APNIC Training

Internet Routing Registry (IRR)

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15 South Asian Network Operators Group Conference

SANOG

In conjunction with ISPAB

ISPAB

APNIC Asia Pacific Network Information Centre

Introduction

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APNIC Asia Pacific Network Information Centre

Assumptions & Objectives

Assumptions

- Are current or prospective APNIC members
- Have not submitted many requests
- Are not familiar or up-to-date with address policies
- Are not familiar with procedures
- Are interested in address management

Objectives

- To provide an understanding of address management
- To provide a working knowledge of the procedures for requesting resources from APNIC and managing these
- To keep membership up-to-date with the latest policies
- Liaise with members.

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What is a Routing Registry?

- A repository (database) of Internet routing policy information
  - Autonomous Systems exchanges routing information via BGP
  - Exterior routing decisions are based on policy based rules
  - However BGP does not provides a mechanism to publish/communicate the policies themselves
  - RR provides this functionality
- Routing policy information is expressed in a series of objects

Routing registry objects

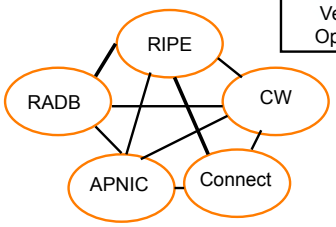
- Route, aut-num, inet-rtr, peering-set, AS -set, rtr-set, filter-set
  - Each object has its own purpose
  - Together express routing policies
- More details covered later

What is a Routing Registry?

- Global Internet Routing Registry database
  - http://www.irr.net/
    - Uses RPSL
- Stability and consistency of routing
  - network operators share information
- Both public and private databases
  - These databases are independent
    - but some exchange data
    - only register your data in one database

What is a Routing Registry?

ARIN, ArcStar, FGC, Verio, Bconnex, Optus, Telstra, ...



IRR = APNIC RR + RIPE DB + RADB + C&W + ARIN + …

Representation of routing policy

NET1 NET2

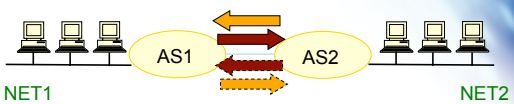
In order for traffic to flow from NET2 to NET1 between AS1 and AS2:

AS1 has to announce NET1 to AS2 via BGP

And AS2 has to accept this information and use it

Resulting in packet flow from NET2 to NET1

Representation of routing policy (cont.)



NET1 NET2

In order for traffic to flow towards from NET1 to NET2:

AS2 must announce NET2 to AS1

And AS1 has to accept this information and use it

Resulting in packet flow from NET 1 to NET2

What is routing policy?

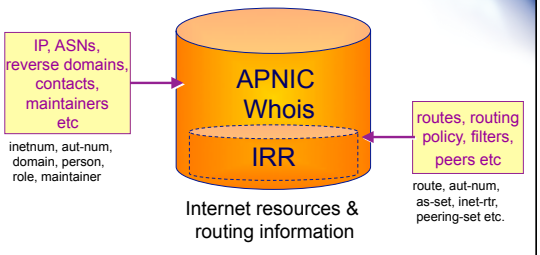
- Description of the routing relationship between autonomous systems
  - Who are my BGP peers?
    - Customer, peers, upstream
  - What routes are:
    - Originated by each neighbour?
    - Imported from each neighbour?
    - Exported to each neighbour?
    - Preferred when multiple routes exist?
  - What to do if no route exists?
  - What routes to aggregate?

APNIC Database & the IRR

- APNIC whois Database
  - Two databases in one
- Public Network Management Database
  - "whois" info about networks & contact persons
    - IP addresses, AS numbers etc
- Routing Registry
  - contains routing information
    - routing policy, routes, filters, peers etc.
  - APNIC RR is part of the global IRR

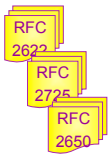
Integration of Whois and IRR

- Integrated APNIC Whois Database & Internet Routing Registry



RPSL

- Routing Policy Specification Language
  - Object oriented language
    - Based on RIPE-181
  - Structured whois objects
- Higher level of abstraction than access lists
- Describes things interesting to routing policy:
  - Routes, AS Numbers …
  - Relationships between BGP peers
  - Management responsibility
- Relevant RFCs
  - Routing Policy Specification Language
  - Routing Policy System Security
  - Using RPSL in Practice

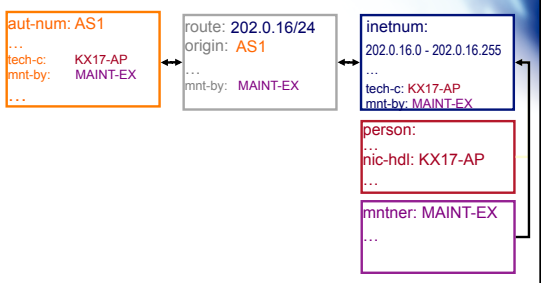


IRR objects

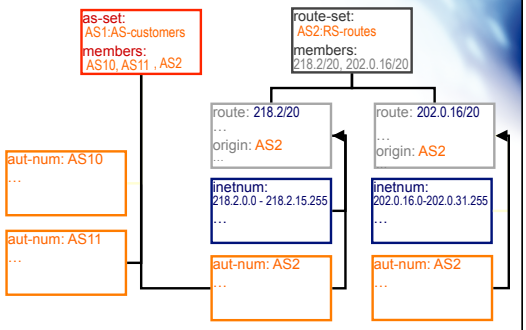
- route
  - Specifies interAS routes
- aut-num
  - Represents an AS. Used to describe external routing policy
- inet-rtr
  - Represents a router
- peering-set
  - Defines a set of peerings
- route-set
  - Defines a set of routes
- as-set
  - Defines a set of **aut-num** objects
- rtr-set
  - Defines a set of routers
- filter-set
  - Defines a set of routes that are matched by its filter

www.apnic.net/db/ref/db-objects.html

Inter-related IRR objects



Inter-related IRR objects



Hierarchical authorisation

- **mnt-routes**
  - authenticates ***creation*** of route objects
    - creation of route objects must pass authentication of mntner referenced in the mnt-routes attribute
  - Format:
    - `mnt-routes: <mntner>`

In: `inetnum` , `aut-num` and `route` objects

Authorisation mechanism

```
inetnum:     202.137.181.0 - 202.137.196.255
netname:     SPARKYNET-WF
descr:       SparkyNet Service Provider
…
mnt-by:      APNIC-HM
mnt-lower:   MAINT-SPARKYNET1-WF
mnt-routes:  MAINT-SPARKYNET2-WF
```

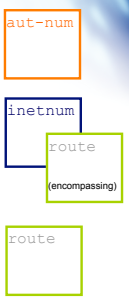
This object can only be modified by APNIC

Creation of more specific objects (assignments) within this range has to pass the authentication of MAINT-SPARKYNET

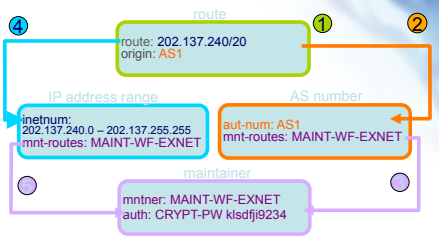
Creation of route objects matching/within this range has to pass the authentication of MAINT-SPARKYNET-WF

Creating route objects

- Multiple authentication checks:
  - Originating ASN
    - mntner in the mnt-routes is checked
    - If no mnt-routes, mnt-lower is checked
    - If no mnt-lower, mnt-by is checked
  - AND the address space
    - Exact match & less specific route
      - mnt-routes etc
    - Exact match & less specific inetnum
      - mnt-routes etc
  - AND the route object mntner itself
    - The mntner in the mnt-by attribute



Creating route objects



1. Create route object and submit to APNIC RR database
2. DB checks aut-num obj corresponding to the ASN in route obj
3. Route obj creation must pass auth of mntner specified in aut-num *mnt-routes* attribute.
4. DB checks inetnum obj matching/encompassing IP range in route obj
5. Route obj creation must pass auth of mntner specified in inetnum *mnt-routes* attribute.

Using the Routing Registry

Overview of the IRRToolSet

IRRToolSet

- Set of tools developed for using the Internet Routing Registry (IRR)
- Work with Internet routing policies
  - These policies are stored in IRR in the Routing Policy Specification Language (RPSL)
- The goal of the IRRToolSet is to make routing information more convenient and useful for network engineers
  - Tools for automated router configuration,
  - Routing policy analysis
  - On-going maintenance etc.

IRRToolSet

- History
  - Originated at the USC Information Sciences Institute during 1997-2001 as the Routing Arbiter ToolSet (RAToolSet) project
  - Later migrated to RIPE NCC in order to continue its development and support (RAToolSet was later changed to IRRToolSet)
  - RIPE NCC later transferred maintenance of the tool set to ISC, who began accepting code from the community and providing code maintenance

IRRToolSet

- Now maintained by ISC:
  - http://irrtoolset.isc.org
  - Download: ftp://ftp.isc.org/isc/IRRToolSet/
    - Installation needs: lex, yacc and C++ compiler

Use of RPSL - RtConfig

- RtConfig v4
  - part of IRRToolSet
- Reads policy from IRR (aut-num, route & -set objects) and generates router configuration
  - vendor specific:
    - Cisco, Bay's BCC, Juniper's Junos and Gated/RSd
  - Creates route-map and AS path filters
  - Can also create ingress / egress filters
    - (documentation says Cisco only)

Why use IRR and RtConfig?

- Benefits of RtConfig
  - Avoid filter errors (typos)
  - Expertise encoded in the tools that generate the policy rather than engineer configuring peering session
  - Filters consistent with documented policy
    - (need to get policy correct though)

Using RPSL in practice

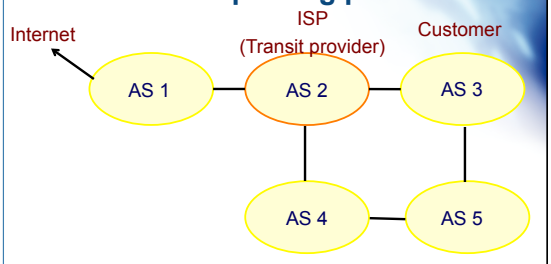
Overview

- Review examples of routing policies expression
  - Peering policies
  - Filtering policies
  - Backup connection
  - Multihoming policies

RPSL - review

- Purpose of RPSL
  - Allows specification of your routing configuration in the public IRR
    - Allows you to check "Consistency" of policies and announcements
  - Gives opportunities to consider the policies and configuration of others

Common peering policies



- Peering policies of an AS
  - Registered in an aut-num object

Common peering policies

- Policy for AS3 in the AS2 aut-num object

```
aut-num:    AS2
as-name:    SAMPLE-NET
dsescr:     Sample AS
import:     from AS1 accept ANY
import:     from AS3 accept <^AS3+$>
export:     to AS3 announce ANY
export:     to AS1 announce AS2 AS3
admin-c:    CW89-AP
tech-c:     CW89-AP
mtn-by:     MAINT-SAMPLE-AP
changed:    sample@sample.net
```

ISP customer – transit provider policies

- Policy for AS3 and AS4 in the AS2 aut -num object

```
aut-num:    AS2
import:     from AS1 accept ANY
import:     from AS3 accept <^AS3+$>
import:     from AS4 accept <^AS4+$>
export:     to AS3 announce ANY
export:     to AS4 announce ANY
export:     to AS1 announce AS2 AS3 AS4
```

AS-set object

- Describe the customers of AS2

```
as-set:     AS2:AS-CUSTOMERS
members:    AS3 AS4
changed:    sample@sample.net
source:     APNIC
```

Aut-num object referring as-set object

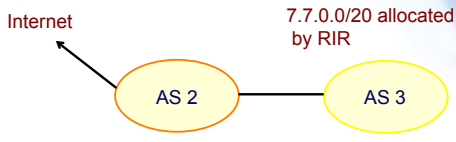
aut-num:	AS2
import:	from AS1 accept ANY
import:	from AS2:AS-CUSTOMERS accept <^AS2:AS-CUSTOMERS+$>
export:	to AS2:AS-CUSTOMERS announce ANY
export:	to AS1 announce AS2 AS2:AS-CUSTOMERS

aut-num:	AS1
import:	from AS2 accept <^AS2+AS2:AS-CUSTOMERS+$>
export:	……

Express filtering policy

- To limit the routes one accepts from a peer
  - To prevent the improper use of unassigned address space
  - To prevent malicious use of another organisation's address space

Filtering policy



AS3 wants to announce part or all of 7.7.0.0/20 on the global Internet.

AS2 wants to be certain that it only accepts announcements from AS3 for address space that has been properly allocated to AS3.

Aut-num object with filtering policy

```
aut-num:    AS2
import:     from AS3 accept { 7.7.0.0/20^20-24 }
…….
```

For an ISP with a growing or changing customer base, this mechanism will not scale well.

Route-set object can be used.

Route-set

```
route-set:  AS2:RS-ROUTES:AS3
members:    7.7.0.0/20^20-24
changed:    sample@sample.net
source:     APNIC
```

Specifies the set of routes that will be accepted from a given customer

Set names are constructed hierarchically:

AS2 : RS-ROUTES : AS3

AS2 ⇩ indicates whose sets these are

AS3 ⇩ indicates peer AS

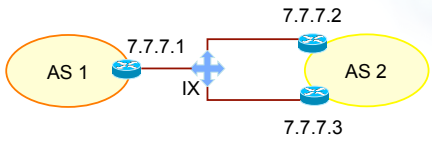
Filter configuration using route-set – AS2

```
import:     from AS1 accept ANY
import:     from AS3 accept AS2:RS-ROUTES:AS3
import:     from AS4 accept AS2:RS-ROUTES:AS4
export:     to AS2:AS-CUSTOMERS announce ANY
export:     to AS1 announce AS2:AS2:AS-CUSTOMERS
```

RPSL allows the peer's AS number to be replaced by the keyword PeerAS

```
import:  from AS2:AS-CUSTOMERS accept
         AS2:RS-ROUTES:PeerAS
```

Including interfaces in peering definitions: AS1



How to define AS1's routing policy by specifying its boundary router?

Including interfaces in peering definitions: AS1 (cont.)

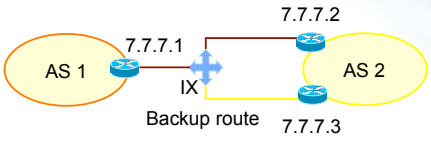
```
aut-num:    AS1
import:     from AS2 at 7.7.7.1 accept <^AS2+$>
```

AS1 may want to choose to accept:

- only those announcements from router 7.7.7.2
- discard those announcements from router 7.7.7.3

```
aut-num: AS1
import:    from AS2 7.7.7.2 at 7.7.7.1 accept <^AS2+$>
```

Describing simple backup connections: AS1



How to define AS1's routing policy of its backup route?

⇨ Use preference

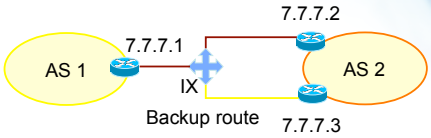
Describing simple backup connections: AS1 (cont.)

```
aut-num:  AS1
import:   from AS2 7.7.7.2 at 7.7.7.1 action pref=10;
          from AS2 7.7.7.3 at 7.7.7.1 action pref=20;
          accept <^AS2+$>
```

Use of pref

- pref is opposite to local-pref
- Smaller values are preferred over larger values

Describing simple backup connections: AS2



How to define AS2's routing policy of AS1's backup route?

⇨ multi exit discriminator metric (med) can be used

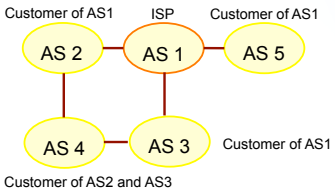
Describing simple backup connections: AS2 (cont.)

```
aut-num:  AS2
export:   to AS1 7.7.7.1 at 7.7.7.2 action med=10;
          to AS1 7.7.7.1 at 7.7.7.3 action med=20;
          announce <^AS2+$>
```

Use of med

- Suitable for load balancing including backups

Multihome routing policy



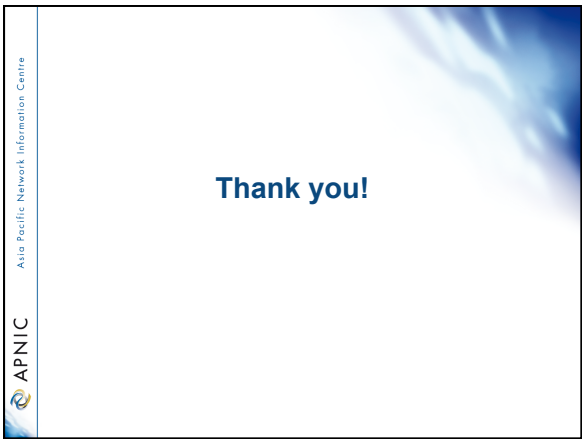
AS1's base policy

- Only accepts routes from customers that are originated by the customer
- or by the customer's customers

Multihome routing policies (cont.)

```
aut-num:  AS1
import:   from AS2 accept (AS2 or AS4) AND
          <^AS2+AS4*$>
import:   from AS3 accept (AS3 or AS4) AND
          <^AS3+AS4*$>
import:   from AS5 accept AS5 AND <^AS5+$>
```

Questions?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Thank you!