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Representation of IP Routing Policies in the RIPE database

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Routing Registry

- Neutral run European registry (RIPE NCC)
- Registration of routing policy information

Proposal for a format for documenting routing policy

"Representation of IP Routing Policies in the RIPE Database" (ripe-81)

- Official RIPE recommendation

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Design Criteria

- Based on arbitrary routing mesh (i.e. no single core)
- "Explainable"
  - Easy for network operators to understand
- "Implementable"
  - Realistic in terms of functionality versus implementation
  - Generate router configurations
- Uses BGP (but not required)
- May require some restructuring/re-engineering in terms of ASs
- Provide the platform for building diagnostic tools, for example in terms of policy information

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Policies

- General Representation
  - Effort to clarify terms and be consistent
  - Networks
    - -- Layer 3 entities NOT organizations
  - Network Operators
    - -- Service Providers
    - -- Customers
  - Autonomous System (AS)
    - -- A group of networks having a single defined **routing policy**
    - -- An entity exchanging reachability information with neighboring ASes

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Policies

- Routing Policies
  - Interaction of routing exchanges between peering ASes
  - Set for various reasons
  - Need to be documented
  - All routing policies are based on network number
  - Defined in terms of groups of networks
- Access Policies
  - Rarely defined in terms of routing policy
  - Need to be documented
  - Several examples (AUP, Closed user groups, etc.)

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Autonomous System (AS)

- Paper gives guidance for creation, engineering and maintenance of an AS
- Key point is a network can only belong to one AS
- By having an AS object we can document clearly the routing policy of that AS when exchanging reachability information with any other AS
- The AS tag can only be created/updated by the "guardian" of the AS. This ensures control and consistency at the AS level
- Provides two basic key things:
  - A manageable group of networks
  - A description of admin detail and routing policy information

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Autonomous System (AS)

- Can be used to generate **network** based routing filters
- Can be used with newer protocols supporting AS path information
- **Doesn't rely on using BGP**, however BGP is recommended wherever possible

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Community

- A network can be part of more than one community
- Group of networks that cannot be represented by an AS
- Other uses...
  - Special/restricted access policies
  - Accountability -- Statistics, accounting, etc.
- Global relevance
- Should not be tied to any single AS
- The community tag can only be created/updated by the guardian of the community object

R e p r e s e n t a t i o n   o f   A S

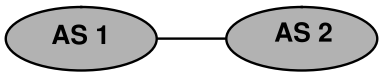
- Routing policies of an AS represented in the AS object
- Details of how routing exchanges take place between ASes
- Based on network number, NOT AS paths, purely on originating AS
- Detail incoming and outbound information for any AS peers an AS has
- Additional preference information

R e p r e s e n t a t i o n

```
aut-num: AS1104
descr: NIKHEF-H
descr: Science Park Watergraafsmeer
descr: Amsterdam, The Netherlands
as-in: AS1213 100 AS1213
as-in: AS1930 200 AS1930
as-in: AS2107 200 AS2107
as-in: AS1755 150 AS-EBONE
as-in: AS2122 150 ANY
as-out: AS1213 ANY
as-out: AS1930 ANY
as-out: AS2107 ANY
as-out: AS1755 AS1104 AS1930 AS2107 AS1213
as-out: AS2122 ANY
as-out: AS2121 ANY
as-out: AS2121 150 ANY
default: AS1755 100
guardian: ripe-op@nikhef.nl
admin-c: Rob Blokzijl
tech-c: Marten Terpstra
changed: marten@ripe.net 930216
```


R e p r e s e n t a t i o n   o f   A S

Basic idea




```
as: AS1
<administrivia go here>
as-out: AS2 AS1      # announce all networks in AS1 to AS2
as-in:  AS2 100 AS2  # accept all AS2 networks from AS2

as: AS2
<administrivia go here>
as-out: AS1 AS2      # announce all networks in AS2 to AS1
as-in:  AS1 100 AS1  # accept all AS1 networks from AS1
```

The value of **100** is a measure of cost AND is always used in “as-in” tag

R e p r e s e n t a t i o n   o f   A S

A simple example


```
as: AS1
<administrivia go here>
as-out: AS2 AS1             # announce all networks in AS1 to AS2
as-in:  AS2 100 AS2 AS3     # accept AS2 and AS3 networks from AS2

as: AS2
<administrivia go here>
as-out: AS1 AS2 AS3         # announce all networks in AS2 and AS3 to AS1
as-in:  AS1 100 AS1         # accept all AS1 networks from AS1
as-out: AS3 AS2 AS1
as-in:  AS3 100 AS3

as: AS3
<administrivia go here>
as-out: AS2 AS3             # announce all networks in AS3 to AS2
as-in:  AS2 100 AS1 AS2     # accept AS2 and AS1 networks from AS2
```

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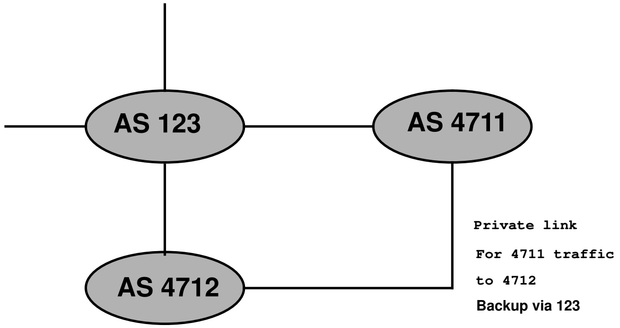
Representation of AS

More complex example



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Representation of AS

```
as: AS4711
as-in:   AS123 100 ALL       # accept all routes from AS123
as-out: AS123 AS4711
as-in:  AS4712 99 AS4712   # prefer AS4712 from AS4712
as-out:  AS4712 AS4711       # announce only own nets to AS4712

as: AS123
as-in:  AS4711 100 AS4711
as-out: AS4711 ALL
as-in:  AS4712 100 AS4712
as-out: AS4712 ALL

as: AS4712
as-in:  AS123 100 ALL
as-out: AS123 AS4712
as-in:  AS4711 99 AS4711
as-out: AS4711 AS4712
```

The cost is now used to show routing policy

The lower the cost value the **more preferred** the route is

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What does it solve?

- Concise way to express routing policy
- Easy to understand
- Easy to publish in existing database
- Suitable to compile into router configurations
- Suitable to be used by NOC tools

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What doesn’t it solve?

- Cannot deal with routing policies based on transit information
  - Whole concept is based on originating AS
- Cannot deal with routing policies for networks which are not published in the (RIPE) database
- Cannot deal with “half baked” routing policies
- limitations of destination based forwarding

Open Issues

- ❍ CIDR (should be OK)
- ❍ configuration exchange between neighboring ASes (multiple links)
- ❍ does it scale to source based forwarding?
- ❍ consistency with routing registries using other representations
- ❍ others??

Status

Routing Registry

- ❍ Ripe-81 produced and general consensus seems very good
  - ❍ Large effort of data collection underway
  - ❍ Positive results so far (some way to go yet)

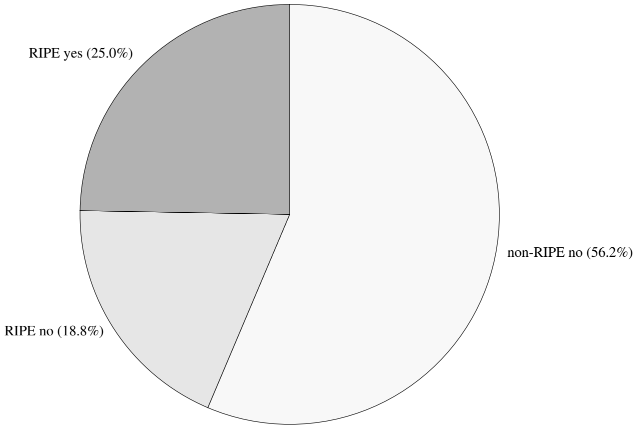
“25 % of ASs have policy information”

  - ❍ Daily generated information of current routing policy information as seen “in routing tables” as opposed to the RIPE database

ftp.ripe.net:ripe/as

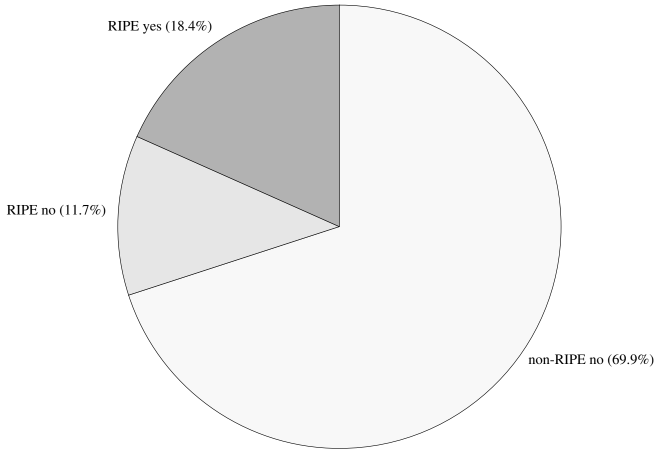
- ❍ Database software enhanced (whois for AS info)
- ❍ Prototype configuration tools working for cisco and gated network and as-path based filter lists

Breakdown of AS in Database (taken from network entries)



Breakdown of AS in Database (taken from Routing Tables)

Includes some U.S. ASes



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MODIFIED WHOIS

```
[mature-tony-224] whois AS786
aut-num: AS786
descr: The JANET IP Service
descr: UK
as-in: AS60 50 AS60
as-in: AS766 100 AS766
as-in: AS1263 45 DEFAULT
as-in: AS1275 100 AS1275
as-in: AS1290 50 AS1290
as-in: AS1755 102 RIPE-DB AND NOT (LOCAL AS786)
as-in: AS1849 50 AS1849
as-in: AS1930 100 AS1930
as-in: AS2107 100 AS2107
as-in: AS2111 100 AS2111
as-out: AS60 AS786 AS766
as-out: AS766 AS786 AS1755
as-out: AS1263 AS786 AS766 AS1930 AS2107 AS2111
as-out: AS1275 AS786 AS1755
as-out: AS1290 AS786
as-out: AS1755 AS786 AS766 AS1275 AS1930 AS2107 AS2111
as-out: AS1849 AS786 AS1755
as-out: AS1930 AS786 AS1755
as-out: AS2107 AS786 AS1755
as-out: AS2111 AS786 AS1755
default: AS1263 1
guardian: jips-nosc@noc.ulcc.ac.uk
admin-c: Duncan Rogerson
admin-c: Kevin Hoadley
tech-c: Duncan Rogerson
tech-c: Kevin Hoadley
remarks: AS2111 link is not yet active, coming soon.
```


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"Prtraceroute"

- Still a prototype (Working !!!)
- Alpha release available

  ftp.ripe.net:tools/routing/prtraceroute.shar.Z

- Requires.....
  - perl
  - traceroute
- Built-in "whois" client

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"Prtraceroute"

Explanation of output:

1st field: normal tarceroute hopcount
2nd : AS number of the network interface of the router that is passed
3rd : hostname
4th : IP address of the incoming interface
5th : Comparison with database policies, where

I = Internal route (hop within the same AS, default for the first hop)
DX = default route, the Xth choice according policy so D1 would indicate the primary default route, D2 the secondary default route etc
EX = External route, the Xth choice according to policy
? = no information. Either the current AS, or the previous AS is unknown, so we can not do any useful database tracing
ERROR = hop is not supposed to be taken according to the database

A path summary will is given, and a description of all ASes passed (if in the database)

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"Prtraceroute"

```
% prtraceroute jolly.nis.garr.it
traceroute to jolly.nis.garr.it (192.12.192.5) with AS and policy
additions

 1 AS1104 hef-router.nikhef.nl (192.87.45.80) [I]
 2 AS1755 Amsterdam-EBS1.Ebone.NET (192.87.4.17) [D1]
 3 AS1755 Cern-EBS1.Ebone.NET (192.87.4.10) [I]
 4 AS 513 chep1.cern.ch (192.65.185.2) [D1]
 5 AS 137 GARR-gw-mi.infn.it (192.12.193.49) [E1]
 6 AS 137 GARR-gw.cilea.it (192.12.193.41) [I]
 7 AS 137 GARR-gw.cineca.it (192.12.193.21) [I]
 8 AS 137 GARR-gw.cnr.it (192.12.193.14) [I]
 9 AS 137 jolly.nis.garr.it (192.12.192.5) [I]

Path followed: 1104 1755 513 137

AS1104 = IXI RBS at NIKHEF
AS1755 = EBONE-INTERNAL
AS 513 = CERN-AS
AS 137 = GARR/INFN IT
```