]	[]
import:	[optional]	[multiple]	[]
mp-import:	[optional]	[multiple]	[]
import-via:	[optional]	[multiple]	[]
export:	[optional]	[multiple]	[]
mp-export:	[optional]	[multiple]	[]
export-via:	[optional]	[multiple]	[]
default:	[optional]	[multiple]	[]

Creating objects is simply done by submitting an object that does not yet exist. It will be created automatically. If you accidentally create an object that you didn't want to create then resubmit it with a `delete:` line added to it:

Updating the IRR

Maintainer object: STUDENT-MNT

Maintainer password: manrs

```
aut-num: AS64599
as-name: STUDENT-AS
descr: Student's ASN
admin-c: STUDENT-MANRS
tech-c: STUDENT-MANRS
mnt-by: ROOT-MNT
mnt-by: STUDENT-MNT
changed: sander@steffann.nl
source: MANRS
password: manrs
delete: I made a mistake
```

DEL OK: [aut-num] AS64599

Submit update to IRR

That will remove the object from the database. Be careful not to delete objects you still need! You will have to re-create them from scratch. We advise you to copy&paste an object and store it on your computer before deleting it from the IRR. If you later want it back you can then copy&paste it into the update field and recreate it.

Currently in the IRR

This section shows you what is currently in the IRR about your AS64500.

IPv4 from ASN

This section shows which IPv4 routes you are going to announce from your ASN. These are found by looking at the `route` objects in the IRR:

IPv4 from ASN (last change at 0:36:13)

Expected	Currently seen
203.0.113.0/120	This prefix is missing

IPv6 from ASN

This section shows which IPv6 routes you are going to announce from your ASN. These are found by looking at the `route6` objects in the IRR:

IPv6 from ASN (last change at 0:36:13)

Expected	Currently seen
2001:db8:1000::/36	This prefix is missing

IPv4 from AS-SET

This section shows which IPv4 routes you are going to your neighbours. It should contain both the routes from your ASN and from those of your neighbours. In these exercises we expect you to create an AS-SET called `AS64500:AS-ALL` which should contain these ASNs:

IPv4 from AS-SET (last change at 0:36:13)

Expected	Currently seen
192.0.2.0/120	This prefix is missing
198.51.100.0/120	This prefix is missing
203.0.113.0/120	This prefix is missing

IPv4 from AS-SET

This section shows which IPv6 routes you are going to your neighbours. It its based on the same AS-SET called `AS64500:AS-ALL` as for the IPv4 routes:

IPv6 from AS-SET (last change at 0:36:13)

Expected	Currently seen
2001:db8:1000::/36	This prefix is missing
2001:db8:1001::/48	This prefix is missing
2001:db8:2002::/48	This prefix is missing

Import/export

You should also document which routes you announce and accept from your neighbours. Others can use this to implement better filters in their networks. This information is based on the import and export rules included in your `AUT-NUM` object:

Import/export (last change at 0:36:13)

Note: This training system only supports simple "mp-import: from A accept B" and "mp-export: to X announce Y" style policy rules. Please limit yourself to that type of policy for this training.

Neighbor ASN	Expected		Currently seen	
	Import	Export	Import	Export
AS64501	AS64501	ANY		
AS64502	AS64502	ANY		
AS64510	ANY	AS64500:AS-ALL		
AS64511	AS64511	AS64500:AS-ALL		

These lines will be taken into account:

- import
- export
- mp-import
- mp-export

The system that checks these lines is not very advanced, so please keep the import and export statements simple. When you add too much complexity the system might not understand you anymore!

Troubleshooting

It can sometimes happen that things don't work as expected. When that happens try the following:

- make sure you can ping the other end of a link
- shutdown an interface and bring it back up to reset the link
- make sure your BGP sessions are up
- clear your BGP sessions after changing filters

And if all else fails, use the "reboot device" button you can find on the bottom of each tab.