RIPE NCC
RIPE NETWORK COORDINATION CENTRE

BGP Security Webinars

Internet Routing Registry

April 2025

RIPE NCC Learning & Development


This session is
being recorded

Agenda

- Introduction to Internet Routing Registry
- BGP Routing Policy and RPSL
- Tools and Automation
- Limitations of the IRR System

Take the poll!

What is the **Internet Routing Registry** (IRR)?

2 min.

Introduction to the Internet Routing Registry

Section 1

What is the IRR system?

- IRR - the Internet Routing Registry
- Public routing policy databases
  - Used to register routing information
  - Declaration of BGP announcements, connected peers and routing policies
- Many IRR databases exist
  - Mostly **mirroring** each other
  - RIPE, APNIC, RADB, JPIRR, Level3, NTTCom, among others

https://irr.net

Why register routing information?

Is that ASN authorised to originate that address range?

Why register routing information?

Document your routing policy

- Associate network prefixes with an **origin AS**

Helps to filter unauthorised announcements

- **Mitigates** route hijacks and denial of service

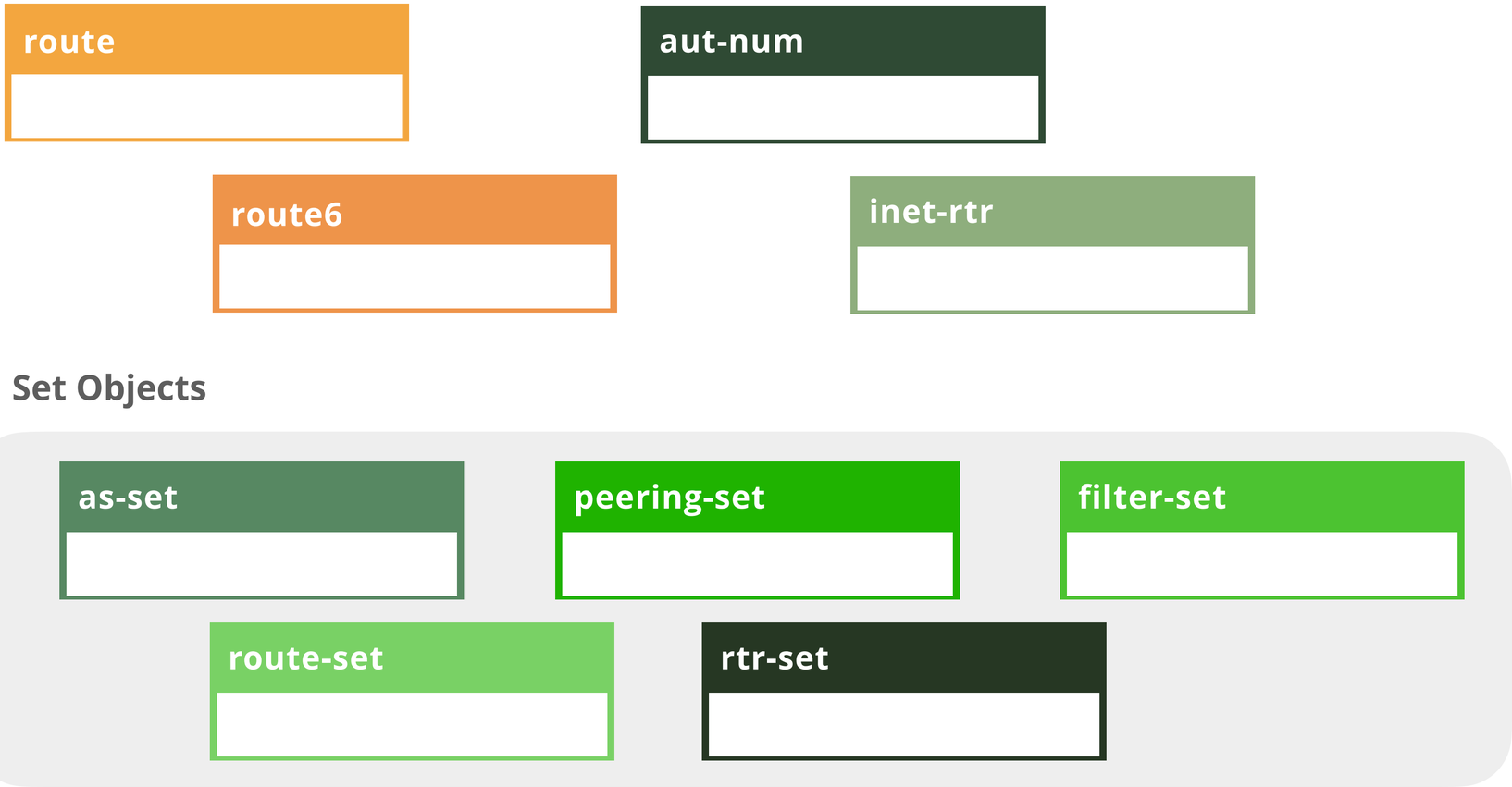
Many transit providers and IXPs **require** it

- They build their filters based on the Routing Registry

IRRs support routing security!

- Improve stability and consistency of routing
- Provide a global view of routing policies
- Automation of creating BGP filters
- Network troubleshooting

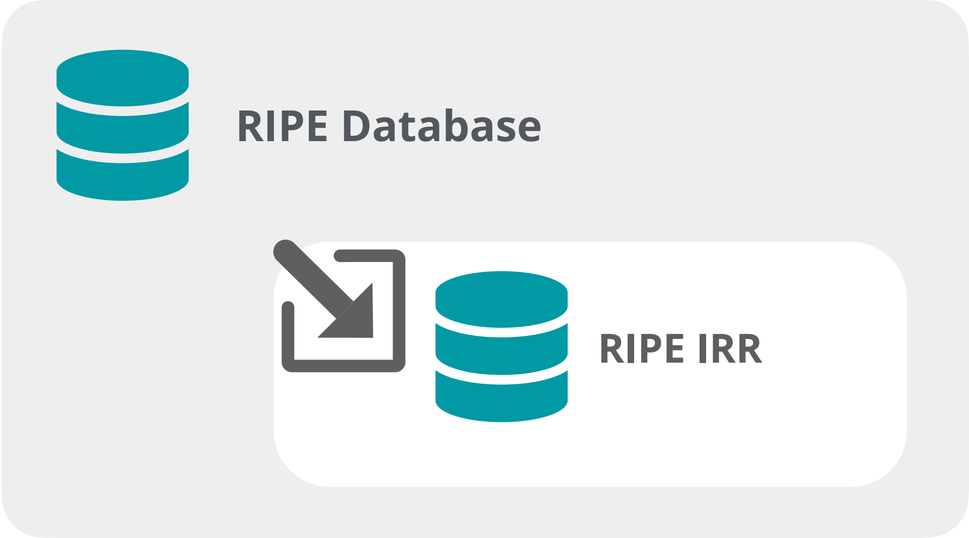
Routing Registry Objects



https://docs.db.ripe.net/RPSL-Object-Types/

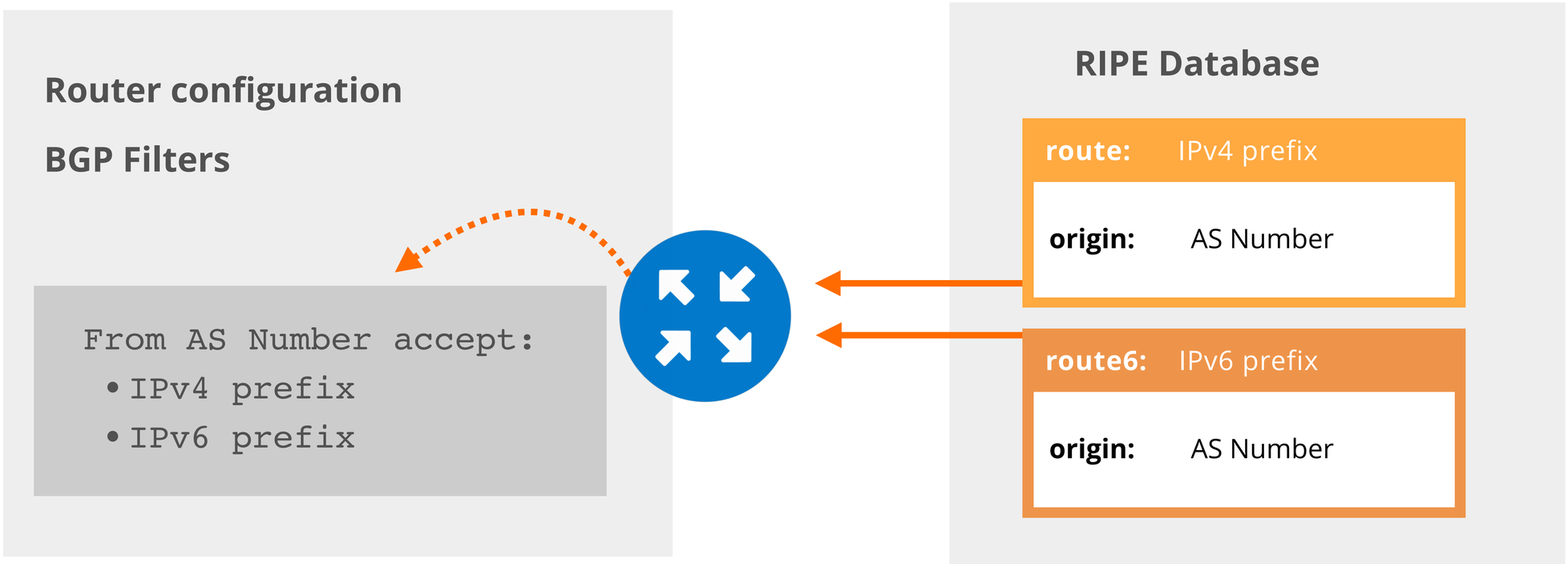
The RIPE Routing Registry

- The RIPE IRR is a subset of the RIPE Database
- Used for registering **routing policy information**
- Includes several objects
  - **route(6)**, **aut-num**, **filter-set**, **route-set**, …
- The RIPE Routing Registry is a part of the global IRR system



ROUTE(6) objects

- Contains routing information for IPv4/IPv6 address space
- **Specifies from which AS a certain prefix may be originated**
- Used for creating BGP filters



Authorisation rules for ROUTE(6) objects

- You need permission from:

1. **inetnum** or **inet6num** objects
2. **route** or **route6** objects

1

Allocation

mnt-by:	RIPE-NCC-HM-MNT
mnt-by:	DEFAULT-LIR-MNT
mnt-routes:	ANOTHER-MNT

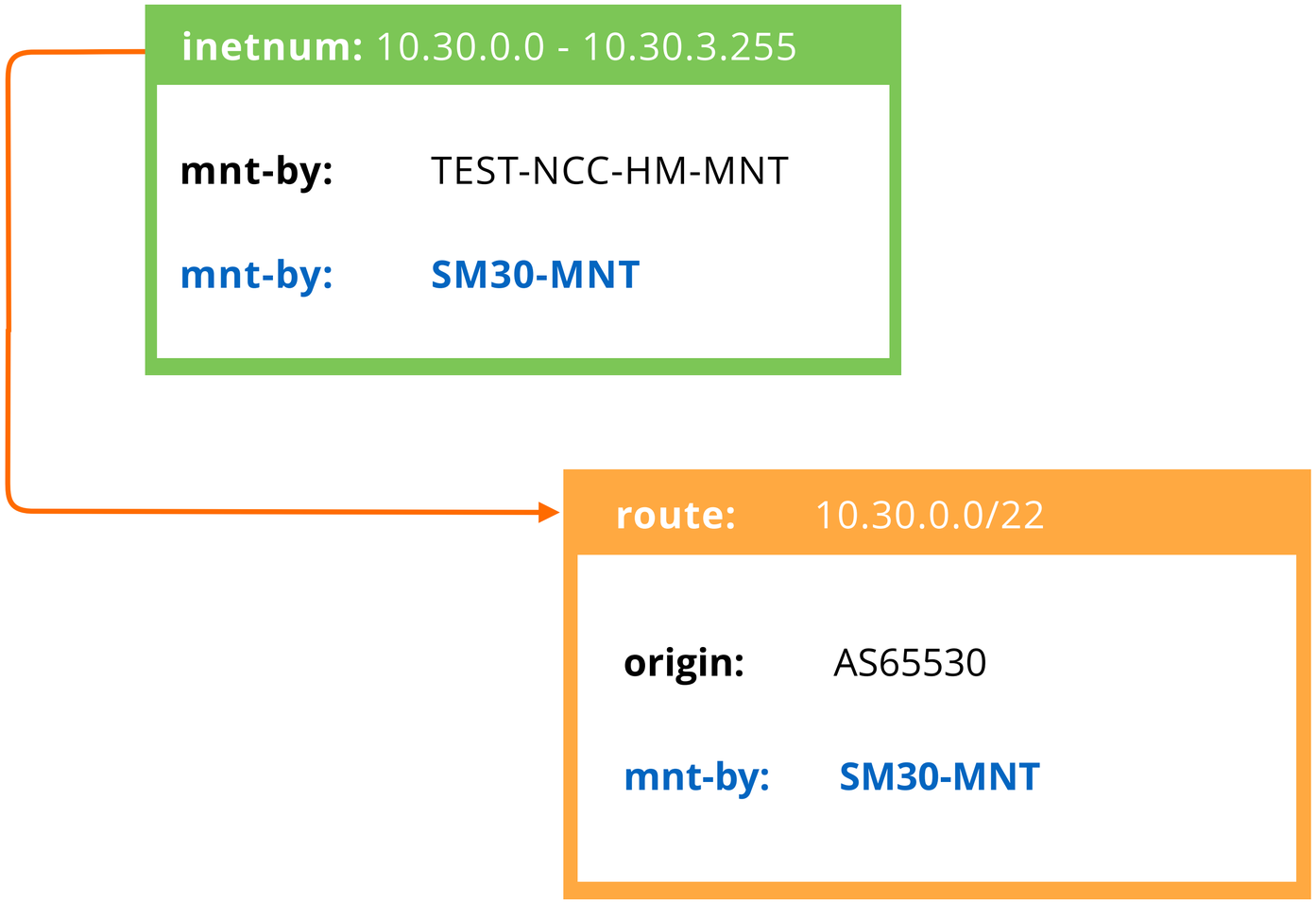
2

route(6)

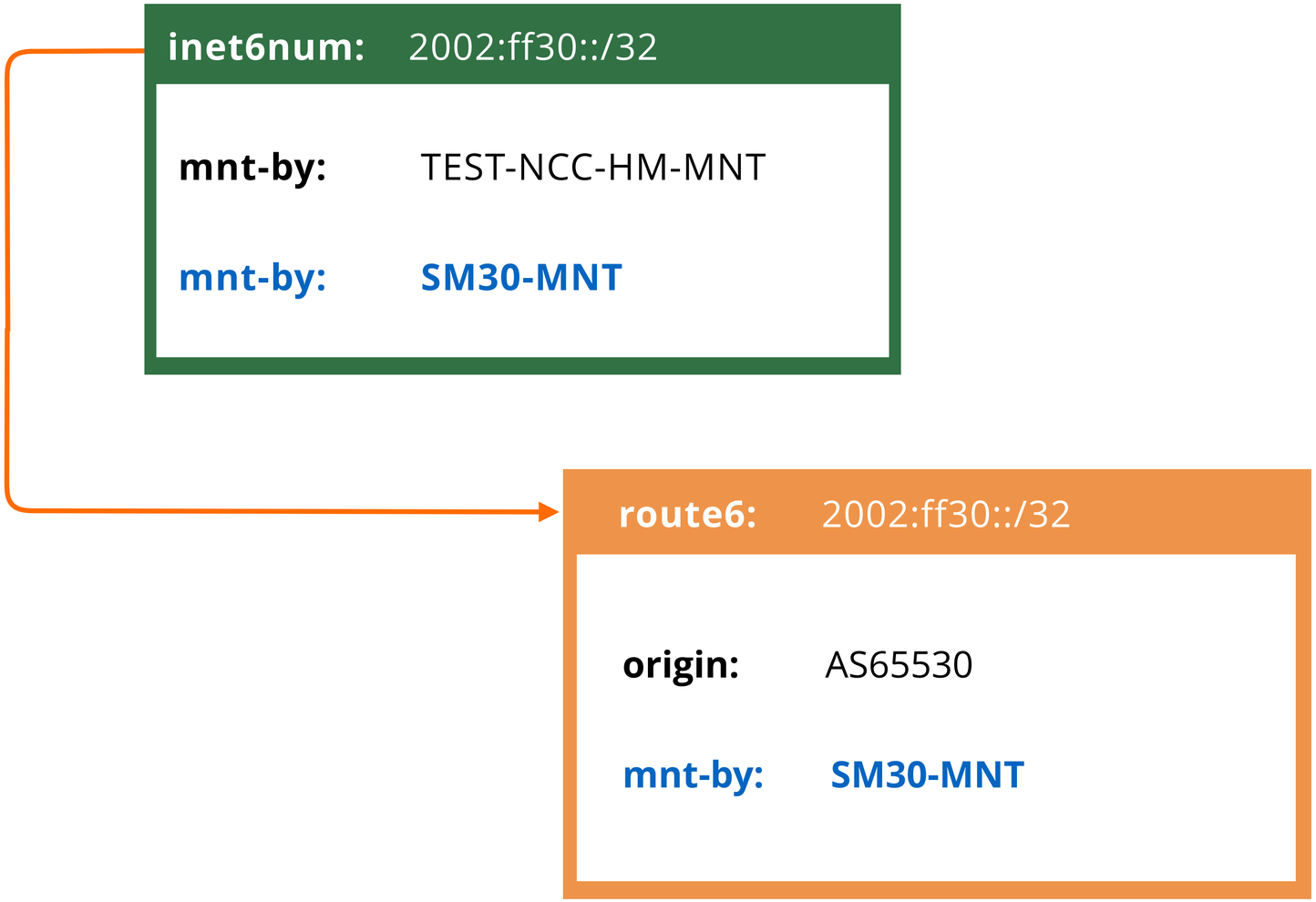
origin:	AS12345
mnt-by:	ANOTHER-MNT

* **mnt-routes** delegates the creation of **route(6)** objects

Registering IPv4 Routes



Registering IPv6 Routes

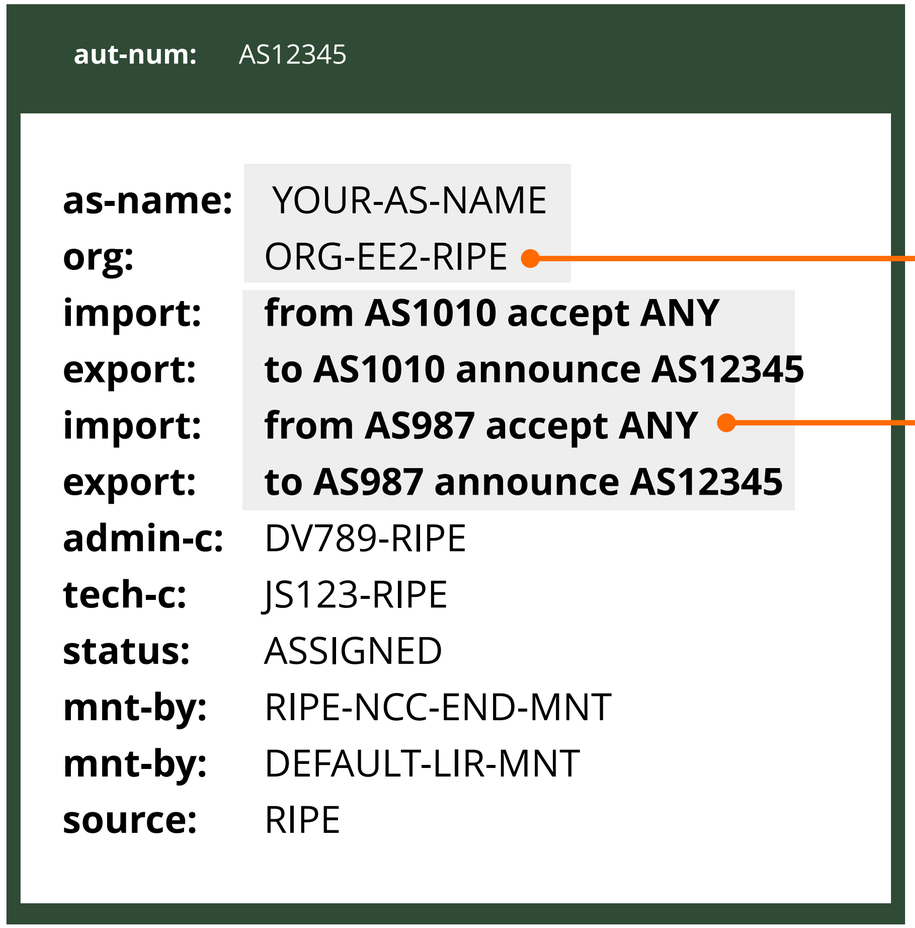


Take the poll!

What would happen if your **route(6)** objects were deleted?

2 min.

AUT-NUM



Registers **who** holds that AS Number

Defines the routing policy for an AS

- **Import** - specifies which routes you accept
- **Export** - specifies which routes you announce

Set Objects

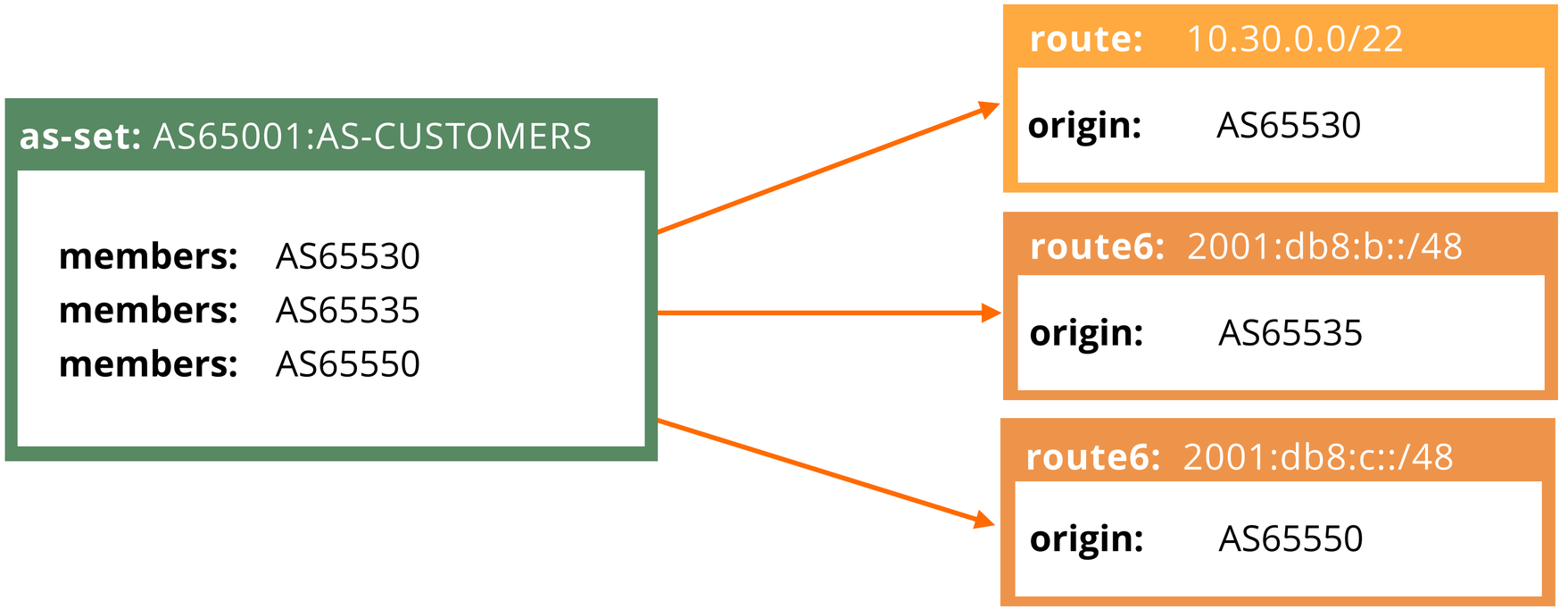
- Objects can be grouped in sets
  - **as-set** : Defines a set of aut-num objects
  - **route-set** : Defines a set of routes
  - **filter-set** : Defines a set of routes that will be filtered
  - **rtr-set** : Defines a set of routers
  - **peering-set** : Defines a set of peerings

as-set:	AS65530:AS-EXAMPLE
members:	AS1
members:	AS2, AS3, AS4
admin-c:	JD1-RIPE
mnt-by:	LIR-MNT

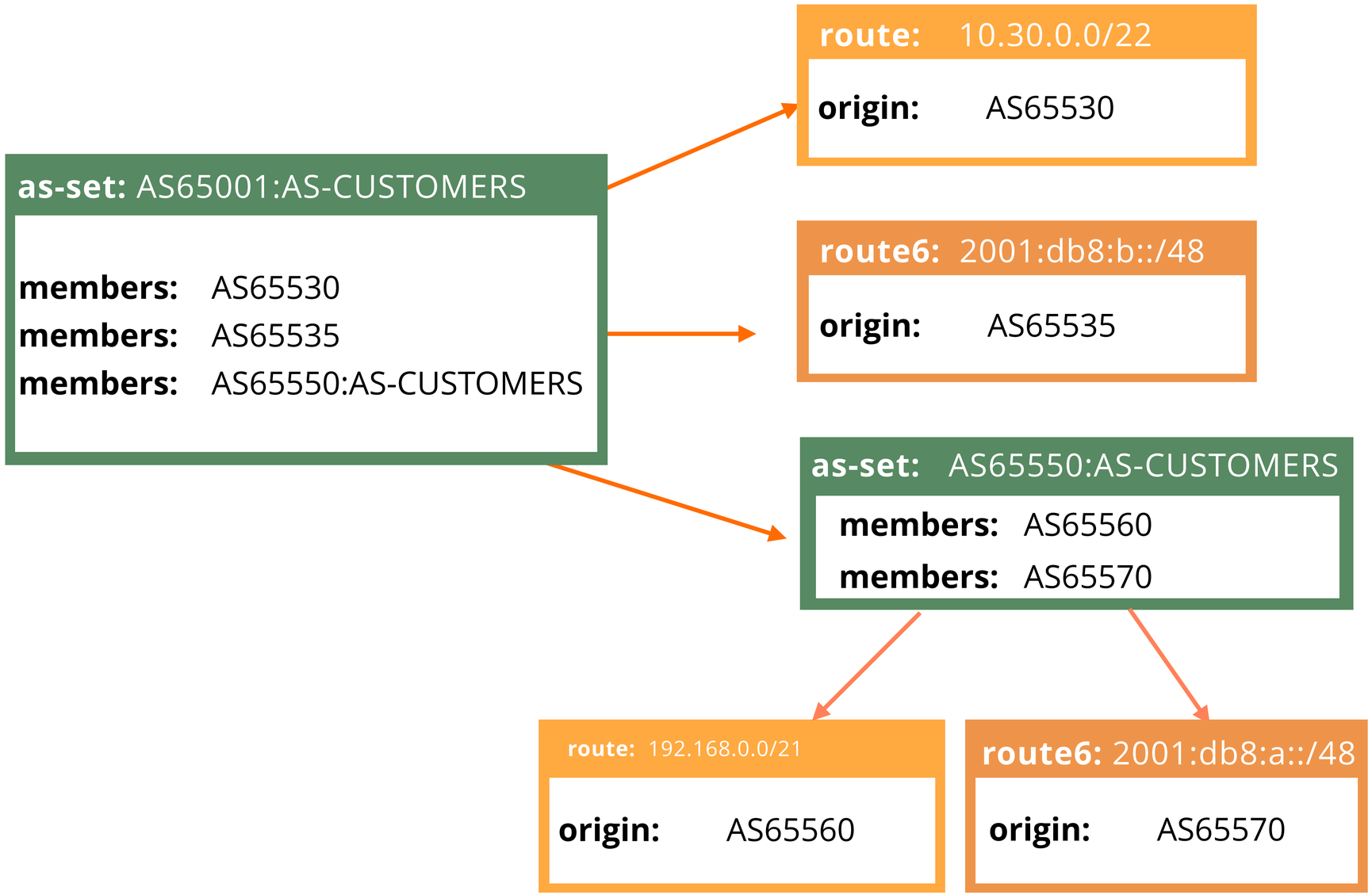
route-set:	RS-EXAMPLE
members:	98.32.162.0/24
members:	128.223.0.0/16
admin-c:	JD1-RIPE
mnt-by:	LIR-MNT

AS-SET

- Existing as-set names
  - can be short (AS-TEST) or hierarchical (AS3333:AS-TEST)
- It is now mandatory to use hierarchical names
  - Creation of the object is authorised by the ASN holder



AS-SET


route: 10.30.0.0/22
origin: AS65530
as-set: AS65001:AS-CUSTOMERS
members: AS65530
members: AS65535
members: AS65550:AS-CUSTOMERS
route6: 2001:db8:b::/48
origin: AS65535
as-set: AS65550:AS-CUSTOMERS
members: AS65560
members: AS65570
route: 192.168.0.0/21
origin: AS65560
route6: 2001:db8:a::/48
origin: AS65570

ROUTE-SET

- Name must begin with “**rs-**“
- Defines a set of prefixes
  - The members are prefixes or other route sets

route-set: rs-martians

```
descr:      routes not accepted from any peer

members:    0.0.0.0/0,      # default route
            0.0.0.0/0^32,   # host routes
            224.0.0.0/3^+, # multicast routes
            127.0.0.0/8^9-32, . . .
```

FILTER-SET

- Name must begin with “**fltr-**“
- Set of routes that will be filtered

filter-set : fltr-martian

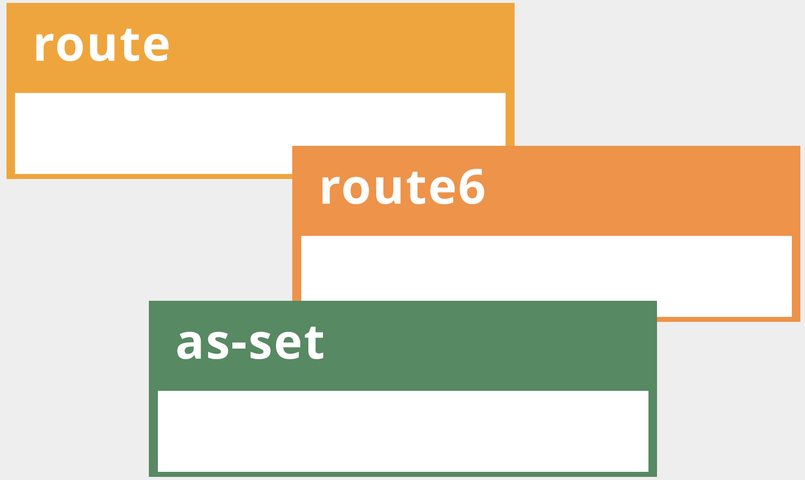
```
descr:      Special use and reserved IPv4 prefixes.

filter:     { 0.0.0.0/8^+,
              10.0.0.0/8^+,100.64.0.0/10^+,
              127.0.0.0/8^+ , 169.254.0.0/16^+ ,
              172.16.0.0/12^+ , 192.0.0.0/24^+,
```

Demo Time!

Let’s create RIPE Database objects!

- A **route** object
- A **route6** object
- An **as-set** object

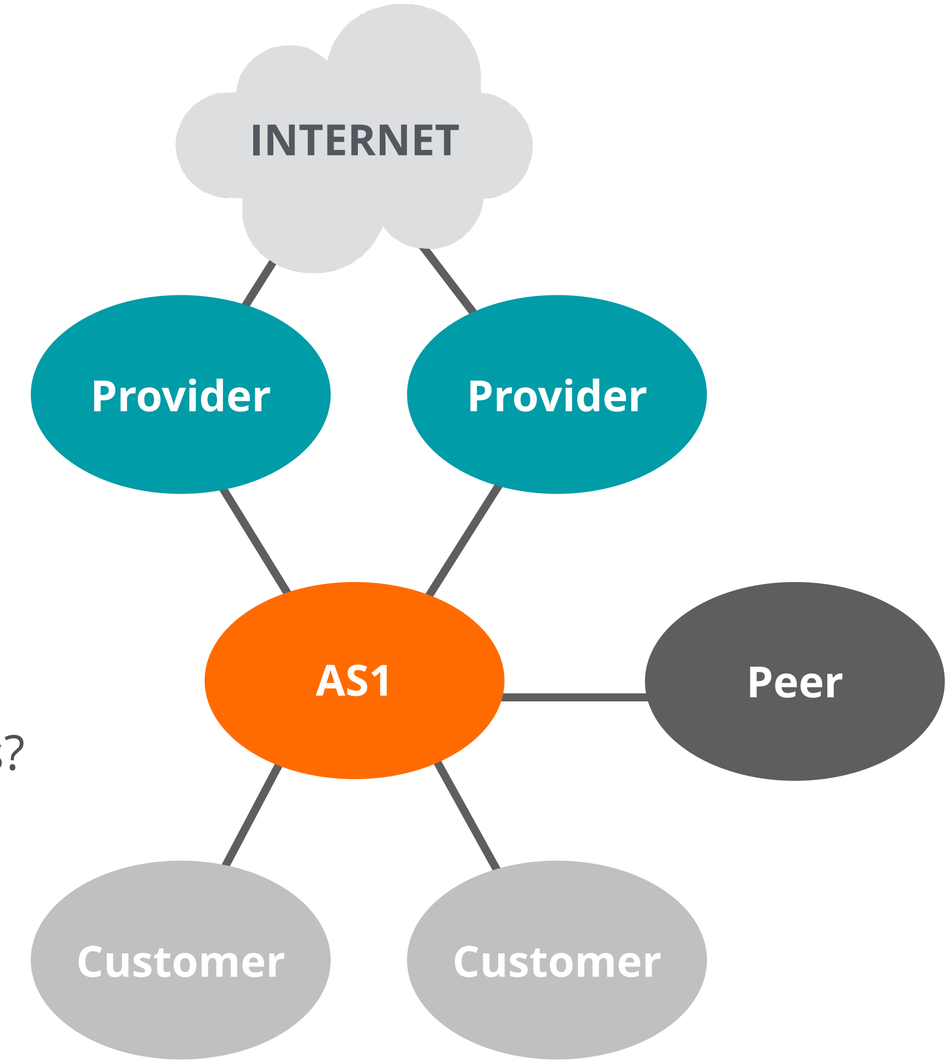


BGP Routing Policy and RPSL

Section 2

What is a Routing Policy?

- Who are your BGP peers? Which ASes?
- What is your BGP relationship with them?
  - Customer, Provider, Peer
- What are your routing decisions?
  - Which prefixes to accept?
  - Which prefixes to announce?
  - Which prefixes will be preferred in case of multiple routes?

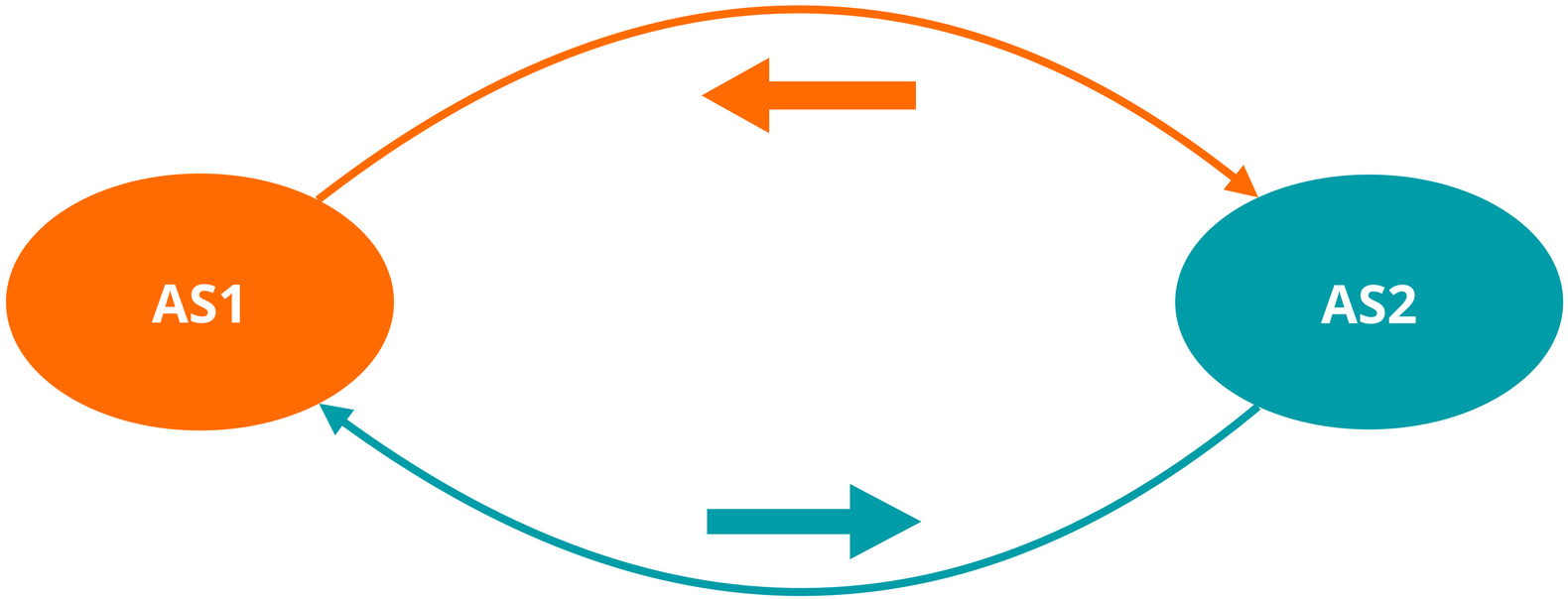


IRRs use RPSL Language

- **RPSL - Routing Policy Specification Language**
- Allows network operators to specify their routing policies
  - Generic way to describe BGP configuration in the IRR
  - Not vendor-specific
- Originated from a RIPE Document (RIPE-181)
- Can be translated into router configuration

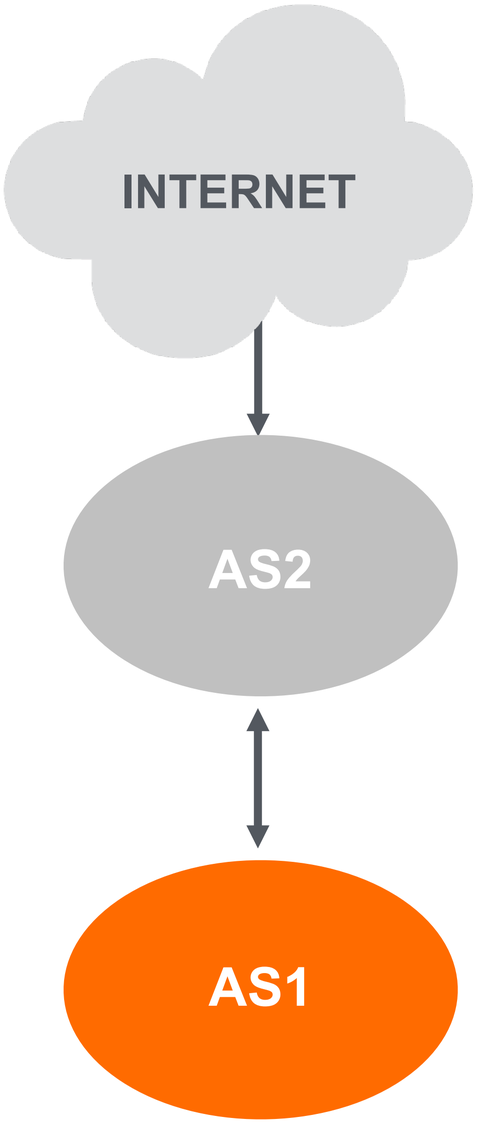
RFC 2622 - Routing Policy Specification Language
RFC 2650 - Using RPSL in Practice

Defining Routing Policy in RPSL




```
aut-num:  AS1
import: from AS2 accept AS2
export: to AS2 announce AS1
```

Routing Policy with Transit

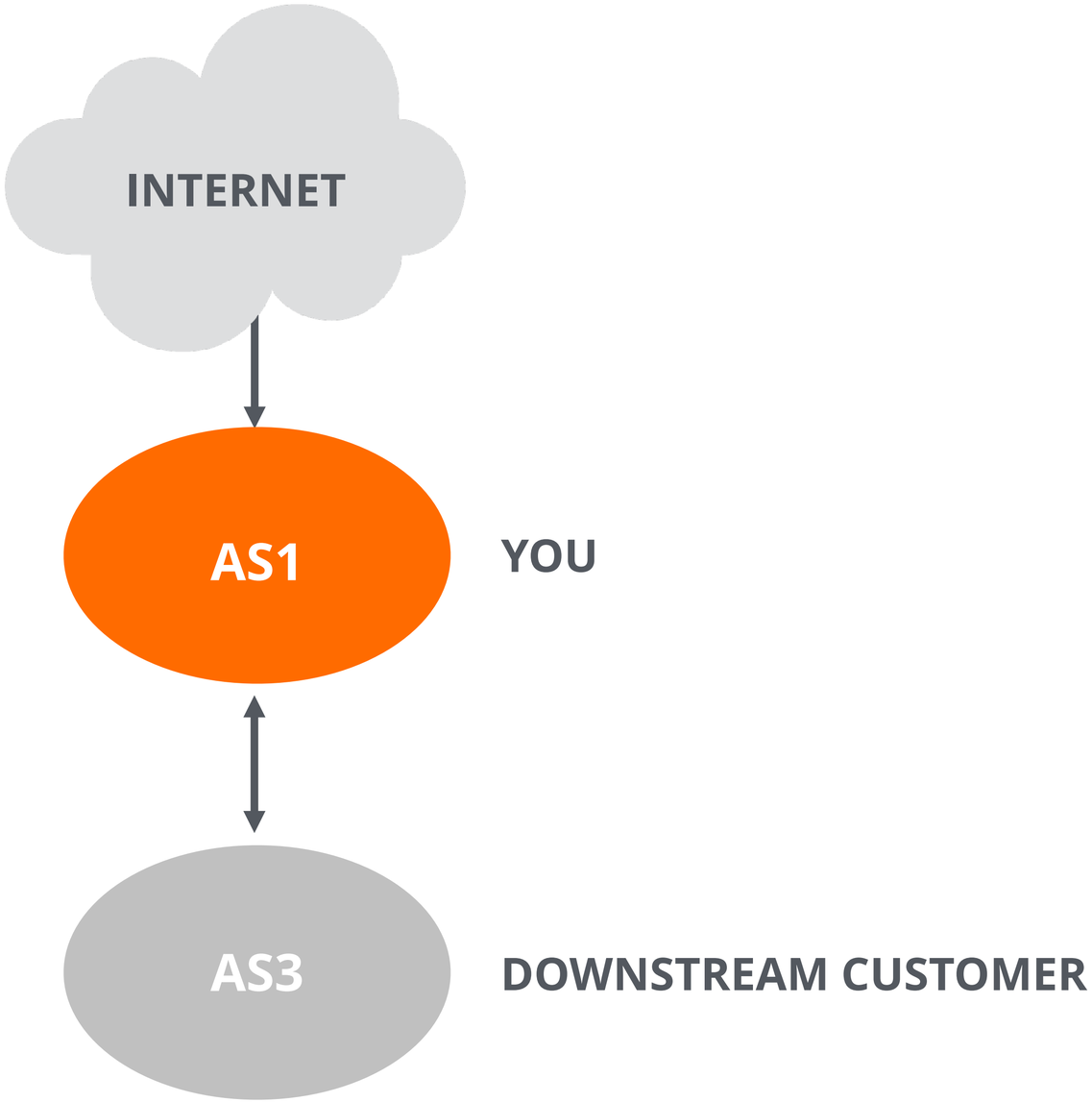


TRANSIT PROVIDER

YOU

```
aut-num:  AS1
import: from AS2 accept ANY
export: to AS2 announce AS1
```

Routing Policy with Customers

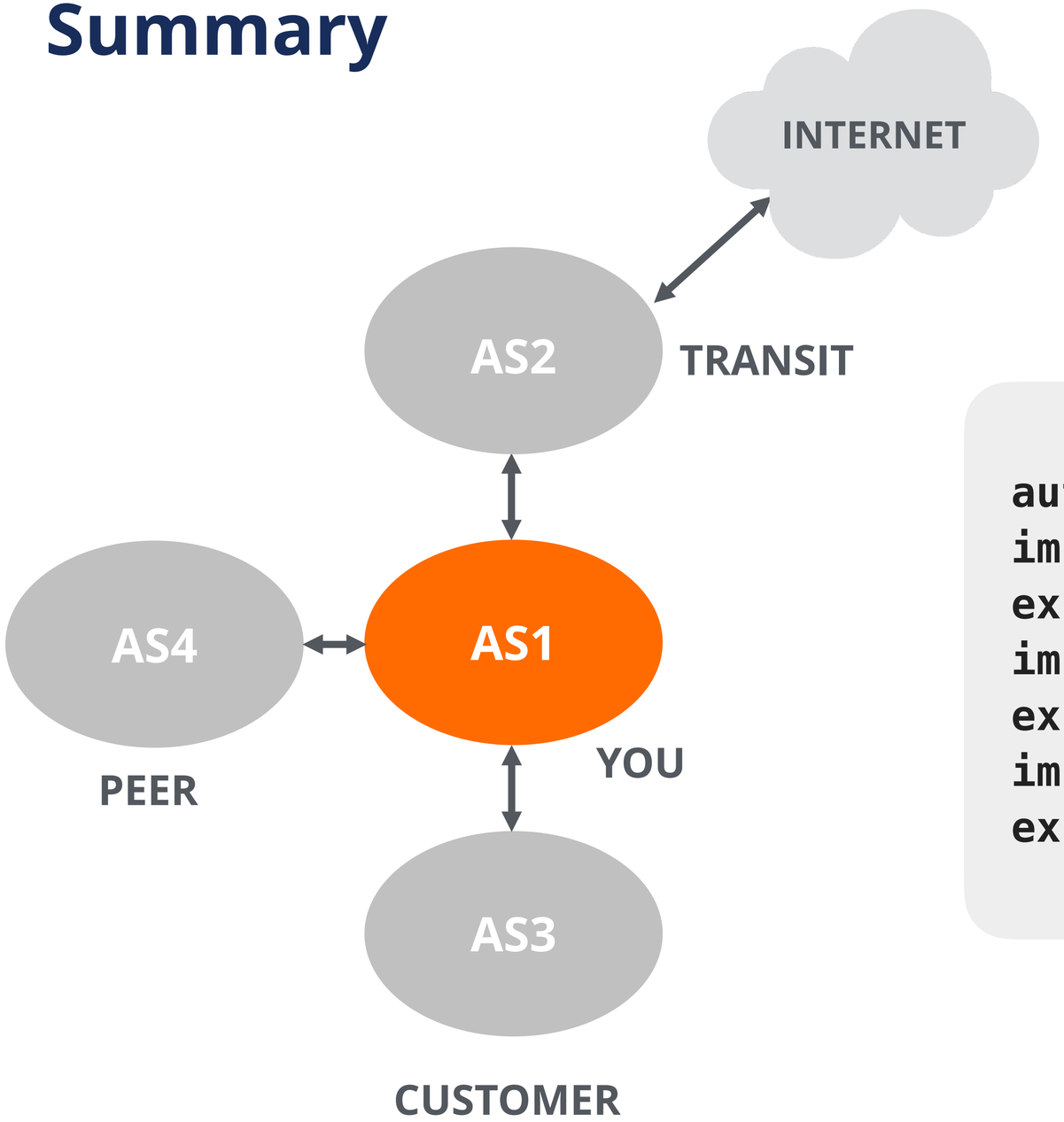



```
aut-num:  AS1
import: from AS3 accept AS3
export: to AS3 announce ANY
```

Routing Policy with Peers

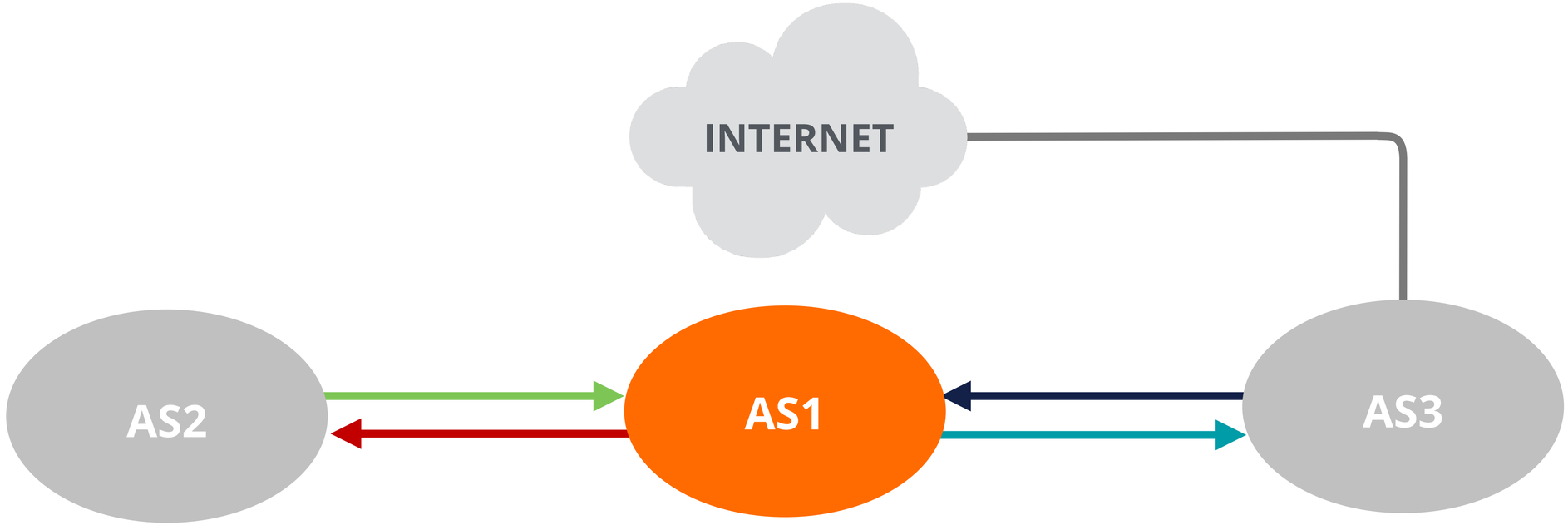

```
aut-num:  AS1
import: from AS4 accept AS4
export: to AS4 announce AS1
```

Summary




```
aut-num:  AS1
import: from AS2 accept ANY
export: to AS2 announce AS1 AS3
import: from AS3 accept AS3
export: to AS3 announce ANY
import: from AS4 accept AS4
export: to AS4 announce AS1 AS3
```

Building an aut-num object



aut-num: AS2

```
import: from AS1 accept AS1
export: to AS1 announce AS2
```

aut-num: AS1

```
export: to AS2 announce AS1
import: from AS2  accept AS2
import: from AS3 accept ANY
export: to AS3 announce AS1
```

aut-num: AS3

```
export: to AS1 announce ANY
import: from AS1 accept AS1
```

RPSLng

- **RPSL is older** than IPv6, the defaults are IPv4
- IPv6 was added later using a different syntax
- You have to **specify** that it's IPv6

```
aut-num:  AS1
mp-import:  afi ipv6.unicast from AS201 accept AS201
mp-export:  afi ipv6.unicast to AS201 announce ANY
```

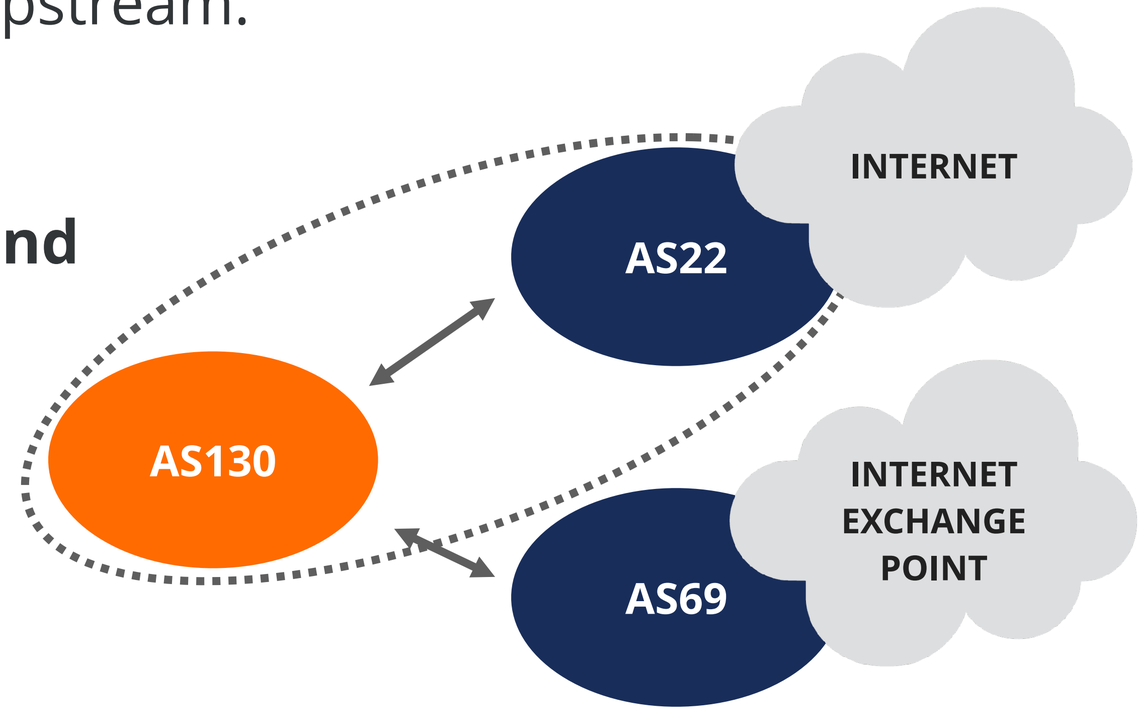
```
route-set:  rs-customers
members:    192.0.2.0/24
mp-members: 2001:db8:abcd::/48
```

RFC 4012 - "Routing Policy Specification Language next generation (RPSLng)"

Take the poll!

AS130 is a stub network and **AS22** is its upstream.

What is the correct **inbound** and **outbound** policy for this BGP relationship?



2 min.

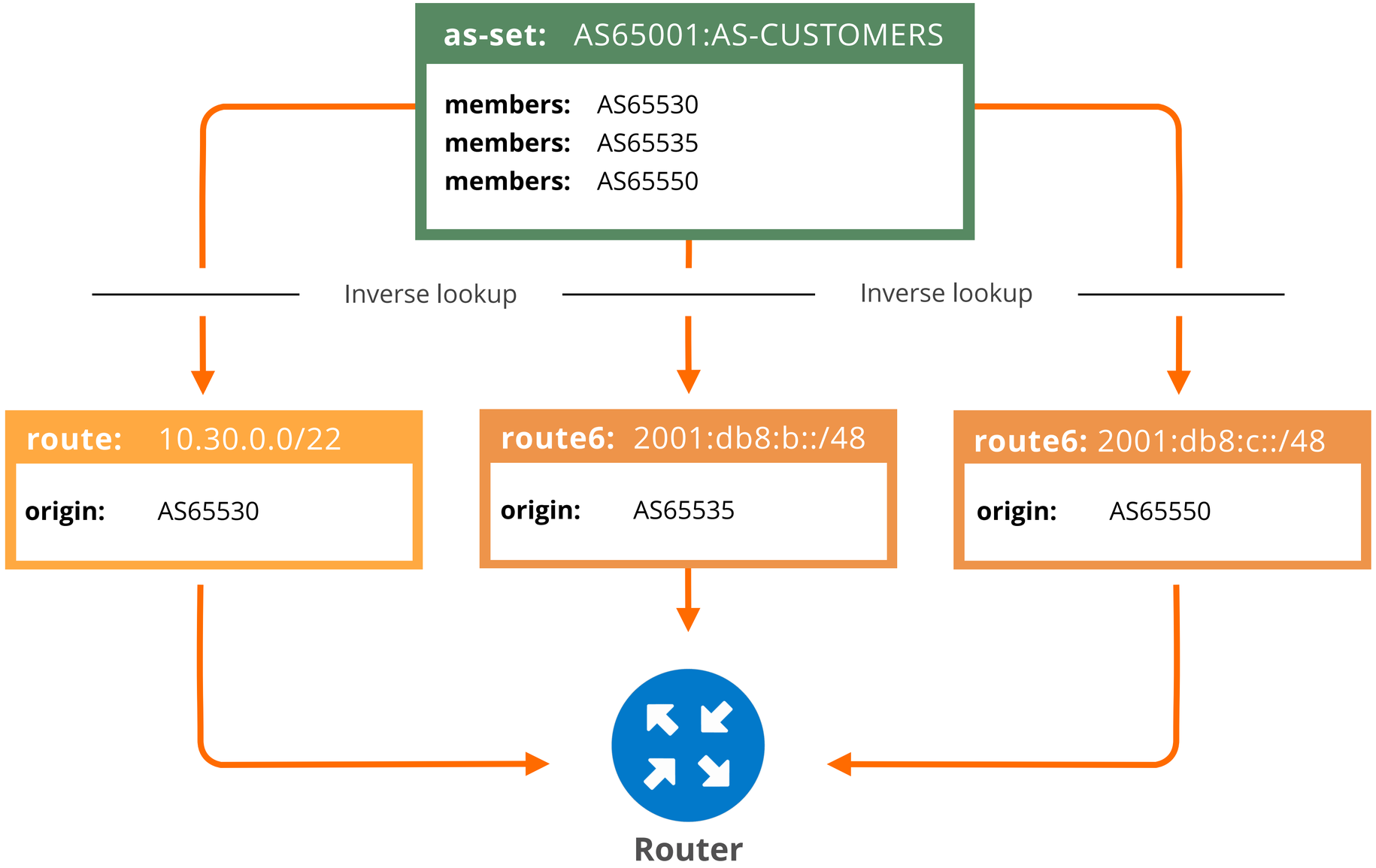
Tools and Automation

Section 3

IRRs & BGP Automation

- Tools available that get the policy data from the IRRs
  - Extract prefixes from **route(6)** objects
  - Query the IRRs over **whois** protocol
- Some can generate complete router configurations
- Most are open source tools
- Some are not well maintained

Generating a Prefix Filter

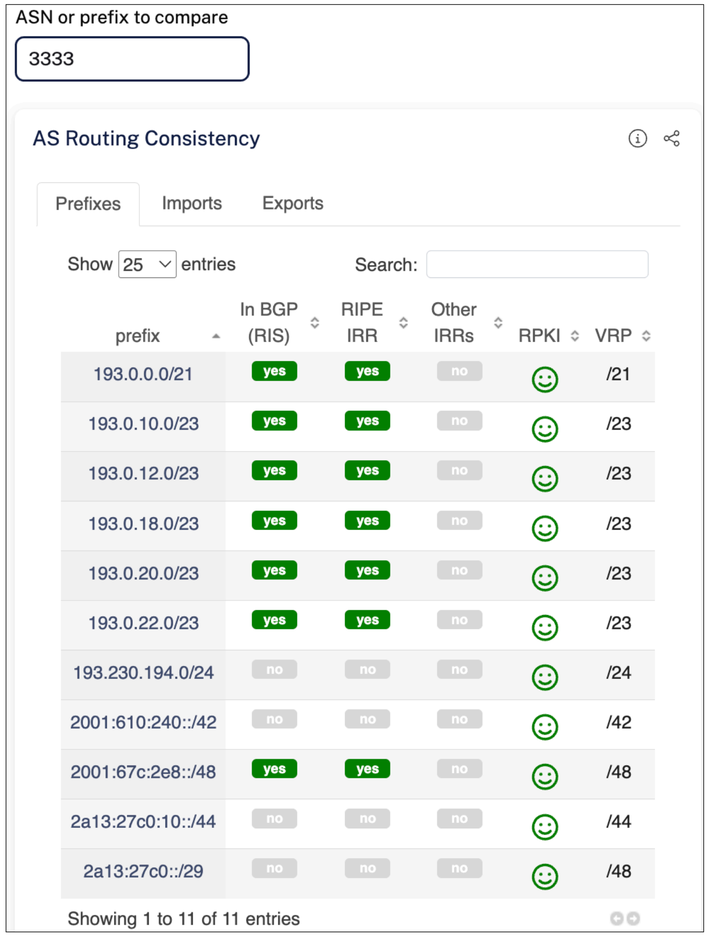


RPSL tools for BGP automation

- IRRToolset (written in C++)
  - https://github.com/irrtoolset/irrtoolset
- Rpsltool (perl)
  - https://github.com/rfc1036/rpsltool
- IRR Power Tools (PHP)
  - https://github.com/6connect/irrpt
- bgpq4 (C)
  - https://github.com/bgp/bgpq4
- Filtergen (Level 3)
  - https://github.com/anchor/filtergen
  - whois -h filtergen.level3.net RIPE::ASxxx

Tools to check IRR status

RIPEstat



https://stat.ripe.net

IRR EXPLORER

https://irrexplorer.nlnog.net/

Limitations of the IRR System

Section 4

Take the poll!

What are the **limitations** of the IRR system?

Choose all that apply.

2 min.

The IRR system has some limitations!

- **IRRs may contain conflicting data**
  - Distributed databases that mirror each other
- **No central authority**
  - Who will verify the accuracy of the data?
- **No verification of holdership**
  - In some IRRs, you can create objects without checks
- **Not updated properly**
  - Information is missing, outdated or incorrect

IRR filters are good only if the IRR entries are correct!

But remains widely used…

- RPKI was developed as a more secure alternative
  - Uses cryptography for verification of holdership
  - Covers more than 55% IPv4 and 55% IPv6 prefixes announced in BGP globally (03.2025)
- So, the IRR system is still widely used for BGP routing security!

Improving IRR accuracy

- IRR hygiene is essential
  - Check your BGP routing consistency
  - Do you have **route(6)** objects in IRRs?
- Keep your IRR information up to date
- Remove RPKI inconsistent records from IRR

Getting the complete picture

- Automation relies on the IRR being complete
- Small mistakes can have a big impact
- Check your output before using it
  - Be prepared to make manual overrides
- **Help others by documenting your routing policy!**

Questions

We want your feedback!

What did you think about this session? Take our survey at:

https://www.ripe.net/feedback/irr/

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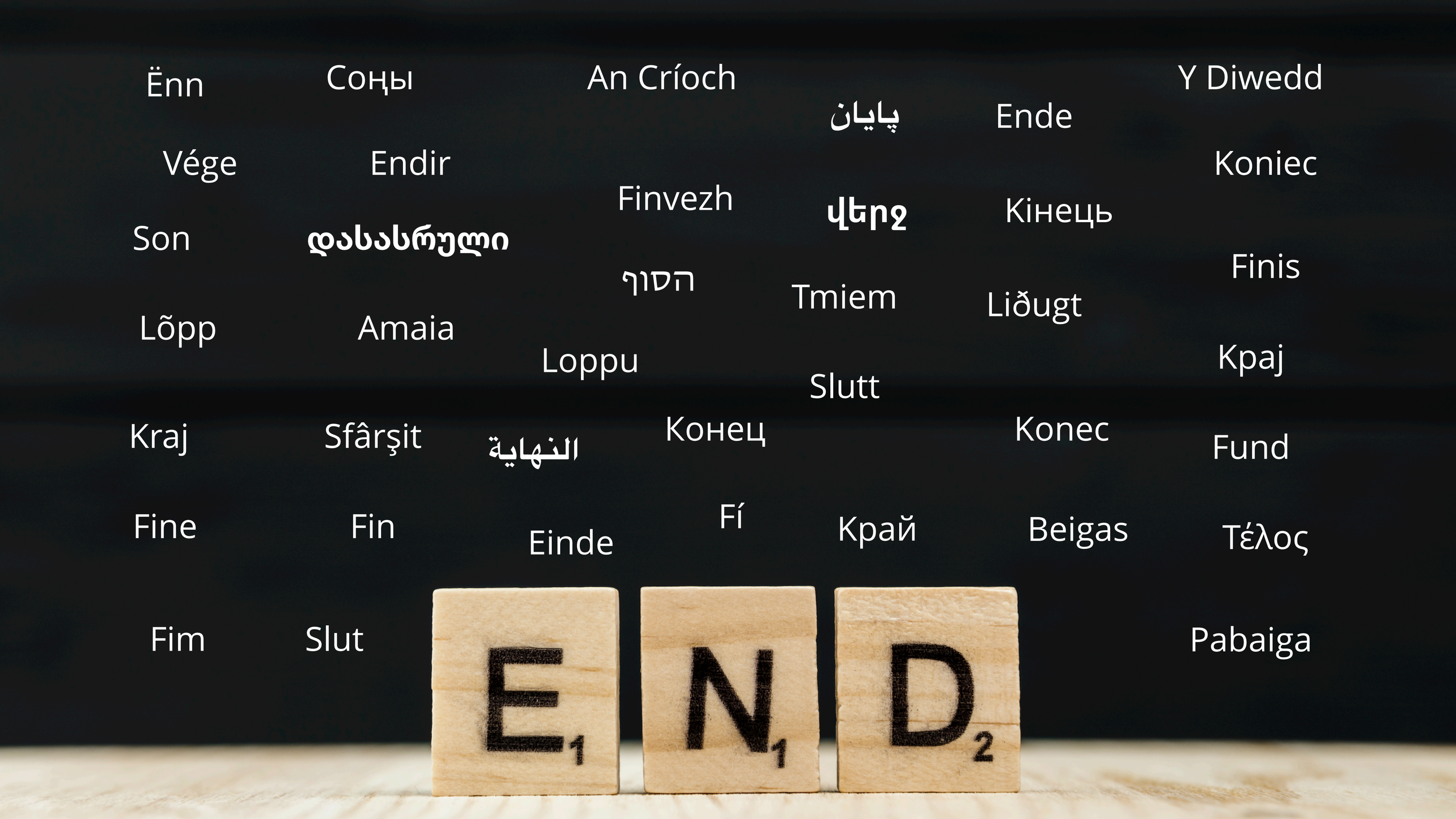
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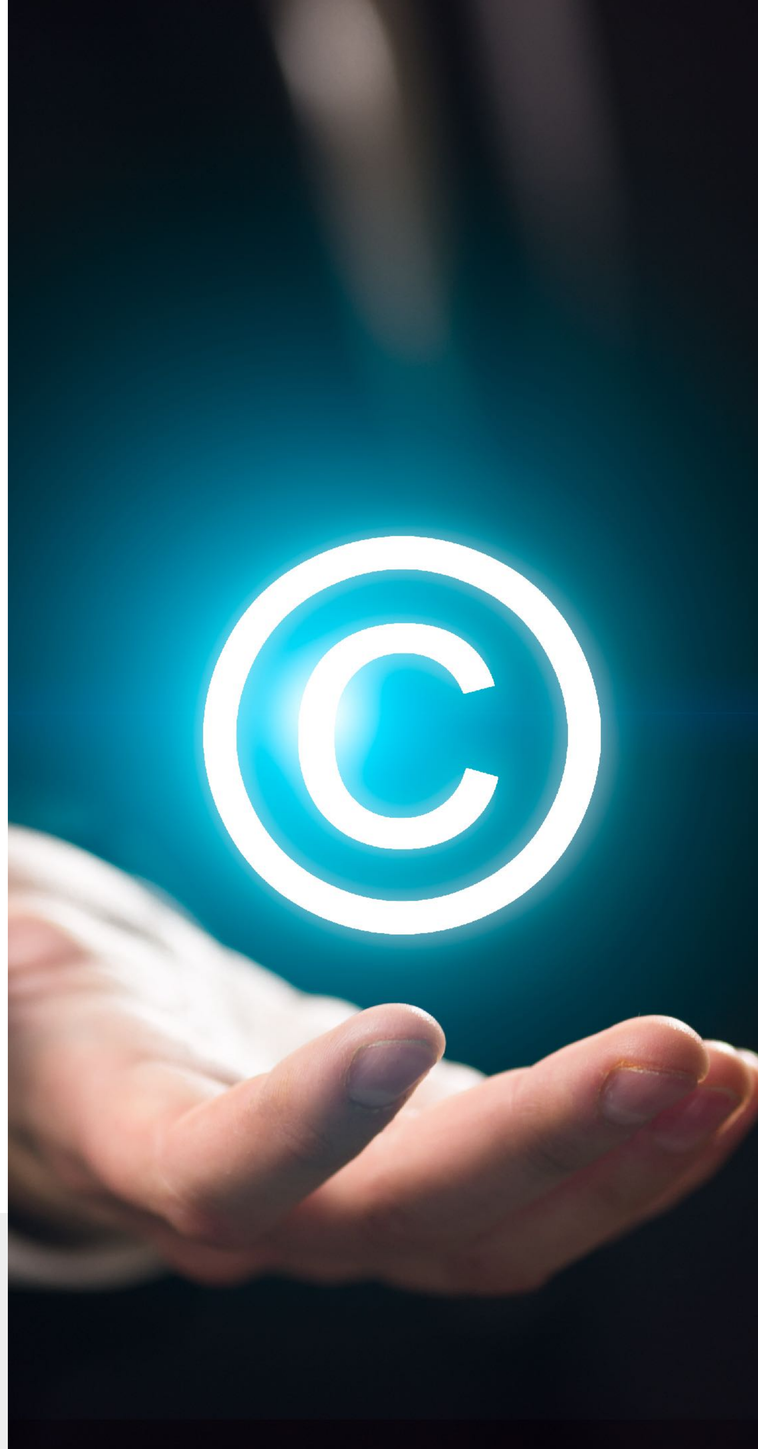

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