

Internet Number Registry Services the Next Generation

RDAP and RPKI

Overview

- What are registry services
- Today's registry services
 - whois
- The next generation...
 - Registration Data Access Protocol (RDAP)
 - Resource Public Key Infrastructure (RPKI)

Registries?

- Organisations running registry services
 - With authority for registration of some “Public Resource”
- Public databases describing status of resources
 - Land titles, vehicle registrations, phone numbers
 - Internet registries - Domain Names, protocols, INRs
 - e.g. .com, .th, IPv4, IPv4, ASNs
- Internet Registries
 - Authoritative registry/database function
 - Public registry service function
 - gTLDs, ccTLDs
 - RIRs, NIRs, LIRs, ISPs...

Registry services (INRs)

- whois
 - Query service on TCP port 43 (RFC 812, 1982)
 - Very simple service
 - Query and response are not standardised
- Registration Data Access Protocol (RDAP) (NEW since 2015)
 - API for access to “whois” registry data
 - Automation, AAA, i18N, redirection, extensibility
- Resource Public Key Infrastructure (RPKI) (since 2010)
 - PKI for INRs
 - Cryptographically verifiable “ownership” of INRs

whois

whois command line

```
$ whois -h whois.apnic.net 210.17.9.242
```

```
% [whois.apnic.net]  
% Whois data copyright terms    http://www.apnic.net/db/dbcopyright.html
```

```
% Information related to '210.17.0.0 - 210.17.127.255'
```


```
% Abuse contact for '210.17.0.0 - 210.17.127.255' is 'ethanchen@taiwanmobile.com'
```

```
inetnum:        210.17.0.0 - 210.17.127.255  
netname:        TTN-TW  
descr:          Taiwan Telecommunication Network Services Co.,LTD.  
descr:          110 , 8F , No 89 , Sung Jen RD , Taipei  
country:        TW  
admin-c:        IP11-AP  
tech-c:         IP11-AP  
remarks:        service provider  
mnt-by:         MAINT-TW-TWNIC  
mnt-irt:         IRT-TFN-TW  
mnt-lower:      MAINT-TTN-AP  
status:         ALLOCATED PORTABLE  
last-modified:  2011-06-01T04:13:58Z  
source:         APNIC
```

Query to port 43

“Blob” reply
– undefined

whois www interface

APNIC

APNIC Whois Search

To assist you with debugging problems, this whois query was received from IP Address:
122.104.142.170
If you experience problems with this form, try the [legacy search form](#).

% APNIC found the following authoritative answer from: whois.apnic.net

% [whois.apnic.net]
% Whois data copyright terms <http://www.apnic.net/db/dbcopyright.html>

% Information related to '210.17.0.0 - 210.17.127.255'

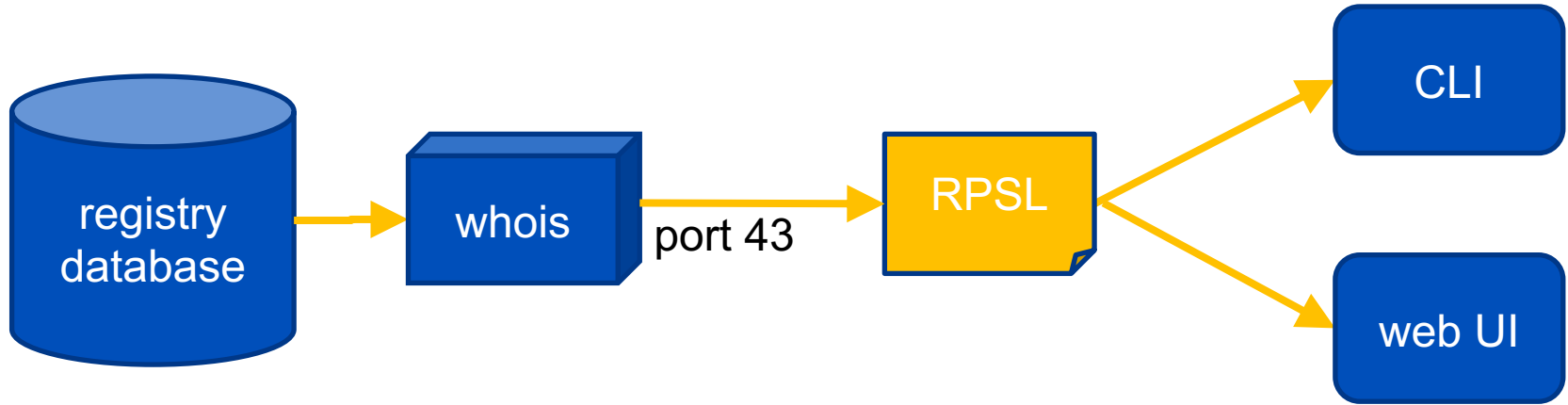
% Abuse contact for '210.17.0.0 - 210.17.127.255' is 'ethanchen@taiwanmobile.com'

inetnum:	210.17.0.0 - 210.17.127.255
netname:	TTN-TW
descr:	Taiwan Telecommunication Network Services Co.,LTD.
descr:	110 , 8F , No 89 , Sung Jen RD , Taipei
country:	TW

HTML wrapper

Same blob

whois at APNIC



Whois – limitations

- “blob” query and result formats
 - Registry-specific questions and answers (eg RPSL)
 - Automation is difficult
- No AAA model
 - Built for public service only
- Most servers serve US-ASCII only
 - i18n is undefined
- No redirection
 - User/client must find the right server

RDAP

Registration Data Access Protocol

RDAP

- RDAP is the successor to the ageing WHOIS protocol.
 - Standardised by IETF
- Query: REST
 - REpresentational State Transfer - via HTTP
 - Query defined within URL issued to RESTful server
 - Inherits useful features from HTTP/HTTPS (AAA, redirection...)
- Response: JSON
 - JavaScript Object Notation
 - Standardised text representation of structured data
 - Easily used by JavaScript/HTML5, Java, Perl, Python...

* Source: RDAP.org

RDAP JSON raw

\$ curl http://rdap.apnic.net/ip/210.17.9.242

```
{
  "rdapConformance": [
    {
      "history_version": 0,
      "rdap_level": 0,
      "notices": [
        {
          "title": "Source",
          "description": [
            "Objects returned came from source",
            "APNIC"
          ],
          "title": "Terms and Conditions",
          "description": [
            "This is the APNIC WHOIS Database query service. The objects are in RDAP format."
          ],
          "links": [
            {
              "value": "http://rdap.apnic.net/ip/210.17.9.242",
              "rel": "terms-of-service",
              "href": "http://www.apnic.net/db/dbcopyright.html",
              "type": "text/html"
            }
          ],
          "country": "TW",
          "events": [
            {
              "eventAction": "last changed",
              "eventDate": "2011-06-01T04:13:58Z"
            }
          ],
          "name": "TTN-TW",
          "remarks": [
            {
              "description": [
                "Taiwan Telecommunication Network Services Co., LTD.",
                "110",
                "8F",
                "No 89",
                "Sung Jen RD",
                "Taipei"
              ],
              "title": "description",
              "description": [
                "service provider",
                "title": "remarks"
              ],
              "type": "ALLOCATED PORTABLE",
              "endAddress": "210.17.127.255",
              "ipVersion": "v4",
              "startAddress": "210.17.0.0",
              "handle": "210.17.0.0 - 210.17.127.255",
              "objectClassName": "ip network",
              "links": [
                {
                  "value": "http://rdap.apnic.net/ip/210.17.9.242",
                  "rel": "self",
                  "href": "http://rdap.apnic.net/ip/210.17.0.0/17",
                  "type": "application/rdap+json"
                }
              ],
              "entities": [
                {
                  "roles": [
                    "abuse"
                  ],
                  "events": [
                    {
                      "eventAction": "last changed",
                      "eventDate": "2017-01-22T22:54:59Z"
                    }
                  ],
                  "vcardArray": [
                    {
                      "vcard": [
                        {
                          "version": {
                            "text": "4.0"
                          },
                          "fn": {
                            "text": "IRT-TFN-TW"
                          },
                          "kind": {
                            "text": "group"
                          },
                          "adr": [
                            {
                              "label": "7F.",
                              "No": "172-1",
                              "Sec": "2",
                              "Ji-Lung Rd.",
                              "Taipei City 106",
                              "Taiwan R.O.C."
                            },
                            {
                              "text": [
                                "",
                                "",
                                "",
                                "",
                                "",
                                ""
                              ],
                              "email": {
                                "text": "ethanchen@taiwanmobile.com"
                              },
                              "email": {
                                "pref": "i",
                                "text": "ethanchen@taiwanmobile.com"
                              },
                              "handle": "IRT-TFN-TW",
                              "objectClassName": "entity",
                              "links": [
                                {
                                  "value": "http://rdap.apnic.net/ip/210.17.9.242",
                                  "rel": "self",
                                  "href": "http://rdap.apnic.net/entity/IRT-TFN-TW",
                                  "type": "application/rdap+json"
                                }
                              ],
                              "roles": [
                                "administrative",
                                "technical"
                              ],
                              "events": [
                                {
                                  "eventAction": "last changed",
                                  "eventDate": "2011-12-06T00:10:19Z"
                                }
                              ],
                              "remarks": [
                                {
                                  "description": [
                                    "### Crime, Abuse, Spam, Security ###",
                                    "CSC TEL : 0809-000-188",
                                    "CSC TEL : +886-2-4066-0357",
                                    "abuse@tfn.com.tw",
                                    "abuse@tfn.com.tw",
                                    "### Crime, Abuse, Spam, Security ###",
                                    "title": "remarks"
                                  ],
                                  "vcardArray": [
                                    {
                                      "version": {
                                        "text": "4.0"
                                      },
                                      "fn": {
                                        "text": "TTN IP-Team"
                                      },
                                      "kind": {
                                        "text": "group"
                                      },
                                      "adr": [
                                        {
                                          "label": "Taiwan Mobile Co., Ltd.",
                                          "Network Assurance & Technical Support Div.",
                                          "Ex TTN merged",
                                          "No 172-1",
                                          "Sec 2",
                                          "Ji-Lung Rd",
                                          "Taipei 106",
                                          "Taiwan"
                                        },
                                        {
                                          "text": [
                                            "",
                                            "",
                                            "",
                                            "",
                                            "",
                                            ""
                                          ],
                                          "tel": {
                                            "type": "voice",
                                            "text": "+886-2-6638-6888"
                                          },
                                          {
                                            "tel": {
                                              "type": "fax",
                                              "text": "+886-2-6639-0607"
                                            },
                                            {
                                              "email": {
                                                "text": "whois@ttn.com.tw"
                                              }
                                            },
                                            {
                                              "handle": "IP11-AP",
                                              "objectClassName": "entity",
                                              "links": [
                                                {
                                                  "value": "http://rdap.apnic.net/ip/210.17.9.242",
                                                  "rel": "self",
                                                  "href": "http://rdap.apnic.net/entity/IP11-AP",
                                                  "type": "application/rdap+json"
                                                }
                                              ],
                                              "port43": "whois.apnic.net"
                                            }
                                          ]
                                        }
                                      ]
                                    }
                                  ]
                                }
                              ]
                            }
                          ]
                        }
                      ]
                    }
                  ]
                }
              ]
            }
          ]
        }
      ]
    }
  ]
}
```

HTTP “get”

JSON reply

RDAP JSON raw

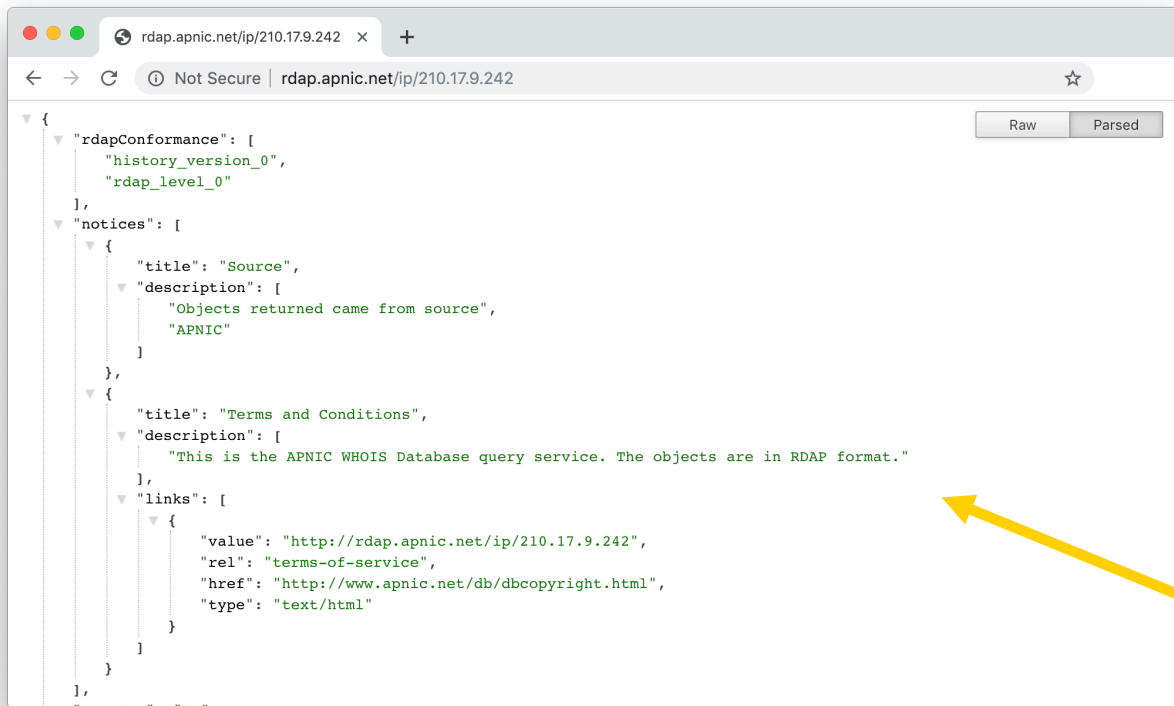
Web client

[illegible]

JSON reply

RDAP JSON formatted

Browser plugin



```
{
  "rdapConformance": [
    "history_version_0",
    "rdap_level_0"
  ],
  "notices": [
    {
      "title": "Source",
      "description": [
        "Objects returned came from source",
        "APNIC"
      ]
    },
    {
      "title": "Terms and Conditions",
      "description": [
        "This is the APNIC WHOIS Database query service. The objects are in RDAP format."
      ],
      "links": [
        {
          "value": "http://rdap.apnic.net/ip/210.17.9.242",
          "rel": "terms-of-service",
          "href": "http://www.apnic.net/db/dbcopyright.html",
          "type": "text/html"
        }
      ]
    }
  ]
}
```

Structured JSON

RDAP client

Web-based client

Search for Internet Resource Registration Data

E.g. AS4608, NO4-AP, 2001:dc0::/32



Search

Query by Entity handles only APNIC entities

Organisation

Name	TTN-TW
Country	TW
Status	ALLOCATED PORTABLE
Description	Taiwan Telecommunication Network Services Co.,LTD. 110 , 8F , No 89 , Sung Jen RD , Taipei

General Information

Object	IP Network (ip network)
Handle	210.17.0.0 - 210.17.127.255
Start Address	210.17.0.0
End Address	210.17.127.255
IP Version	v4

Processed result

RDAP client

RDAP Web client

Home

Español | [English](#) | Português


Home

Query by Autnum

Query by IP

Query by Entity

About RDAP



IP: 210.17.9.242

IP

Handle	210.17.0.0 - 210.17.127.255
Status	ALLOCATED PORTABLE
Net Range	210.17.0.0 - 210.17.127.255
Net Version	v4
Registration	No data
Last Changed	2011-06-01T04:13:58Z

CONTACTS

[ABUSE]	
Handle	IRT-TFN-TW
Name	IRT-TFN-TW
Telephone	No data
E-mail	ethanchen@taiwanmobile.com
Source	Click here..
[ADMINISTRATIVE, TECHNICAL]	
Handle	IP11-AP
Name	TTN IP-Team

Web-based client

Processed result
(redirected)



RDAP application (whowas)

APNIC WHOIS SEARCH

Whowas 210.17.9.242

210.17.0.0 - 210.17.127.255
210.0.0.0 - 210.255.255.255
0.0.0.0 - 255.255.255.255

2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

04/09/2008 07:54 <3 versions> <Present>

network name TTN-TW
network 210.17.0.0 - 210.17.127.255
country TW
type ALLOCATED PORTABLE
description Taiwan Telecommunication Network Services Co.,LTD.
110 , 8F , No 89 , Sung Jen RD , Taipei
remarks service provider

handle [IP11-AP](#)
name TTN IP-Team
kind group
address Taiwan Mobile Co., Ltd.
Network Assurance & Technical Support Div.
Ex TTN merged
8F.,No 172-1, Sec 2, Ji-Lung Rd
Taipei 106 Taiwan
voice +886-2-6638-6888
fax +886-2-6639-0607
email whois@ttn.com.tw

network name TTN-TW
network 210.17.0.0 - 210.17.127.255
country TW
type ALLOCATED PORTABLE
description Taiwan Telecommunication Network Services Co.,LTD.
110 , 8F , No 89 , Sung Jen RD , Taipei
remarks service provider

+ handle [IRT-TFN-TW](#)
+ name IRT-TFN-TW
+ kind group
+ address 7F., No. 172-1, Sec. 2, Ji-Lung Rd.
Taipei City 106, Taiwan R.O.C.
+ email ethanchen@taiwanmobile.com
+ email ethanchen@taiwanmobile.com

handle [IP11-AP](#)
name TTN IP-Team
kind group
address Taiwan Mobile Co., Ltd.
Network Assurance & Technical Support Div.
Ex TTN merged
8F.,No 172-1, Sec 2, Ji-Lung Rd
Taipei 106 Taiwan
voice +886-2-6638-6888
fax +886-2-6639-0607
email whois@ttn.com.tw

Complex result

<https://www.apnic.net/whowas>

RDAP application (vizAS)

vizAS

Home

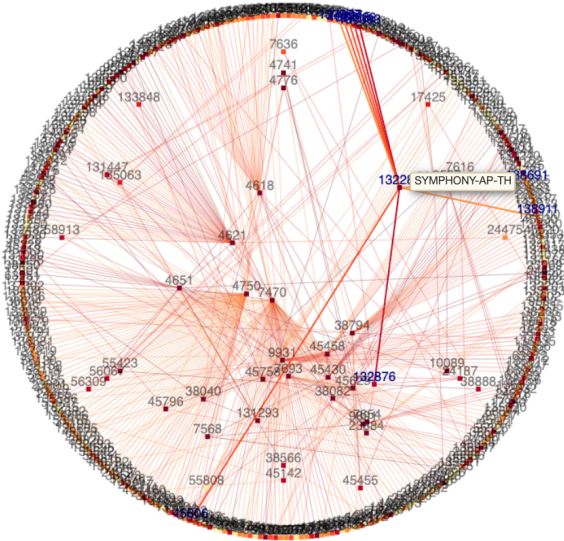
About

vizAS explores the interconnections between ASes within an economy, and compares the state of interconnections between the IPv4 and IPv6 address families.

 TH

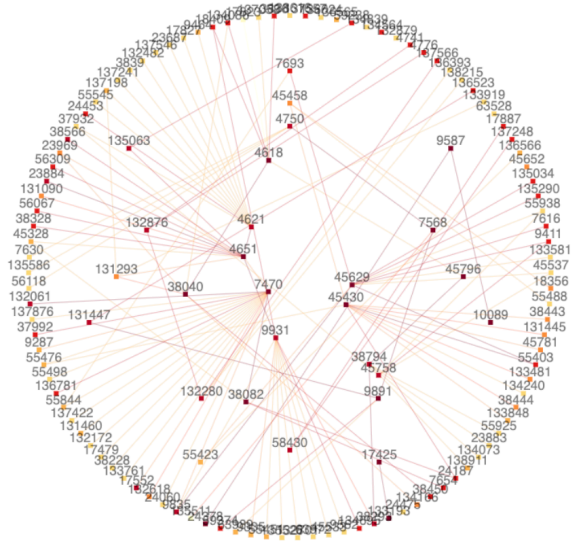
Thailand

IPv4 - 363 total ASNs in 505 visible peerings



[PNG](#) [SVG](#) [JSON](#)

IPv6 - 132 total ASNs in 129 visible peerings



[PNG](#) [SVG](#) [JSON](#)

<https://www.apnic.net/vizas>

RDAP application (vizAS)

ASN 132280: SYMPHONY-AP-TH

Registration | Peers

Remarks

Description	Symphony Communication (Thailand) PCL. Symphony Internet Service Provider		
-------------	--	--	--

Entities

IRT-SYMPHONY-TH SCPC1-AP	abuse	ip-admin@violin.co.th	
	administrative technical	ip-admin@violin.co.th	

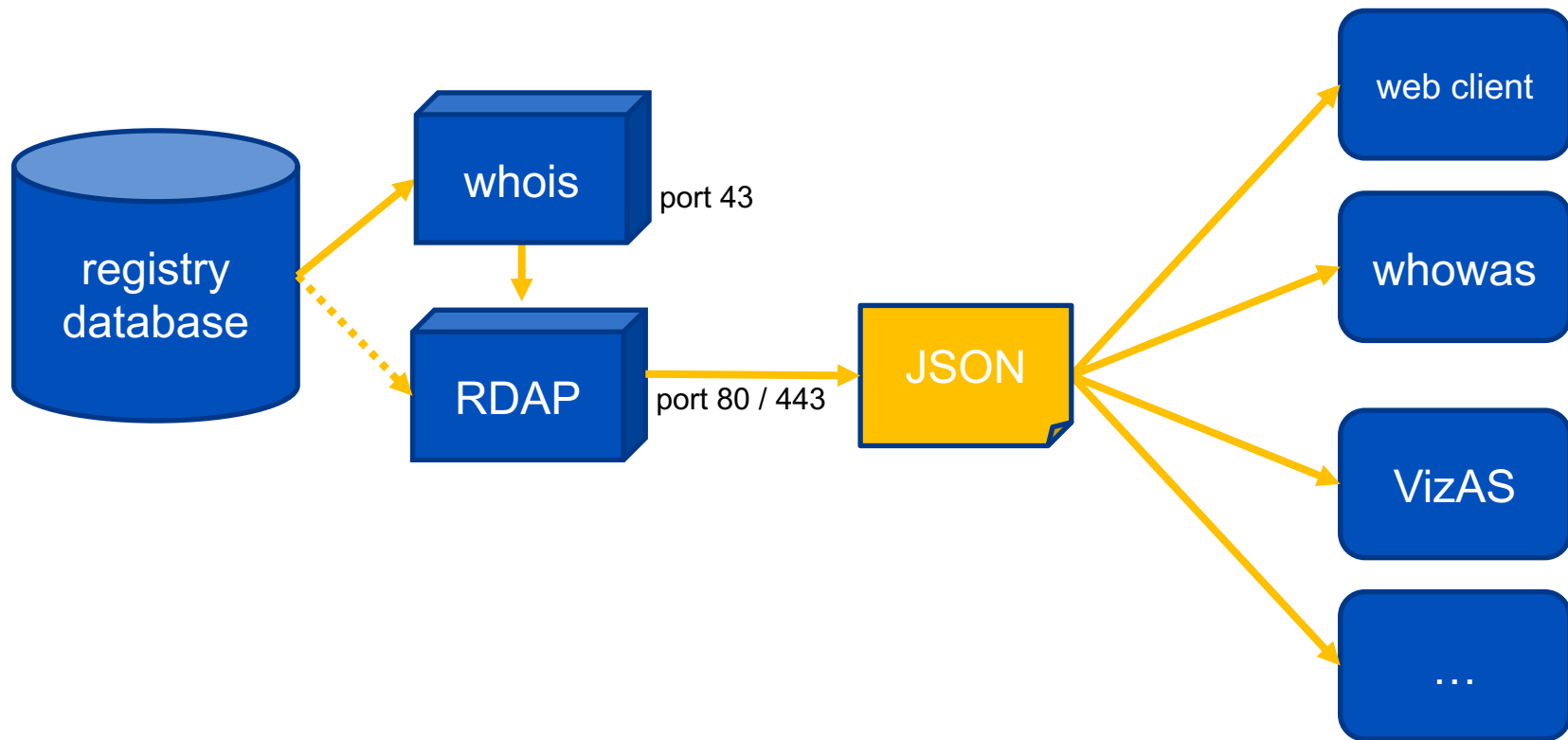
Notices

Source	Objects returned came from source APNIC		
Terms And Conditions	This is the APNIC WHOIS Database query service. The objects are in RDAP format.		

Close

APNIC

RDAP



RDAP benefits

- Automation – JSON input to common programming languages
 - Integration with firewall, NMS, IPAM...
- “Differentiated Access”
 - If needed
- Speaks your language (and character set)
 - Can implement server-side or in-client language preference
- One stop query
 - Will auto-redirect to the right authoritative server
- Web protocol is CDN friendly
 - Serve local, via anycast or DNS redirection methods
 - Cacheable, survives DDoS longer since distributed

APNIC RDAP Status

- First implemented May 2015
 - Adjunct service query to WHOIS radix tree (in memory)
 - Rewrote RPSL on-the-fly
- Re-implemented into WHOWAS Late 2016
 - Static in-memory data model. Fast response
- Working with NIRs
 - Hope to serve <nir>.rdap.apnic.net more-specific service
- APNIC region-wide consistent service model goal for 2019
 - Working with NIRs and other RIRs

RPKI

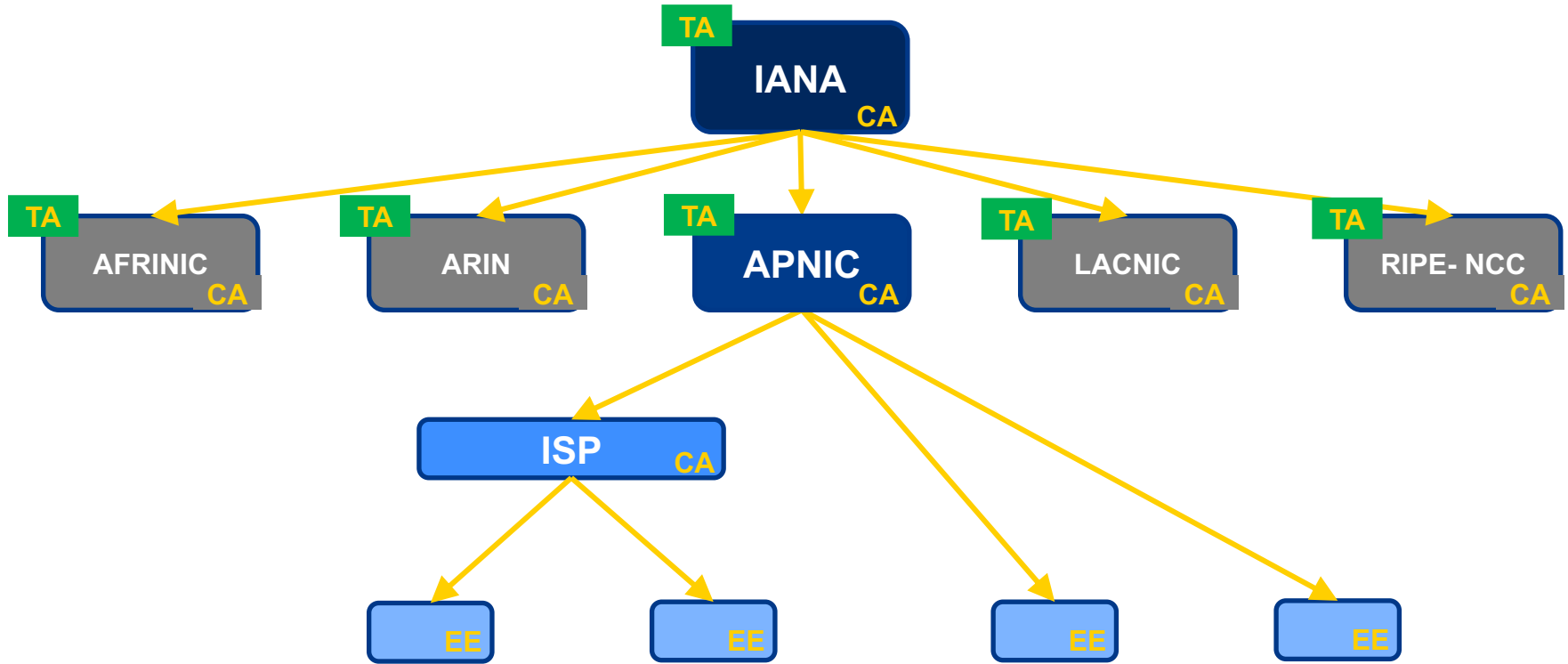
Resource Public Key Infrastructure

RPKI

- **RPKI** is a public key infrastructure (PKI) framework, designed to secure BGP routing
 - Based on X.509 PKI standards
- **RPKI** adds INR information to X.509 certificates issued to resource holders
 - Representing “ownership” and other status
 - Certification hierarchy follows INR delegation hierarchy

IANA → RIR → NIR → ISP → ...

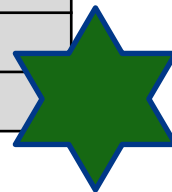
RPKI hierarchy



RPKI application: ROA

- Route Origin Authorization
 - List of prefixes with ASN authorized to announce
 - Signed by the prefix holder with RPKI certificate

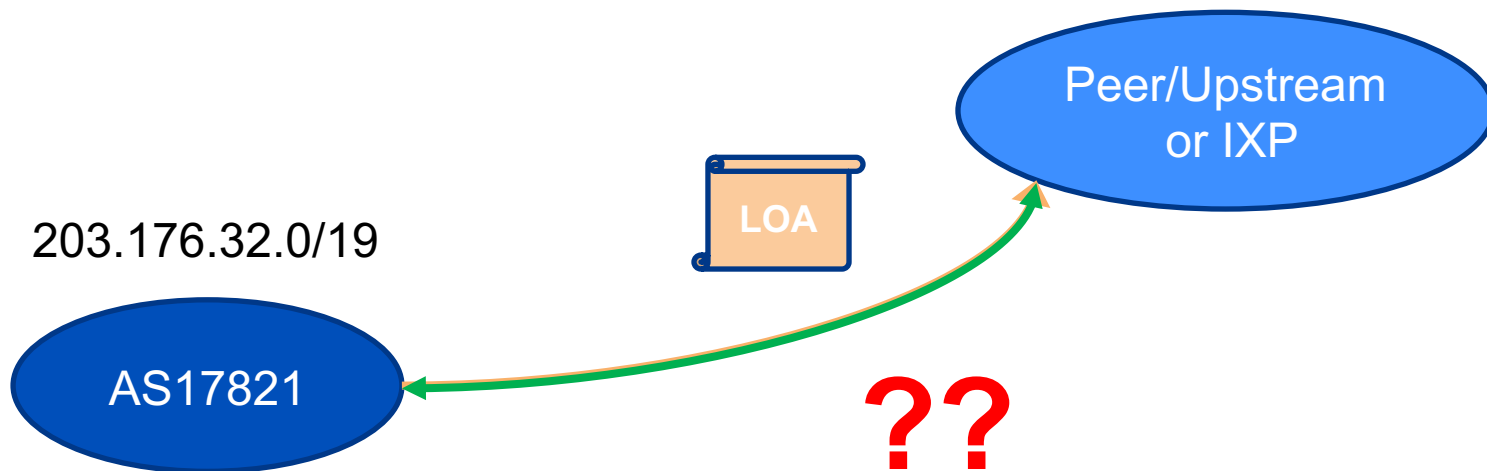
Prefix	203.176.32.0/19
Max-length	/24
Origin ASN	AS17821



- ROV relies on the integrity of the ROA
 - If valid, can now be used to construct route filters

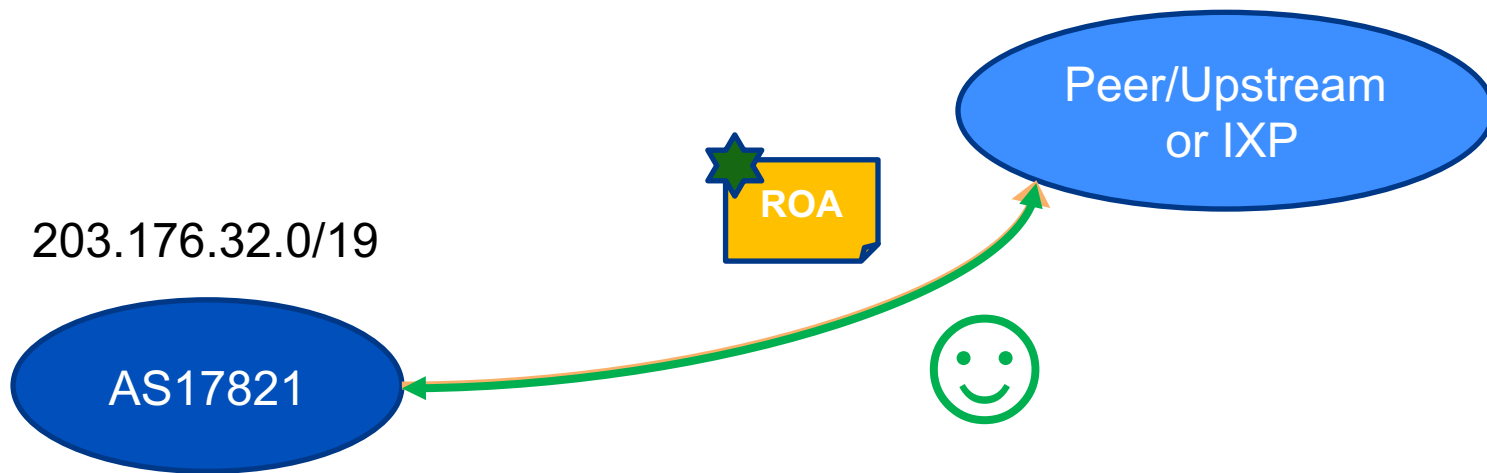
Route Origin Validation (ROV)

- Using RPKI Route Origin Authorisation (ROA)



Route Origin Validation (ROV)

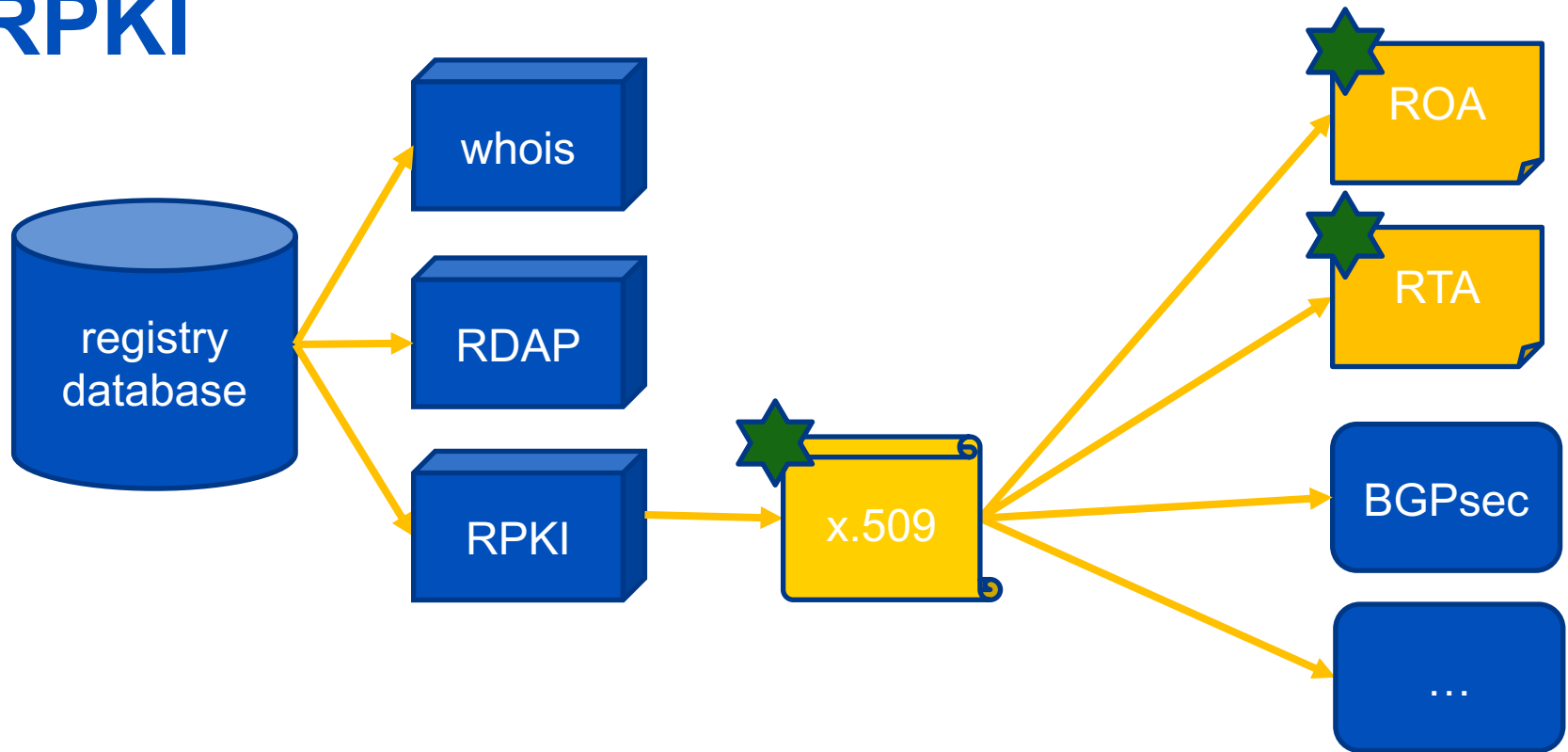
- Using RPKI Route Origin Authorisation (ROA)



RPKI application: RTA

- Resource Tagged Attestation
 - Use of RPKI cert to sign an arbitrary object
- RTA application: LOA
 - Replace existing informal “letter of authority” practice
 - Now digitally secured and can be automated
- Pilot implementation
 - In development at APNIC (via MyAPNIC)
 - IETF draft in progress

RPKI

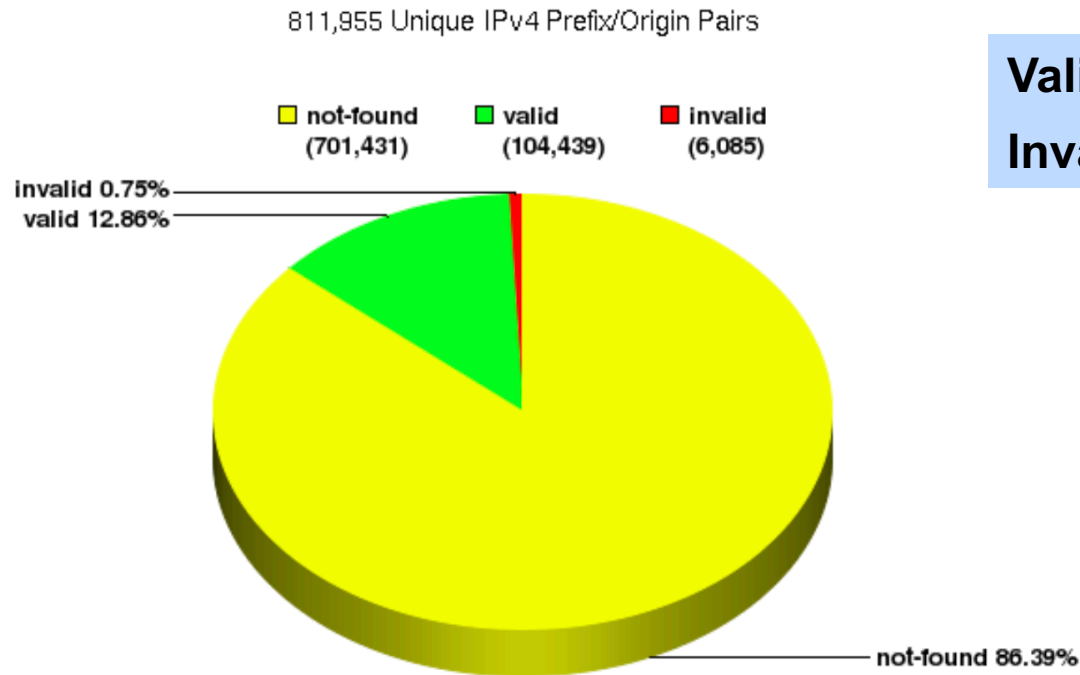


RPKI at APNIC

RPKI Service Models

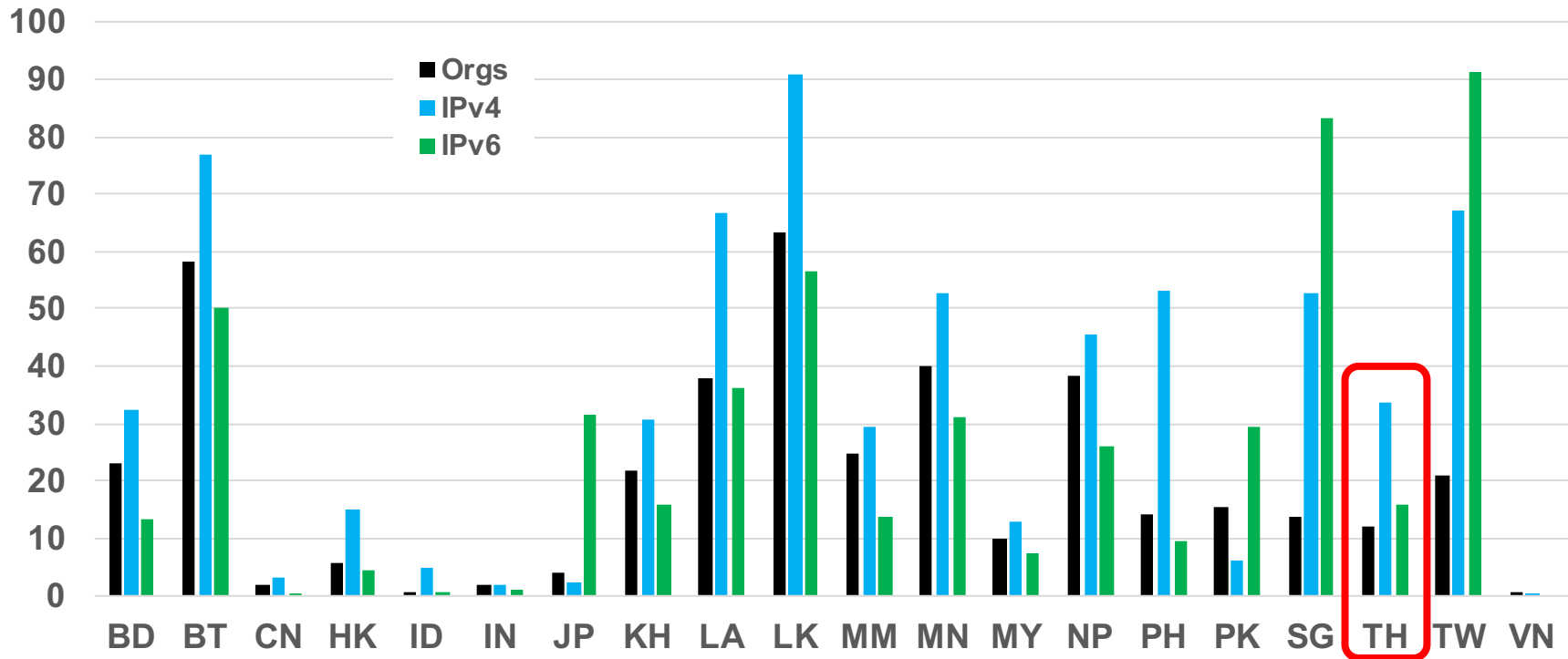
- Hosted service
 - APNIC performs CA functions on behalf of members
 - Manage keys, repository etc
 - Generate certificates for resource delegations
 - This “Member CA” is separate from the “APNIC CA”
- Provisioning model
 - Member operates full RPKI system including CA
 - Communication with APNIC via provisioning protocol
 - This is live at JPNIC, CNNIC and TWNIC (IDNIC in progress)

ROA deployment – Global



Valid	12.85%
Invalid	0.75%

ROA deployment – Regional



RPKI benefits

- Improved in-band verification of resource custodianship
 - Much safer than manually checking whois or IRR database
 - Ease of automation
- Primary application: Secure Origin (ROA)
 - A first step to preventing many attacks on BGP integrity
 - BGP Path remains a problem which is under development
 - Related information such as IRR Policy can now leverage strong proofs of validity (end the maintainer-authority problem in RADB/IRR)
- Also: secure attestation (RTA)
 - And more in future?

How do I start?

- Create ROAs to better protect your own routes
 - Encourage your peers/customers to do the same
 - Encourage your IXP to implement ROV in the RS
- Then
 - Set up route validation at your own border routers
 - Using public or IXP validator, or your own
- APNIC members, use MyAPNIC
 - We can help!
 - Please contact APNIC Helpdesk
 - And...

Over to Tashi...

pwilson@apnic.net