RPKI Tools From Soup to Nuts

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... and a lot of help from our friends

APNIC 30, 24 August 2010
### Why We’re Doing This

<table>
<thead>
<tr>
<th>Why We’re Doing This</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>For us, this is all about inter-domain routing security</strong></td>
</tr>
<tr>
<td>The tools we build are a means to that end</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Right now, routing security consists of</th>
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<tbody>
<tr>
<td>- Knowing your neighbors</td>
</tr>
<tr>
<td>- Filtering based on rumors and poorly validated data</td>
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<table>
<thead>
<tr>
<th>Right now, most of the threats are fat fingers</th>
</tr>
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<tbody>
<tr>
<td>- Some real attacks, but so far they’re still rare</td>
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<td>- This will change</td>
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<tr>
<td>- Monkey-in-the-middle attacks on TCP used to be considered hard—now we call them “NAT”</td>
</tr>
<tr>
<td>- The “Waiting for Kaminsky” deployment model</td>
</tr>
</tbody>
</table>
What We’re Trying To Do About It

Use RPKI data to formally validate some of BGP’s inputs

- Origin validation code is engineering now, could deploy in next few years but requires production RPKI
- Path validation is still research, but we know some of what it needs
Origin Validation On The Router

What does router really need to know for origin validation?

“Holder of prefix X authorizes origination from ASN Y”

Validation of prefix X on ASN Y can return three states

- **Valid**: Authorization found for X on Y
- **Invalid**: Authorization found for X and Y doesn’t have it
- **Unknown**: No authorization data found for X
Origin Validation On The Router

Router just needs a trusted source of these data
Some other owned and trusted box in the POP can do the crypto; router just needs secure channel to that box

This turns out to be really cheap
- Router’s part of it runs on current hardware
- The “other box” can be a cheap rackmount PC
- Software for the “other box” is free :)}
Origin Validation Implementation Status

**Specification**
draft-ietf-sidr-rpki-rtr

**Implementations**
- Open source server and sample client available
- (Test) client running in IOS and IOS-XR
- Other router vendors working on implementations

**Caches used to feed servers can be**
- Simple stand-alone cache in each POP
- Tree or mesh of caches, rsyncing with each other
- Router doesn’t care, server handles all this
Example: “Secure” Configuration

Plan
- Drop routes with status “invalid”
- Downpref routes with status “unknown”
- Default preference for status “valid”

Configuration
```plaintext
route-map validity-0
  match rpki-invalid
  drop
route-map validity-1
  match rpki-not-found
  set localpref 50
// Valid defaults to 100
```
Example: “Paranoid” Configuration

Plan
- Prefer routes with status “valid”
- Drop routes with status other than “valid”

Configuration
```
route-map validity-0
  match rpki-valid
  set localpref 110
route-map validity-1
  drop
```
Example: “Smaller Hammer” (After AS-Path)

Plan

- Tweak “metric” rather than “localpref”
- Use metric 100 for status “valid,” 50 for status “unknown,” 25 for status “invalid”

Configuration

```plaintext
route-map validity-0
  match rpki-unknown
  set metric 50
route-map validity-1
  match rpki-invalid
  set metric 25
route-map validity-2
  set metric 100
```
Some People Like IRR

Some operators have deployed infrastructure using IRR

- We want to upgrade them to RPKI as data source
- This is easy, just feed validated data to irrd

What the heck, let’s make it available via WHOIS too

```
$ whois -h whois.rpki.net 198.180.150.1
route:   198.180.150.0/24
descr:   198.180.150.0/24-24
origin:  AS3927
notify:  irr-hack@rpki.net
mnt-by:  MAINT-RPKI
changed: irr-hack@rpki.net 20100706
source:  RPKI
```
RPKI Validation: “rcynic”

“Cynical rsync”
- Recursive tree walk starting from trust anchor(s)
- Uses rsync to fetch objects, walks manifests to find children
- Checks all the X.509 details including RFC 3779 rules
- Performs object-specific checks on certificates, CRLs, ROAs, manifests

Result is validated cache of current global RPKI state
- Preserves “fall-back cache” from previous runs
- Cache can be seeded from other caches
- All data still validated locally each cycle
## rcynic In Action: Summary Listing

<table>
<thead>
<tr>
<th>Publication Repository</th>
<th>Current certificates accepted</th>
<th>Current certificates rejected</th>
<th>Current CRLs accepted</th>
<th>Current Manifests accepted</th>
<th>Current Manifests rejected</th>
<th>rsync transfers failed</th>
<th>rsync transfers succeeded</th>
<th>Stale CRLs</th>
<th>Invalid manifest certificates</th>
<th>Stale manifests</th>
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### Problems

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## Validation Status

<table>
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<tr>
<th>Timestamp</th>
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</tbody>
</table>
RFC 3779 support in OpenSSL since 2007

- Development funded by ARIN in 2006
- Contributed to OpenSSL project
- Hooks directly into OpenSSL validation code
- Enabled by default on some platforms
- Easy to enable if not yet the default on yours
But Where Do We Get The RPKI Data?

Our guess at the breakdown of who will do what

- 98% of resource holders will want IANA/RIRs/NIRs to do their RPKI work for them
- But that’s probably about 10% of the address space
- The other 2% of resource holders are the big ISPs who account for 90% of the address space
- We think they’ll want to hold their own keys and do RPKI for themselves
But Where Do We Get The RPKI Data?

RIRs are mostly focused on serving their own members

- That is, after all, what their members pay them to do
- Which includes serving a lot of those 98% of resource holders directly

We’re concentrating on the big ISPs

- Who we think will want to run their own engines
- Who may (or may not) want to run own publication sites
A Usage Scenario

User Web GUI

98% of an RIR's Users
10% of an RIR's IP Space

Publication Protocol

Internal Protocol

Mac Front End GUI & Management

IR's Database(s)
My RightsToRoute
Delegations to Cists

Resources [OrgID]

ID=Me

Public Keys
Internal CA Data
Up/Down EEs Public Keys
My Mix Config Options

Certs Issued to DownStreams
Issued ROAs

RPKI Engine

2% of an RIR's Users
90% of an RIR's IP Space

Contract Out To Google

Publication Point

Up/Down Protocol

2010.05.03 RIPE RPKI
Core program for generating and maintaining RPKI objects

- Manages certificates, CRLS, ROAs, manifests
- Client and server for provisioning ("up-down") protocol
- Client for publication protocol
- Supports hosting (single rpkid instance, multiple entities)

Independent of back-end operation (database, BPKI)

- Speaks internal ("left-right") protocol to back-end
- Sample back-end with GUI provided, feel free to roll your own
What rpkid Does

Basic tasks

- Get resource certificates from parent(s)
- Issue resource certificates to children
- Generate ROAs for self
- Generate support objects (CRLs, manifests)
- Regenerate, revoke, or clean up objects as needed
- Publish outputs via publication protocol
pubd, And Why We Need It

Separate program ("pubd") to handle object publication

- Server for publication protocol
- Just does what rpkid asks, after access control checks

Why is this separate from rpkid?

- Different security constraints: rpkid holds RPKI private keys, pubd does not
- Different availability constraints
- Consolidating publication sites is better for everybody
- Outsourcing publication looks like win-win in many cases
Sample Back End

rpkid and pubd are intended to be portable
- Back-end code tends to be highly non-portable
- So rpkid and pubd operate at arms length from back-end code, via defined protocols

We supply a customizable set of back-end tools
- Use them if they fit your operation
- Modify or replace them if they don’t
Sample Back End

Command line tool
- To set up parent/child/repository relationships
- To handle CMS authentication keys and certificates
- To support various hosting models

GUI (Django-based web interface)
- Simple interface for resource administration
- Monitor status of received resources

Back-end tools use simple text-based transfer format
- Which you can generate from SQL
- Or spreadsheet
- Or Python (AWK, Perl, TECO, . . .) script
Control Panel

RPKI Tools
From Soup to Nuts
www.rpki.net

Introduction
Relying Party
On The Router
IRR Hacks
rcynic
OpenSSL

Intermission
RPKI
Production
rpkid
pubd
Back End
GUI
Relationship Management

Conclusion

---

My RPKI

Handle: Alice | export identity | select

Logged in as sra | admin | Log Out

---

Parents

- RIR

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Children

- Betty

Delegated resources:
  - ASN 64533
  - 10.0.0.0/8

My ROA [request]s

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<th>Prefix</th>
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http://10.0.4.179:8000/myrpkil
Unallocated Resources

-- none --
Allocation View

MyRPKI

Handle: Alice

Logged in as sra | admin | Log Out

ASN View

| ASN: | ASN 64533 |
| Received from: | RIR |
| Validity: | 2010-08-13 14:17:21 - 2011-08-13 14:16:52 |
| Allocated: | Betty |

Edit

Child: Alice's child Betty

Submit Query

Action: give to child
Parent/Child/Repository Relationships

Discovered we needed out-of-band setup protocol
So we wrote yet another little protocol, tried to keep it simple

Two stages

1. Parent/child setup dance
2. Publication repository setup dance

Happens in this order so parent can give hints to child
## Parent/Child Setup Dance

### Child
- “I call myself . . .”
- “My public key is . . .”

### Parent
- “I call myself . . .”
- “I call you . . .”
- “My public key is . . .”
- “Your service URL with me is . . .”
- And one of:
  - “You can publish with me” (offer)
  - “I publish at . . ., maybe you should too” (referral)
Child/Repository Setup Dance

Note
This stage is optional, child might run its own pubd

Child
- “I call myself . . .”
- “My public key is . . .”
- “My parent is . . .”
- And maybe:
  - “Joe sent me”

Repository
- “My public key is . . .”
- “Your service URL with me is . . .”
- “Your publication location is . . .”
Where To Get The Code

Open source implementation

http://www.rpki.net/

Thanks to

- ARIN (initial funding)
- DHS (current funding)
- IIJ
- Cisco
- Google
- NTT
- Equinix
Questions?