Welcome to the

Internet Routing Registry

APRICOT 2007, Bali, Indonesia
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APNIC and RIPE NCC

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Introduction

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Objectives

• To provide an introduction to the APNIC Routing Registry
  – Explain basic concepts of the global RR
  – Outline the benefits of the APNIC Routing Registry
  – A chance for practical exercise
• NOT to:
  – Teach basic routing
  – Explain Internet resource policy and procedures
  – Provide advise on network configuration

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Assumptions

- The audience
  - Knowledgeable about BGP routing
  - Familiar with basic APNIC database operations
  - Curious about Internet Routing Registry usage (IRR)
  - But not yet familiar with Routing Policy Specification Language (RPSL) and IRR

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Schedule

- What is APNIC
- What is RIPE
- APNIC db recap
- DB protection
- What is an IRR
- Documenting policy
- RPSL introduction

- Specifying routing policies using RPSL
- RPSL in practice
  - Case studies
  - AS-sets, grouping peers
  - Bogon filtering
- RtConfig
- IRR Toolset

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What is APNIC?

- Regional Internet Registry (RIR) for the Asia Pacific region
  - One of five RIRs currently operating around the world
  - Non-profit, membership organisation
    - Open participation, democratic, bottom-up processes
  - Responsible for distributing Internet resources throughout the AP region
- Industry self-regulatory body
  - Consensus-based, open, and transparent decision-making and policy development
- Meetings and mailing lists
  - Open to anyone
  - http://www.apnic.net/meetings/23/index.html
  - http://www.apnic.net/community/lists/index.html

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What does APNIC do?

Resource service	Policy development

• IPv4, IPv6, ASNs
• Reverse DNS delegation
• Resource registration
  • Authoritative registration server
  • whois
	• Facilitating the policy development process
	• Implementing policy changes

Information dissemination	**Training & Outreach**

• APNIC meetings
• Web and ftp site
• Publications, mailing lists
• Outreach seminars
 	
http://www.apnic.net/community/lists/
	• Training
	  • Internet Resource management
	  • DNS workshops
	  • IPv6 tutorial
	  •Routing workshop
	  •e-Learning
	- Subsidised for members
	Schedule:
	http://www.apnic.net/training

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RIPE and RIPE NCC

- Réseaux IP Européens (1989)
  – Collaborative, open community for Internet operators, administration and development

- RIPE Network Coordination Centre (1992)
  – Independent not-for-profit membership organisation
  – One of 5 Regional Internet Registries
  – Member services
  – Public services

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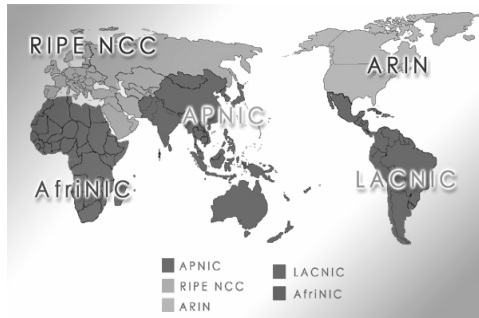## RIPE NCC services

Member services	Public services

• Registration services
  – IPv4, IPv6
  – AS numbers
• Training courses
• Test traffic measurements
	• Giving information
	• Reverse DNS
	• DISI
	• ENUM (e164.arpa)
	• K-root nameserver
	• RIPE Whois DB
	• RIS
	• RRCC
	• E-Learning

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5 RIRs' regions

APNIC
RIPE NCC
ARIN
LACNIC
AfriNIC

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APNIC database recap

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What is the APNIC database

- Public network management database
  - Operated by IRs
    - Public data only
    - For private data can be accessed via MyAPNIC
      - Access restricted to relevant members
- Tracks network resources
  - IP addresses, ASNs, Reverse Domains, Routing policies
- Records administrative information
  - Contact information (persons/roles)
  - Authorisation
- APNIC RR is part of IRR
  - Distributed databases that mirror each other

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Database object

- An object is a set of attributes and values
- Each attribute of an object...
  - Has a value
  - Has a specific syntax
  - Is mandatory or optional
  - Is single- or multi-valued
- Some attributes ...
  - Are primary (unique) keys
  - Are lookup keys for queries
  - Are inverse keys for queries

  – Object "templates" illustrate this structure

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Person object example

– Person objects contain contact information

Attributes   **Values**

```
person:    Ky Xander
address:   ExampleNet Service Provider
address:   2 Pandora St Boxville
address:   Wallis and Futuna Islands
country:   WF
phone:     +680-368-0844
fax-no:    +680-367-1797
e-mail:    kxander@example.com
nic-hdl:   KX17-AP
mnt-by:    MAINT-ENET-WF
changed:   kxander@example.com 20020731
source:    APNIC
```

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Database update process

- Update transactions
  - Create a new object
  - Change an object
  - Delete an object

  Template

- Updates are submitted by email
  - E-mail to: `<auto-dbm@apnic.net>`
- Email message contains template representing new or updated object

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Database protection

Database protection

- Authorisation
  - "mnt-by" refers to a mntner object
    - Can be found in all database objects
    - "mnt-by" should be used with every object!
    - Checked at every update
- Authentication
  - Updates to an object must pass authentication rule specified by its maintainer object
- Multiple auth / mnt-by / mntner-s are OR-ed

Mntner Template

mntner:	[mandatory]	[single]	[primary/look-up key]
descr:	[mandatory]	[multiple]	[ ]
country:	[optional]	[single]	[ ]
admin-c:	[mandatory]	[multiple]	[inverse key]
tech-c:	[optional]	[multiple]	[inverse key]
upd-to:	[mandatory]	[multiple]	[inverse key]
mnt-nfy:	[optional]	[multiple]	[inverse key]
auth:	[mandatory]	[multiple]	[inverse key]
Remarks:	[optional]	[multiple]	[ ]
Notify:	[optional]	[multiple]	[inverse key]
mnt-by:	[mandatory]	[multiple]	[inverse key]
referral-by:	[mandatory]	[single]	[inverse key]
Changed:	[mandatory]	[multiple]	[ ]
source:	[mandatory]	[single]	[ ]

Authentication methods

- 'auth' attribute
  - Crypt-PW
    - Crypt (Unix) password encryption
    - Use web page to create your maintainer
  - PGP – GNUPG
    - Strong authentication
    - Requires PGP keys
  - MD5
    - Strong authentication
    - Use https://www.ripe.net/cgi-bin/crypt.cgi to create a MD5 hashed value
      - Copy the entire outcome into the auth attribute
      - Auth: MD5-PW

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Hierarchical authorisation

- 'mnt-by' attribute
  - Refers to mntner object
  - Can be used to protect any object
  - Changes to protected object must satisfy authentication rules of 'mntner' object

- 'mnt-lower' attribute
  - Also refers to mntner object
  - Hierarchical authorisation for inetnum & domain objects
  - The creation of child objects must satisfy this mntner
  - Protects against unauthorised updates to an allocated range - highly recommended!

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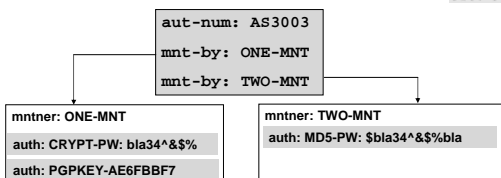
Prerequisite for updating objects

- Create person objects for contacts
  - To provide contact info in other objects

- Create a mntner object
  - To provide protection of objects

- Protect your person object

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Multiple protection illustrated

```
aut-num: AS3003
mnt-by: ONE-MNT
mnt-by: TWO-MNT
```

```
mntner: ONE-MNT
auth: CRYPT-PW: bla34^&$%
auth: PGPKEY-AE6FBBF7
```

```
mntner: TWO-MNT
auth: MD5-PW: $bla34^&$%bla
```

- In order to update the object AS3003, need to have:
  - **Either** the (crypt) password
  - **Or** the MD5 password
  - **Or** the PGP key
- If you forget password: email to helpdesk@apnic.net

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Hierarchical authorisation

```
inetnum: 10.0.0.0 - 10.255.255.255
mnt-lower: MNT1
mnt-by: MNT2
```

WHAT	WHO
Create Sub Groups 'under' this Object	MNT1
Change this Object	MNT2

```
inetnum: 10.10.0.0 - 10.10.255.255
mnt-by: MNT3
```

WHAT	WHO
Create Sub Groups 'under' this Object	MNT3
Change this Object	MNT3

```
aut-num: AS1234
mnt-by: MNT1
mnt-by: MNT4
mnt-routes: MNT3
```

WHAT	WHO
Create Route Objects with AS1234 as Origin	MNT3
Change this Object	MNT1 **or** MNT4

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Test database

- Playground Database: "**source: testapnic**"
  - **whois –h testwhois.apnic.net**
  - mailto: <test-dbm@apnic.net>

- Differences from APNIC DB:
  - Does not contain same info as operational APNIC DB

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Summary

- APNIC Whois DB
- Maintainer
- Hierarchical authorisation

Questions?

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What is an IRR?

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What is a Routing Registry?

- A repository (database) of Internet routing policy information
  - ASes 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

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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

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What is a Routing Registry?

- Global Internet Routing Registry database
  - http://www.irr.net/
    - The union of a growing number of world-wide routing policy databases that use the Routing Policy Specification Language (RPSL)
      - We will talk about RPSL in more details later
  - Established in 1995
- 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

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Integration of Whois and IRR

- Integrated APNIC Whois Database & Internet Routing Registry

IP, ASNs, reverse domains, contacts, maintainers etc

inetnum, aut-num, domain, person, role, maintainer

APNIC Whois

IRR

Internet resources & routing information

routes, routing policy, filters, peers etc

route, aut-num, as-set, inet-rtr, peering-set etc.
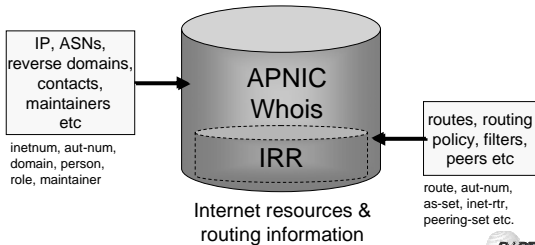
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What is routing policy?

- Description of the routing relationship between autonomous systems
  - Who are my BGP peers?
    - Customer, peers, upsteam
  - 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?

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Summary

- APNIC IRR
- Routing policy

Questions?

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Documenting policy

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Why document routing policy?

- Recreate your policy in case of loss of hardware/administrators
  - Less downtime
- Scaling
- Troubleshooting

Q: How do you document your routing policy?

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Why document in IRR?

- Required by some Transit Providers
- Required by some Exchange Points
- Allows peers to automatically update filters
  - For your announcements
  - Consistent information between neighbours

- Good housekeeping

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Information to share

- Routes and AS objects give an abstract specification of the policy of an AS
  - Provides device independent view of routing policy
  - Neighbouring ASes can lookup, verify and understand the other party's policy
  - Provides a clear picture where this AS fits into the Internet

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Information to share

- Information – if policy and routes are registered for each individual AS….
  - a global view of routing policy could be mapped
    - This global picture has the ability to improve the integrity of global Internet routing
  - Provides LIR/ISP with a mechanism to find all possible paths between any two points in the Internet
- Provides a high level of abstraction

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Network planning

- Simulation
  - Changes in polices can be simulated first by changing the registry but not the routers
    - To understand effects of policy changes to the existing networks
    - To make better network planning
    - To make it easier to adjust policies to maximise the performance of the network
- Route filtering
  - Peering networks
  - A provider and its customer

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Ease of use…

- Router configuration
  - By using IRRToolSet
    - ftp.ripe.net/tools/IRRToolSet
    - Abstract information from IRR to create a router readable configuration file
    - Vendor independent
    - Protect against inaccurate routing info distribution
    - Verification of Internet routing
- Network troubleshooting
  - Easier to locate routing problems outside your network

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Why document in APNIC IRR?

- Convenience
  - inetnums already there
  - aut-num already there
  - maintainer already there
  - person objects already there
- Secured database
- Mirrored (RPSL objects) by RADB
- It's free!!
- Database most likely used by your peers

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Summary

- Why documenting policy?
- Use of APNIC IRR

Questions?

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RPSL introduction

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RPSL

- RPSL: Routing Policy Specification Language

- Object-oriented language
  – Structured whois DB objects

- Describes routing policy
  – Routes, AS numbers…
  – Relations between BGP peers

- Established standard
  – *Routing Policy Specification Language (RFC-2622)*
  – *Routing Policy System Security (RFC-2725)*
  – ***Using RPSL in Practice (RFC-2650)***

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RPSLng

- Adds IPv6 and multicast to RPSL
  – RFC 4012
  – new object: ROUTE6
  – new attributes like "mp-import:" and "mp-export:"

- RPSLng compliant:
  – Ripe Whois DB
  – some IRRToolset tools (from 4.8.1)
    - peval
    - rpslcheck
    - RtConfig

- This course **does not** cover RPSLng

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Policy expression

- Aut-num
  – Lists neighbors (in import / export lines)
  – Defines filter rules for each neighbour
  – Defines route parameters modifications per prefix

- Route object
  – Represents address range originating by ASN

- Set objects
  – Grouping objects with similar policy / usage

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Aut-num object

```
aut-num:    AS4000
as-name:    Ahmad-Company-AS
descr:      Very Basic Object
import:             # Policy: Empty, for now
export:             # Policy: Empty, for now
default:            # Policy: Empty, for now
admin-c:    AC2-RRTEST
tech-c:     AC2-RRTEST
mnt-by:     Ahmad-MNT
mnt-routes: ahmad-s-customer-mnt
changed:    c.ahmad@example.net 20070101
source:     TESTAPNIC
```

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Route object

Attribute	Value	Type
route	Prefix of the InterAS route	mandatory, single-valued, class key
origin	<AS-number> originates the route	mandatory, single-valued
member-of	List of <route-set-name>	optional, multi-value
mnt-routes	see slide# x	optional, multi-value

Why a route object?

The only link between IP address space and an AS number

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Route object

- Origin attribute
  - Specifies the AS that originates the route
  - The corresponding aut-num object should be registered in the database

- Members-of
  - identifies a set object that this object wants to be a member of.
  - must start with "rs-" or origin AS (e.g. as1:rs-)

- Mnt-routes
  - references a maintainer object which is used in determining authorisation for the creation of route objects
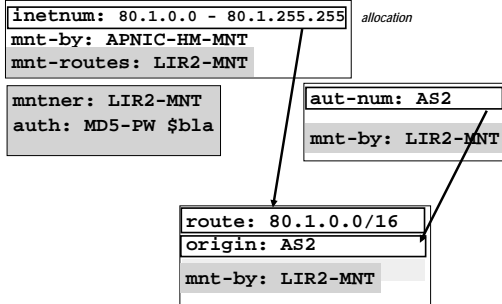
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Creating route objects

- Route object 2 primary keys:
  - Address range **and** origin ASN

- Must pass multiple authentications:
  - Originating ASN
  - AND the address space
  - AND the **mntner** of the route object itself

Creating route objects

```
inetnum: 80.1.0.0 - 80.1.255.255   allocation
mnt-by: APNIC-HM-MNT
mnt-routes: LIR2-MNT
```

```
mntner: LIR2-MNT
auth: MD5-PW $bla
```

```
aut-num: AS2

mnt-by: LIR2-MNT
```

```
route: 80.1.0.0/16
origin: AS2

mnt-by: LIR2-MNT
```

Summary

- RPSL introduction
- Aut-num object
- Route object

Questions?

Specifying routing policies using RPSL

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Creating RPSL objects

- To create a routing policy in RPSL you need:
  - Aut-num object (place to put the policy)
  - Route object (prefix to announce)

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Aut-num policy syntax

import:	**from** <peering> [**action** <action>];
	accept <filter>
export:	**to** <peering> [**action** <action>] ;
	announce <filter>

- <peering>: ASN (or AS-set)
- <filter>:   set of prefixes (for example AS)
- <action>:   med, communities, pref

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Controlling outbound traffic

- `import` line determines outbound traffic
- You decide who and how (filters)
- RPSL `pref` different from `local pref`
  - lower "`pref`" = more preferred
  - higher "`local pref`" = more preferred

```
import:   from AS3 action pref=100;
          accept ANY
```

Controlling inbound traffic

- `export` line determines inbound traffic
- You have less control
- Control by make certain paths less interesting
- Choose, then put filters in
- `AS path prepending`

```
export:   to AS3 action
          aspath.prepend (AS1, AS1);
          announce AS1
```

Fliters

- Prefix filters:
  - Prefixes
  - Route sets: lists of prefixes
  - AS: all prefixes in DB with that origin AS
  - AS sets: multiple AS's
- AS-path filters:
  - Regular expressions

- Keywords: ANY, PeerAS
- Logical operators: AND, OR, NOT

Building an aut-num object

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

aut-num: AS1
export: to AS2 action aspath.prepend (AS1, AS1); announce AS1
import: from AS3 **action pref=100;**
          accept ANY
import: from AS2 **action pref=20;**
          accept AS2
export: to AS3 announce AS1
import: from AS2 **action pref=200;**
          accept **ANY**

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

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Summary

• Inbound traffic policy syntax
• Outbound traffic policy syntax
• Filters

Questions?

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RPSL in practice

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Scenario A

- You have AS9001
- AS1001 is your upstream provider
- AS2001 is a private peer

Exercise:
- Create RPSL policy reflecting this scenario
- Put this policy in your aut-num object

- Time: 15 mins

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Scenario A

AS1001

AS2001

Exercises
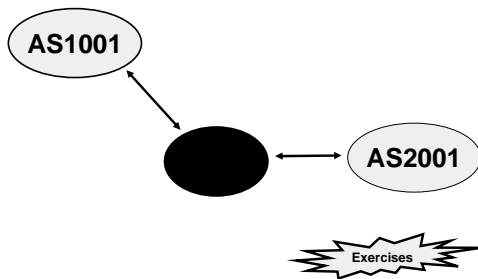
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AS9001 aut-num

```
aut-num:    AS9001
as-name:    Scenario-A-NET
dsescr:     Scenario A AS
import:     from … accept …
import:     from … accept …
export:     to …  announce …
export:     to …  announce …
admin-c:    SA1-AP
tech-c:     SA2-AP
mtn-by:     MAINT-SAMPLE-AP
changed:    sample@sample.net
```

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Scenario A - Solution

```
aut-num:
as-name:      Scenario-A-NET
dsescr:       Scenario A AS
import:       from AS1001 accept ANY
import:       from AS2001 accept AS2001
export:       to AS1001 announce AS9001 AS2001
export:       to AS2001 announce AS9001
admin-c:      SA1-AP
tech-c:       SA2-AP
mtn-by:       MAINT-SAMPLE-AP
changed:      sample@sample.net
```

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Scenario B

- You have AS9001
- AS1001 is your preferred upstream provider
- AS2001 is your backup upstream provider

Exercise:
- Create RPSL policy reflecting this scenario
- Put this policy in your aut-num object

- Time: 15 mins

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Scenario B - Solution

```
aut-num:
as-name:    Scenario-A-NET
dsescr:     Scenario A AS
import:       from AS1001 action pref=100;
                 accept ANY
import:       from AS2001 action pref=200;
                 accept ANY
export:       to AS1001 announce AS9001 AS2001
export:       to AS2001
                 action aspath.prepend (as9001, as9001);
                 announce AS9001 AS1001
admin-c:    SA1-AP
tech-c:     SA2-AP
mtn-by:     MAINT-SAMPLE-AP
changed:    sample@sample.net
```

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Questions?

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RPSL in practice

AS-sets, grouping peers

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Grouping peers

- for multiple peers with same policy: as-sets

- as-sets can be used for:
  - filters (from AS3 accept AS-BGP-PEERS)
  - grouping peers (to AS-CUSTOMERS announce ANY)

- Special filter keyword 'PeerAS'
  - makes simple import lines possible

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As-set objects

- *as-set* objects for groups of aut-num-s
  - name starts with "as-" (as-customers)
  - or indicating origin (as1:as-customers)

- **members**: ASN(s), or as-set(s)
  - direct

- **mbrs-by-ref**: mntner or ANY
  - indirect, any AS qualifying can put "member-of" to include itself in the as-set

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PeerAS

```
as-set: AS4:AS-CUSTOMERS
members: AS7, AS5, AS8
```

```
aut-num: AS4

import: from AS4:AS-CUSTOMERS accept PeerAS
export: to AS4:AS-CUSTOMERS announce ANY
```

- *PeerAS* means:
  - from AS7 accept AS7
  - from AS5 accept AS5
  - from AS8 accept AS8

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Summary

- AS-sets
- mbrs-by-ref, members
- PeerAS

Questions?

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RPSL in practice

Bogon filtering

Security

- Problems:
  - Bogon address space used as source for spamming, DDoS, probes…
  - Leaking "martians" & bogons due to mis-configuration

- Definitions:
  - Martians – reserved ranges (rfc-1918)
    - http://www.isi.edu/~bmanning/dsua.html
  - Bogons – un-allocated (&reserved) address ranges

- Secure BGP Template
  - www.cymru.com/Documents/secure-bgp-template.html

Applying "bogon" filters

Q: Do you filter out bogons? How?

- RPSL: add "AND NOT fltr-bogons" to all your import and export attribute *filter* rules

```
aut-num:    AS1
import:     from AS1:AS-CUSTOMERS accept
     PeerAS AND NOT fltr-bogons
import:     from AS1:AS-UPSTREAMS accept
     ANY AND NOT fltr-bogons
export:     to AS1:AS-CUSTOMERS announce
     ANY AND NOT fltr-bogons
export:     to AS1:AS-UPSTREAMS announce
     AS1 AS1:AS-CUSTOMERS AND NOT fltr-bogons
```

Example "filter-set": fltr-bogons

filter-set:	fltr-bogons
filter:	fltr-unallocated OR fltr-martian
descr:	All bogon IPv4 prefixes.
remarks:	For the complete set of bogons, please see: fltr-unallocated – unallocated prefixes. fltr-martian - special use and reserved prefixes. http://www.cymru.com/Documents/bogon-list.html
admin-c:	Rob Thomas RT624
tech-c:	Rob Thomas RT624
notify:	radb@cymru.com
mnt-by:	MAINT-BOGON-FILTERS
changed:	radb@cymru.com 20021230
source:	RADB

```
filter-set: fltr-unallocated
filter:{1.0.0.0/8^+,2.0.0.0/8^+, [...] }
```

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Outdated bogon filters

- Bogon filters in place, but not kept up-to-date
  - Consequence: new networks unreachable

- Solutions:
  - Use fltr-bogons
  - Check for RIR announcements of new /8 blocks
  - Use a bogon route server

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Summary

- Keep your bogon filters up-to-date
- Use filter-set objects
- Add "AND NOT fltr-bogons"

Questions?

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RtConfig

Router configuration

- RtConfig reads policy from the IRR

- Generates **parts** of the router configuration file
  - Creates access list, route-map and AS path filters
  - Vendor specific

- You need to use other scripts (built around it)!

- One of the tools in the IRRToolSet

RtConfig: RR integration

```
RPSL DB Objects          Commands in the
(routing policy)         Template/Input File
```

RtConfig   Flags, Env_Var

```
(Partial)
Router Configuration
```
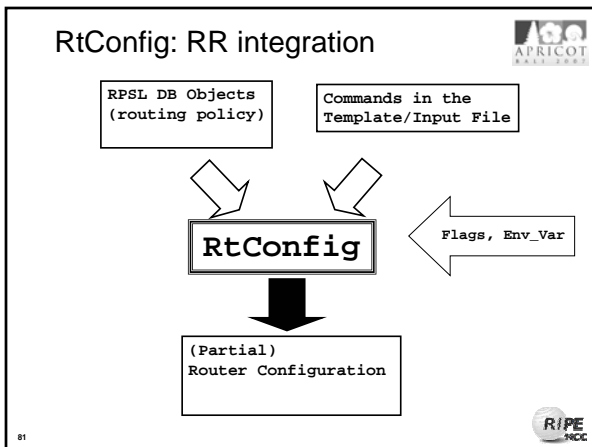
Environment variables

- IRR_HOST
  - Whois server to connect to
- IRR_PORT
  - Whois server port number
- IRR_SOURCES
  - List of DBs to search

- Used by all IRRToolset tools
- Command line options take precedence
  - some are needed!

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Command line options

- config <config-format>
  - cisco, junos, bcc, gated, rsd
- -protocol <protocol>
  - irrd(rawwhoisd), ripe(bird), and ripe_perl
  - default does not work with the RIPE Whois DB!
- -T [whois_query | whois_response | input | all]
  - "Trace": useful for debugging
- -ignore_errors
  - useful when sending output to router

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Martian Filtering

- **-supress_martian**
  - **only for cisco config**
  - **will deny the following routes:**

```
host          0.0.0.0            any
127.0.0.0     0.255.255.255     255.0.0.0         0.255.255.255
10.0.0.0      0.255.255.255     255.0.0.0         0.255.255.255
172.16.0.0    0.15.255.255      255.240.0.0       0.15.255.255
192.168.0.0   0.0.255.255       255.255.0.0       0.0.255.255
192.0.2.0     0.0.0.255         255.255.255.0  0.0.0.255
128.0.0.0     0.0.255.255       255.255.0.0       0.0.255.255
191.255.0.0   0.0.255.255       255.255.0.0       0.0.255.255
192.0.0.0     0.0.0.255         255.255.255.0  0.0.0.255
223.255.255.0 0.0.0.255         255.255.255.0  0.0.0.255
224.0.0.0     31.255.255.255  224.0.0.0       31.255.255.255
any           255.255.255.128  0.0.0.127
```

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Command Line Options

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- There are many more!
  - check man page
- Easiest option: make an alias

- On server:
  - rt='RtConfig -h localhost -p 43 -s RRTEST -protocol ripe -cisco_use_prefix_lists'

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RIPE

RTConfig commands

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- All commands start with "@RtConfig"
  - man page lists all commands

- @RtConfig access_list filter AS2
  ```
  no ip prefix-list pl100
  ip prefix-list pl100 permit 10.20.0.0/20
  ip prefix-list pl100 deny 0.0.0.0/0 le 32
  ```
- @RtConfig set cisco_map_name= "AS%d-EXPORT-%d"
  - First %d replaced by peer's ASN
  - Second %d incremented
- @RtConfig set junos_policy_name = "AS%d-EXPORT-%d"
  - Juniper version of same

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RIPE

Template files

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- Template files make scripting easy

- Use separate template for each router

- Template file contents:
  - import/export commands
  - comments
  - extra settings
    - map names/max pref/etc...

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RIPE

Example template file

```
! setting up the Max_Preference to 100
@RtConfig set cisco_max_preference = 100
send community
!
! Peering with OTHERCOMPANY (AS2)
@RtConfig set cisco_map_name = "AS%d-
   IMPORT-%d"
@RtConfig import AS1 10.0.0.1 AS2 10.0.0.2
!
@RtConfig set cisco_map_name = "AS%d-
   EXPORT-%d"
@RtConfig export AS1 10.0.0.1 AS2 10.0.0.2
```

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Testing policy change

- Copy your aut-num object into a txt file
- Modify the file to reflect the desired change
- Run RtConfig with the flag "-f filename"
  - E.g. "rt –f changed_asn.txt < rt-template >
    new_config"
- Other values will be read from the RR
- Compare new router config output with the old
  - check if the result describes desired behaviour

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Using RtConfig

- To use RtConfig conveniently you need:
  - Template files
  - Scripts

Demos:
- Task 1 - Create RtConfig template file
- Task 2 - Run RtConfig with this template file
  - easiest to use "rt" alias

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Summary

- Command line options
- RtConfig commands
- Template file

Questions?

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IRR Toolset

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Introduction

- Started as RAToolSet
- Changed to IRRToolset
  - first maintained by RIPE NCC
- Now maintained by ISC
  - http://www.isc.org/index.pl?/sw/IRRToolSet/

- Download: ftp://ftp.isc.org/isc/IRRToolSet/
- Installation needs: lex, yacc and C++ compiler

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AOE

- Eases Aut-num editing
- Takes input from:
  - Your Aut-num object
  - Your peer's Aut-num object
  - BGP
  - Templates

- Sends mail with updated Aut-num object
  - Does not sign

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Other tools

- prtraceroute
  - Prints the route packets take with the policy information
- peval
  - Lightweight policy evaluation tool
- prpath
  - Shows possible paths between ASes as registered in RR
- CIDRAdviser
  - Suggest safe aggregations
- Rpslcheck
  - Checks RPSL syntax
- ROE (Routing Object Editor)
  - List routes and dependencies
  - Displays and compare routes registered
  - Create route object for you based on BGP dump

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Summary

- IRRToolset
- AOE
- Other tools

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Using the Routing Registry

Define your routing policy — Enter policy in IRR — Run RtConfig — Apply config to routers
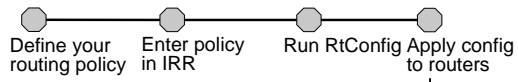
Costs
- Requires some initial planning
- Takes some time to define & register policy
- Need to maintain data in RR

Benefits
- You have a clear idea of your routing policy
- Consistent config over the whole network
- Less manual maintenance in the long run

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Summary

- IRRToolset
- AOE
- Other tools

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Questions?

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Reference

Creating person object – sample template

```
person:     Miwa Fujii
address:    APNIC, Level 1, 33, Park Road
address:    Milton, QLD 4064
country:    AU
nic-hdl:    AUTO-1
phone:      +61-7-38583189
fax-no:     +61-7-38583199
e-mail:     miwa@apnic.net
mnt-by:     MAINT-AP-TESTAPNIC-NULL
changed:    miwa@apnic.net 20070207
source:     testapnic
```

Creating mntner object – sample template

```
mntner:       MAINT-AP-MXCOM
descr:        Training Department, APNIC
country:      AU
admin-c:      MX1-AP
tech-c:       MX1-AP
notify:       miwa@apnic.net
upd-to:       miwa@apnic.net
auth:         CRYPT-PW ORADi1sftgue
mnt-by:       MAINT-AP-MXCOM
referral-by:  MAINT-AP-TESTAPNIC-NULL
changed:      miwa@apnic.net 20070208
source:       TESTAPNIC
```