The impact of an RPKI validator in Bangladesh and Lessons Learned

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#APRICOT2020
Feb 18, 2020

Image source: Internet

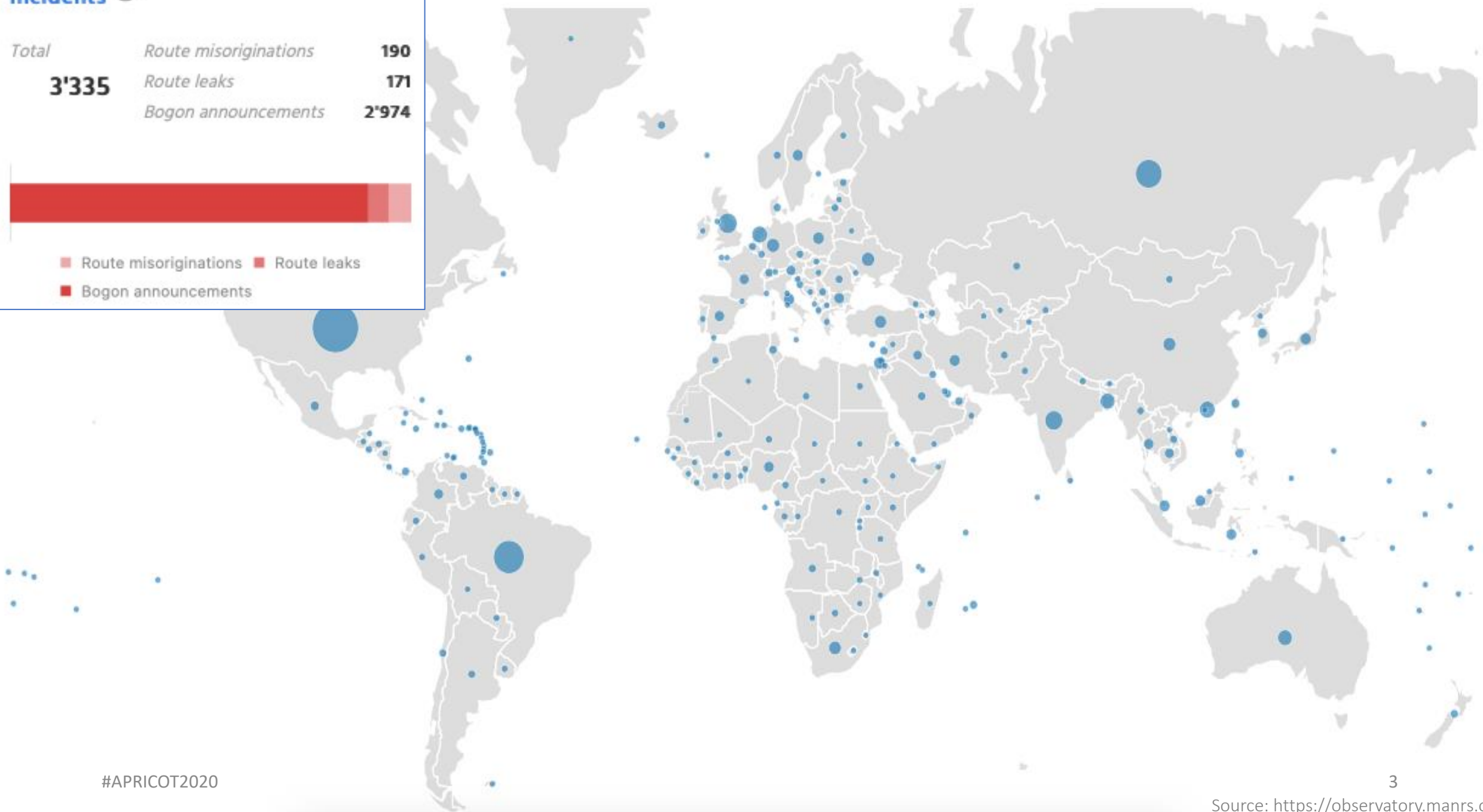# Starting with some routing incidents…

Incidents ⓘ

Total	Route misoriginations	190
3'335	Route leaks	171
	Bogon announcements	2'974

■ Route misoriginations ■ Route leaks
■ Bogon announcements

Source: https://observatory.manrs.org

- A Prefix is announced by both AS 134599 and AS 133957 (might be unintentional)

- Either AS cloud be closest to different geographic locations

- Legitimate traffic might get blackholed

	Announced By	
Origin AS	**Announcement**	
AS134599	45.118.70.0/24	✅
AS133957	45.118.70.0/24	✅

```
route-views>show ip bgp 45.118.70.0/24 | i 133957
  3277 3267 174 58601 138197 138197 138197 138197 138197 133957
  24441 3491 3491 3257 58601 138197 138197 138197 138197 138197 133957
  3561 209 174 58601 138197 138197 138197 138197 138197 133957
  20912 174 58601 138197 138197 138197 138197 138197 133957
  852 174 58601 138197 138197 138197 138197 138197 133957
  101 101 174 58601 138197 138197 138197 138197 138197 133957
  3267 174 58601 138197 138197 138197 138197 138197 133957
  3303 3257 58601 138197 138197 138197 138197 138197 133957
  54728 20130 23352 3257 58601 138197 138197 138197 138197 138197 133957
```

```
route-views>show ip bgp 45.118.70.0/24 | i 134599
  8283 6762 132602 58717 135341 135341 135341 135341 134599 134599 134599 134599 134599 134599 134599 134599 134599 134599
  6939 58717 135341 135341 135341 135341 134599 134599 134599 134599 134599 134599 134599 134599 134599 134599
  7018 2914 132602 58717 135341 135341 135341 135341 134599 134599 134599 134599 134599 134599 134599 134599 134599 134599
  1403 1299 2914 132602 58717 135341 135341 135341 135341 134599 134599 134599 134599 134599 134599 134599 134599 134599 134599
  1403 1299 2914 132602 58717 135341 135341 135341 135341 134599 134599 134599 134599 134599 134599 134599 134599 134599 134599
  1351 6939 58717 135341 135341 135341 135341 134599 134599 134599 134599 134599 134599 134599 134599 134599 134599
  286 6762 132602 58717 135341 135341 135341 135341 134599 134599 134599 134599 134599 134599 134599 134599 134599 134599
  57866 6762 132602 58717 135341 135341 135341 135341 134599 134599 134599 134599 134599 134599 134599 134599 134599 134599
  4826 58717 135341 135341 135341 135341 134599 134599 134599 134599 134599 134599 134599 134599 134599 134599
```

- Issue informed to the IP owner.
- They removed one announcement
- Created ROA for valid ASN
- Valid announcement visible in the global routing table

	Announced By	
Origin AS	Announcement	
AS133957	45.118.70.0/24	🔑 ✅

```
route-views>show ip bgp 45.118.70.0/24 | i 133957
  3277 3267 174 58601 138197 138197 138197 138197 138197 133957
  24441 3491 3491 3257 58601 138197 138197 138197 138197 138197 133957
  3561 209 174 58601 138197 138197 138197 138197 138197 133957
  20912 174 58601 138197 138197 138197 138197 138197 133957
  852 174 58601 138197 138197 138197 138197 138197 133957
  101 101 174 58601 138197 138197 138197 138197 138197 133957
  3267 174 58601 138197 138197 138197 138197 138197 133957
  3303 3257 58601 138197 138197 138197 138197 138197 133957
  54728 20130 23352 3257 58601 138197 138197 138197 138197 138197 133957
```

```
route-views>sho ip bgp 45.118.70.0/24 | i 134599
route-views>
```

- Client AS didn't update APNIC membership
- Shouldn't have valid prefix allocation with revoked membership
- Transit still announces client's prefixes
- Prefixes marked as BOGON in global routing table

| AS Info | Graph v4 | Graph v6 | Prefixes v4 | Prefixes v6 | Peers v4 | Peers v6 | Whois | IRR |

AS136555 announces bogons.

Company Website: http://bkonlinebd.net/

| AS Info | Graph v4 | Graph v6 | Prefixes v4 | Prefixes v6 | Peers v4 | Peers |

Prefix		Description
103.67.199.0/24	✅	BK ONLINE
103.92.152.0/24		Asia Pacific Network Information Centre
103.92.153.0/24		Asia Pacific Network Information Centre
103.92.154.0/24		Asia Pacific Network Information Centre
103.92.155.0/24		Asia Pacific Network Information Centre

core3.fmt1.he.net> show ip bgp routes detail 103.92.152.0/24

Matching Routes	2
Status Codes	A - Aggregate B - Best b - Not Install Best C - Confederation eBGP D - Damped E - eBGP H - History I - iBGP L - Local M - Multipath m - Not Installed Multipath S - Suppressed F - Filtered s - Stale x - Best-External

Status		Network		Next Hop		Metric	LocPrf	Weight		Path		Origin	ROA
BI		103.92.152.0/24		198.32.176.203		15	100	0		9498, 132884, 58717, 136555x5		IGP	?
I		103.92.152.0/24		206.72.210.149		95	100	0		9498, 132884, 58717, 136555x5		IGP	?
Last Update		7h35m37s ago (1 path installed)											

Entry cached for another 60 seconds.

2019-10-27 13:18:47 UTC

- The issue has been informed to the transit provider

- Then, they dropped it

- The announcement was removed from global table

- Later on, the AS got membership renewed and has its allocated prefixes back for use

```
route-views>show ip bgp 103.92.152.0/24
% Network not in table
route-views>show ip bgp 103.92.153.0/24
% Network not in table
route-views>show ip bgp 103.92.154.0/24
% Network not in table
route-views>show ip bgp 103.92.155.0/24
% Network not in table
```

Prefix			
103.67.199.0/24	🔑	✅	BK ONLINE
103.92.152.0/24	🔑	✅	BK ONLINE
103.92.153.0/24	🔑	✅	BK ONLINE
103.92.154.0/24	🔑	✅	BK ONLINE
103.92.155.0/24	🔑	✅	BK ONLINE

- AS 64075 delegated its prefix 103.204.210.0/24 to AS 137842

- AS 137842 announced the prefix

- AS 64075 is also announcing its delegated prefixes as AS 137842 (AS Hijack)

- It's upstream accepting it and further announcing it globally

	Announced By
Origin AS	Announcement
AS137842	103.204.210.0/24 ✅
AS64075	103.204.210.0/24 ✅

AS137842 MH ONLINE

| AS Info | Graph v4 | Prefixes v4 | Peers v4 | Whois | IRR |

Rank	Description	
1	BDCOM	
2	CIRCLE NETWORK BANGLADESH	

core1.sin1.he.net> show ip bgp routes detail 202.181.16.0/24

Matching Routes	10

Status Codes: **A** - Aggregate **B** - Best **b** - Not Install Best **C** - Confederation eBGP **D** - Damped **E** - eBGP **H** - History **I** - iBGP **L** - Local **M** - Multipath **m** - Not Installed Multipath **S** - Suppressed **F** - Filtered **s** - Stale **x** - Best-External

Status	Network	Next Hop	Metric	LocPrf	Weight	Path	Origin	ROA
BEx	202.181.16.0/24	74.82.51.74	0	140	0	132602, 10075, 134371, 137842	IGP	⊘
E	202.181.16.0/24	27.111.228.140	0	100	0	10075, 134371, 137842	IGP	⊘
E	202.181.16.0/24	27.111.228.140	0	100	0	10075, 134371, 137842	IGP	⊘
E	202.181.16.0/24	27.111.228.140	0	100	0	10075, 134371, 137842	IGP	⊘
E	202.181.16.0/24	27.111.228.40	0	100	0	9498, 10075, 134371, 137842	IGP	⊘
E	202.181.16.0/24	27.111.229.76	0	100	0	132602, 10075, 134371, 137842	IGP	⊘
E	202.181.16.0/24	65.49.109.182	0	100	0	9498, 10075, 134371, 137842	IGP	⊘
E	202.181.16.0/24	27.111.228.111	0	100	0	6762, 132602, 10075, 134371, 137842	IGP	⊘
E	202.181.16.0/24	74.82.48.70	0	100	0	3491, 9498, 10075, 134371, 137842	IGP	⊘
E	202.181.16.0/24	216.218.221.142	0	100	0	4637, 9498, 10075, 134371, 137842	IGP	⊘
Last Update	4d5h31m58s ago (1 path installed)							

Entry cached for another 60 seconds.

2019-10-24 13:20:23 UTC

- A /64 IPv6 prefix announced in global routing table
- Most specific announcement in global table is /48
- A /64 should never be in global routing table

Prefix		
2405:1500::/32	🔑	✅
2405:1500::/48	🔑	✅
2405:1500:0:8::/64	🔑	✅
2405:1500:30::/48	🔑	✅
2405:1500:40::/48	🔑	✅
2405:1500:60::/48	🔑	✅
2405:1500:70::/48	🔑	✅
2405:1500:80::/48	🔑	✅

- The issue was informed to the AS
- The announcement has been removed

Prefix		
2405:1500::/32	🔑	✅
2405:1500::/48	🔑	✅
2405:1500:30::/48	🔑	✅
2405:1500:40::/48	🔑	✅
2405:1500:60::/48	🔑	✅
2405:1500:70::/48	🔑	✅
2405:1500:80::/48	🔑	✅

Somebody is announcing non-routable prefixes in the global BGP table.

Prefix	
103.82.232.0/24	✅
103.96.230.0/23	✅
103.96.232.0/24	✅
123.253.228.0/22	✅
172.18.3.0/24	

Prefix		
103.82.232.0/24	🔑	✅
103.96.230.0/23	🔑	✅
103.96.232.0/24	🔑	✅
123.253.228.0/22	🔑	✅

The announcement has been removed once the issue was informed to them

- Previously, AS 136909 used transit from AS 24342 using static routing.

- AS 24342 announced prefixes of AS 136909 in global BGP table on their behalf.

- Later, AS 136909 stated doing BGP but AS 24342 still didn't stop the announcement.

- AS 24342 has been informed to stop announcing client's prefixes
- Client AS 136909 has signed their prefixes
- Issue resolved.

```
route-views>show ip bgp 103.98.200.0/24 | i 24342
  7660 2516 6453 58601 24342 24342 24342 136909
  286 6453 58601 24342 24342 24342 136909
  852 3491 9498 58601 24342 24342 24342 136909
  6079 4637 9498 58601 24342 24342 24342 136909
  1351 9498 58601 24342 24342 24342 136909
  54728 20130 6939 58601 24342 24342 24342 136909
  3333 1257 6453 58601 24342 24342 24342 136909
  3267 6461 7473 17494 58601 24342 24342 24342 136909
  1403 6453 58601 24342 24342 24342 136909
  1403 6453 58601 24342 24342 24342 136909
  8283 6453 58601 24342 24342 24342 136909
  57866 6461 7473 17494 58601 24342 24342 24342 136909
  49788 12552 9498 58601 24342 24342 24342 136909
  3277 3267 6461 7473 17494 58601 24342 24342 24342 136909
```

AS Info	Graph v4	Prefixes v4	Peers v4

Prefix		
103.98.200.0/22	🔑	✅
103.98.200.0/24	🔑	✅
103.98.201.0/24	🔑	✅
103.98.202.0/24	🔑	✅
103.98.203.0/24	🔑	✅

AS Info	Graph v4	Prefixes v4	Peers v4	Whois

Prefix		
115.127.0.0/17	🔑	✅
115.127.0.0/18	🔑	✅
115.127.0.0/19	🔑	✅
115.127.0.0/20	🔑	✅
115.127.0.0/24	🔑	✅
115.127.1.0/24	🔑	✅
115.127.2.0/24	🔑	✅
115.127.3.0/24	🔑	✅
115.127.4.0/24	🔑	✅

- AS 136901 got an allocation of /22.

- They announce part of its prefix (not the whole), e.g. /23 is announced but the other /23 is not.

- Opportunists can try to use the unannounced /23 for unauthorized activities.

Prefix	
103.98.64.0/24	✅
103.98.65.0/24	✅

```
awal@Awals-MacBook-Air ~> whois -h whois.radb.net 103.98.64.0/22
route:          103.98.64.0/22
origin:         AS136901
```

- AS 137515 announced BCC's prefix 103.48.17.0/24 in a NIX (Prefix hijack)
- Important government services became unavailable to the citizens
- Costs our time to fix.

| | AS Info | Graph v4 | Graph v6 | Prefixes v4 | Prefixes v6 | Peers v4 | Peers v6 | Whois | IRR |

Prefix	Description	
43.229.12.0/22	Bangladesh Computer Council	
43.229.15.0/24	Bangladesh Computer Council	
103.48.16.0/22	Bangladesh Computer Council	
114.130.54.0/23	Bangladesh Computer Council	
114.130.116.0/22	Bangladesh Computer Council	
180.211.213.0/24	Bangladesh Computer Council	

```
SadabM@PXN-EDGE-JR> show route 103.48.17.50

inet.0: 801403 destinations, 6284521 routes (787268 active, 0 holddown, 3604693 hidden]
+ = Active Route, - = Last Active, * = Both

103.48.17.0/24        *[BGP/170] 00:01:34, localpref 100
                        AS path: 132602 56032 137515 I, validation-state: unverified
                      > to 103.16.155.45 via et-0/0/1.517
                       [BGP/170] 00:01:13, localpref 100
                        AS path: 132602 56032 137515 I, validation-state: unverified
                      > to 103.16.155.41 via et-0/0/2.520
                       [BGP/170] 00:01:34, localpref 100
                        AS path: 132602 56032 137515 I, validation-state: unverified
                      > to 163.47.83.29 via et-0/0/3.73

SadabM@PXN-EDGE-JR>
```

What they reply about it? Funny but they really did

- We mistakenly announced the prefix
- We do not manually check our clients' APNIC membership status
- The client is very close to us and well trustworthy, so we never required to check their announcements
- We don't do prefix or AS filtering for our clients
- Forgot to stop announcing the prefix after it's delegated to another AS

Image source: Internet
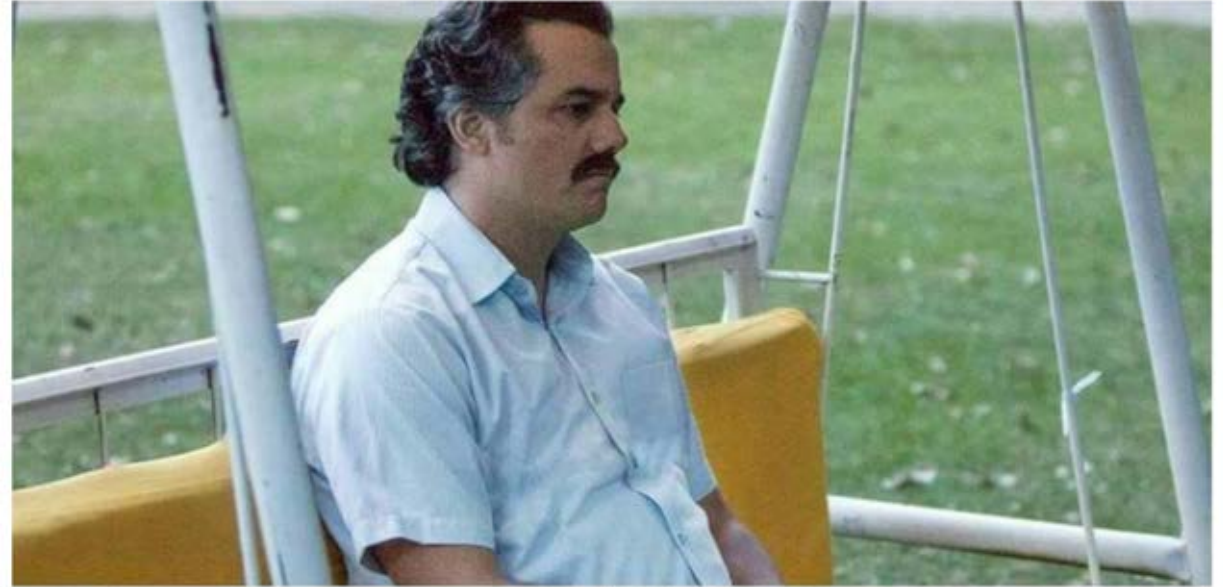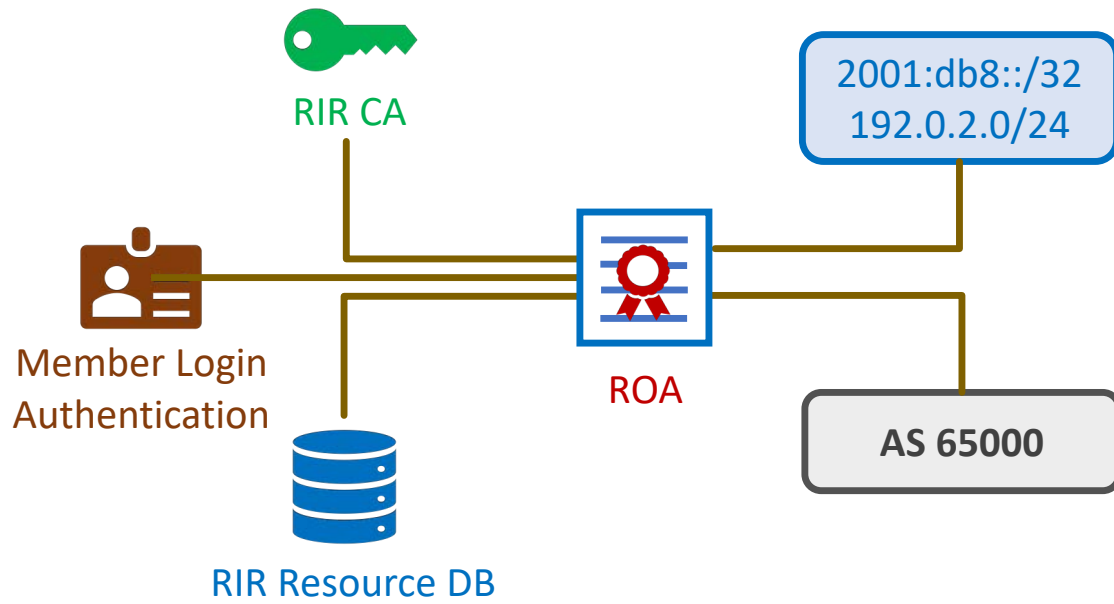
How we ensure the routing hygiene manually?

Nightmare…

Image source: Internet

Image source: Internet

RPKI is about 2 things: ROA and ROV

1 Signing prefixes
a.k.a. creating ROAs

Prefix	2401:ED80::/32
Origin AS	AS63932
❶ MSA	/32
ROA	☑ Enabled
Whois	☑ Enabled
Actions	Update whois 🗗

Cancel   Submit

Route		Origin AS		ROA status ❶	Whois status ❶
103.48.16.0/22		AS63932		⊘	⊘
2401:ED80::/32		AS63932		⊘	⊘
43.229.12.0/22		AS63932		⊘	⊘
43.229.15.0/24		AS63932		⊘	⊘

RIR CA

2001:db8::/32
192.0.2.0/24

Member Login
Authentication

ROA

AS 65000

RIR Resource DB

RPKI is about 2 things: ROA and ROV

2 Validating ROAs

a.k.a doing ROV

RPKI Repository ←→ rsync/RRDP ←→ RPKI Validator ←→ RTR Protocol ←→ BGP Router

```
RPKI server is 172.20.22.4, port 3323
RPKI current state: Established, Age: 01m46s
    Local host: 172.19.19.1, Local port: 60462
    Remote host: 172.20.22.4, Remote port: 3323
Refresh time : 900
Aging time : 1800
Session ID : 59791
Serial number : 10
Session Statistics:
    IPv4 record : 98101
    IPv6 record : 16506
```

```
RPKI validation codes: V - valid, I - invalid, N - not-found


Total Number of Routes: 1005452
        Network                NextHop                      MED

*>   V 1.0.0.0/24            103.9.114.161
*    V                       114.130.31.5
*>   N 1.0.4.0/22            103.9.114.161
*>   N 1.0.4.0/24            103.9.114.161
*>   N 1.0.5.0/24            103.9.114.161
*>   N 1.0.6.0/24            103.9.114.161
*>   N 1.0.7.0/24            103.9.114.161
*>   N 1.0.16.0/24           103.9.114.161
*>   N 1.0.64.0/18           103.9.114.161
```

Why Create ROA?

Origin AS	Announced By	
	Announcement	
AS134599	45.118.70.0/24	🔑 ✅
AS133957	45.118.70.0/24	🔑 ☑

To ensure the authenticity of your IP resources and help others verify it if requires

So that your IP resources are not knowingly or unknowingly used or abused by anyone

Why Deploy ROV?

To build and maintain a secure and trustworthy global routing infrastructure

To validate BGP routes and identify the authorized originator of the prefix

RPKI Validation in NDC
and subsequent impact

RPKI Validation at National Data Center

- NDC declared to drop invalids since Dec 1, 2019

- Bangladesh has more than 700 active ASN

- BD ROA stats in Sep 2019:
  - Valid – 29%
  - Unknown – 69%
  - Invalid – 2%

- Need to find out ASNs who are getting impact
  - BD ASNs are easy to reach for obvious reason
  - How about the global ASNs?

Awareness Before the ROV

BDNOG :
Bangladesh
Network Operators
Group
🌐 Public group

About
Discussion
Announcements
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Mohammad Abdul Awal shared a link.
Admin · 1 hr

বাংলাদেশ কম্পিউটার কাউন্সিলের অধীনস্থ জাতীয় ডাটা সেন্টারে আগামী ১ ডিসেম্বর ২০১৯ তারিখ থেকে আরপিকেআই ভেলিডেশন শুরু হচ্ছে। এর ফলে যেসব ইন্টারনেট প্রিফিক্সসমূহের রোআ ভুল বা ইনভ্যালিড সেইসব আইসি এড্রেস থেকে জাতীয় ডাটা সেন্টারের কোন কনটেন্ট আর এক্সেস করা যাবে না।

National Data Center at Bangladesh Computer Council starts RPKI ROA validation on Dec 1, 2019. Please check the ROA for your prefixes and correct/create if required.

RPKI

আরপিকেআই ভেলিডেশন শুরু
...ার প্রতি আমাদের দৃঢ় প্রতিশ্রুতির অংশ হিসেবে বাংলাদেশ...

🔵 BGD e-GOV CIRT   ✉ info@cirt.gov.bd   📞 +880255006801 f

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জাতীয় ডাটা সেন্টারে আরপিকেআই ভেলিডেশন শুরু

নেটওয়ার্ক ও সাইবার নিরাপত্তার প্রতি আমাদের দৃঢ় প্রতিশ্রুতির অংশ হিসেবে বাংলাদেশ কম্পিউটার কাউন্সিলের অধীনস্থ জাতীয় ডাটা সেন্টার আগামী ১ ডিসেম্বর ২০১৯ তারিখ থেকে আরপিকেআই ভেলিডেশন শুরু হচ্ছে। এর ফলে যেসব ইন্টারনেট প্রিফিক্সসমূহের রোআ ভুল বা ইনভ্যালিড সেইসব প্রিফিক্সসমূহকে জাতীয় ডাটা সেন্টারের রাউটারসমূহ আর গ্রহণ করবে না।

কারা এর প্রতিক্রিয়া উপলব্ধি করবেঃ

বাংলাদেশসহ বিশ্বের যেকোন নেটওয়ার্ক অপারেটর বা ইন্টারনেট সার্ভিস প্রোভাইডার এর যদি কোন প্রিফিক্সের রোআ ভুল বা ইনভ্যালিড থাকে তাহলে সেইসব আইপি এড্রেস থেকে জাতীয় ডাটা সেন্টারের কোন কনটেন্ট আর এক্সেস করা যাবে না।

আরপিকেআই (RPKI) এবং রোআ (ROA) কি ?

রিসোর্স পাবলিক কি ইনফ্রাস্ট্রাকচার বা আরপিকেআই হল এক ধরনের কাঠামো যার মাধ্যমে বর্ডার গেটওয়ে প্রোটোকল (বিজিপি) এর মত বিশ্বব্যাপী বিস্তৃত ইন্টারনেট রাউটিং অবকাঠামোকে নিরাপদ সম্ভব।

Subject: NDC starts RPKI Validation on Dec 1
Date: Thu, 7 Nov 2019 00:44:32 +0600
From: Md. Abdul Awal <awal.ece@gmail.com>
To: nog <nog@bdnog.org>

Dear Colleagues,

National Data Center (NDC) at Bangladesh Computer Council (BCC) starts RPKI ROA validation on December 1, 2019.

Read more here:
https://www.cirt.gov.bd/%e0%a6%9c%e0%a6%be%e0%a6%a4%e0%a7%80%e0%a7
%a6%b8%e0%a7%87%e0%a6%a8%e0%a7%8d%e0%a6%9f%e0%a6%be%e0%a6%b0%e

NDC team tried to reach ASNs who have INVALID ROAs and helped many of them to fix it. However, there are still about 2% invalid prefixes in Bangladesh. Please be informed that the INVALID prefixes would not be able to access any content hosted at NDC after Nov 30.

Please spend some time to check the ROA for your prefixes. Correct any invalid ROAs immediately from your MyAPNIC portal. Also, if you didn't create ROA for your prefixes yet, please do so asap.

Best regards,
Awal

Awareness Before the ROV

- We helped others to create and/or fix their ROAs
  - LEAs, Police, Special forces
  - Govt. Organizations
  - IXPs
  - Banks and Financial Organizations
  - Transit providers
  - ISPs
  - Data Centers

The impact of awareness campaign

Source: https://bgp.he.net

The impact of awareness campaign

The impact of awareness campaign

Routing completeness (RPKI) ⓘ

Total		
100%	Valid	29%
	Unknown	69%
	Invalid	2%

■ Valid ■ Unknown ■ Invalid

Sep 2019

Routing completeness (RPKI) ⓘ

Total		
100%	Valid	31%
	Unknown	67%
	Invalid	2%

■ Valid ■ Unknown ■ Invalid

Oct 2019

Routing completeness (RPKI) ⓘ

Total		
100%	Valid	45%
	Unknown	54%
	Invalid	1%

■ Valid ■ Unknown ■ Invalid

Nov 2019

Source: https://observatory.manrs.org
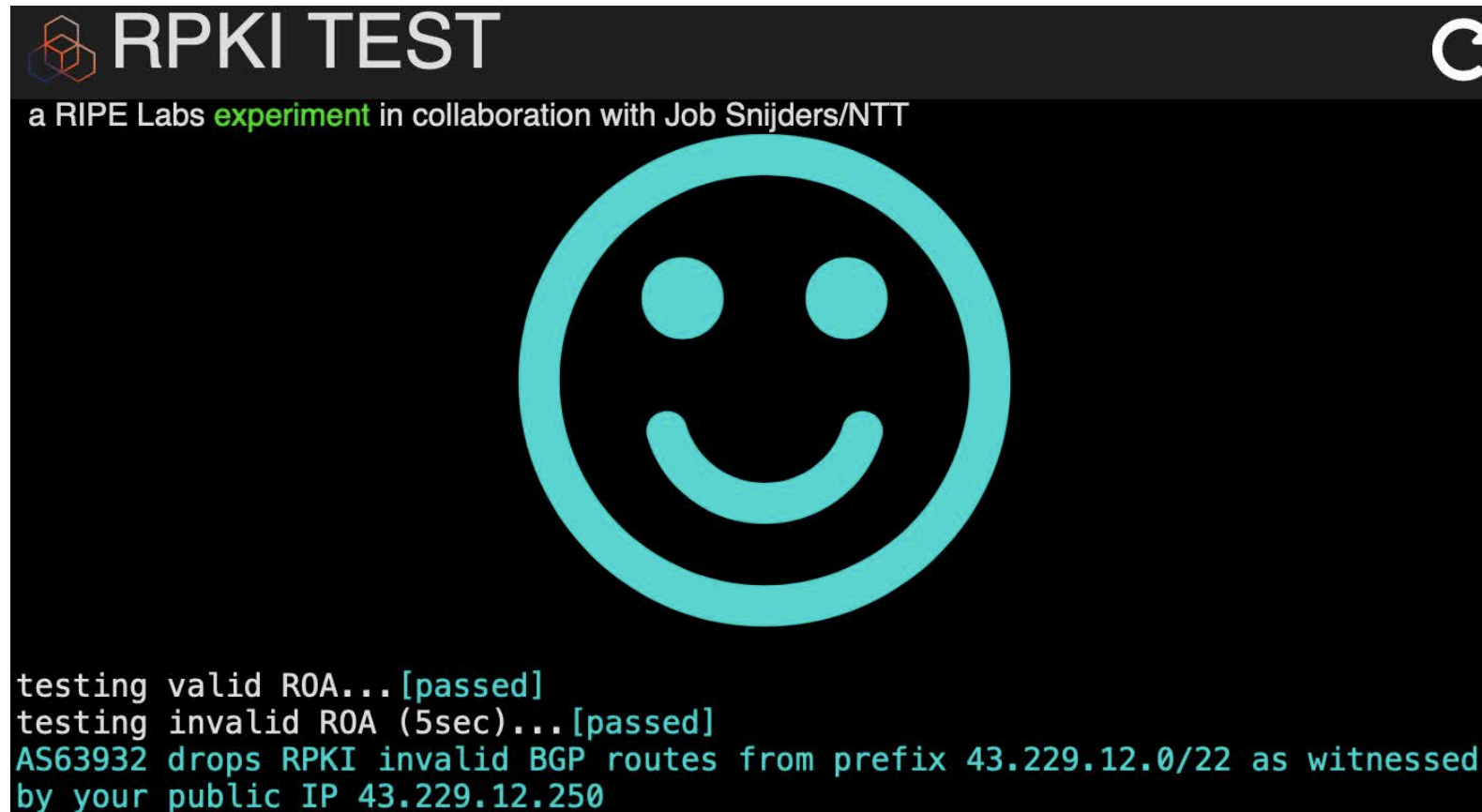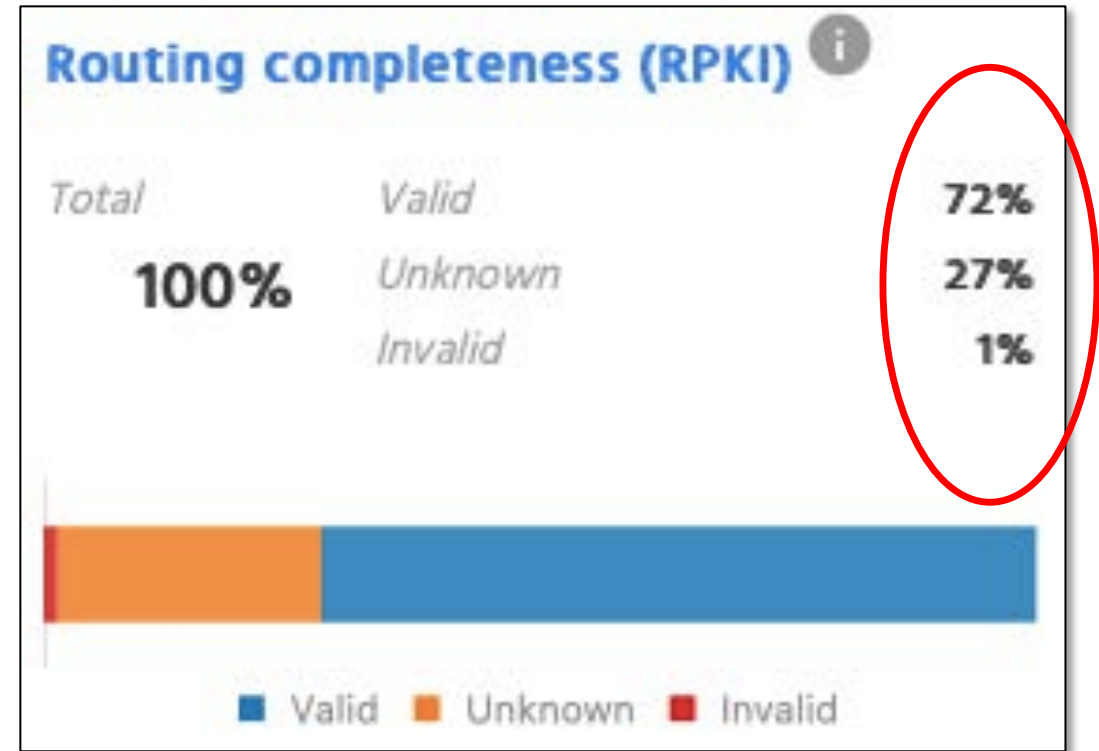
And, finally NDC drops invalids since Dec 1, 2019
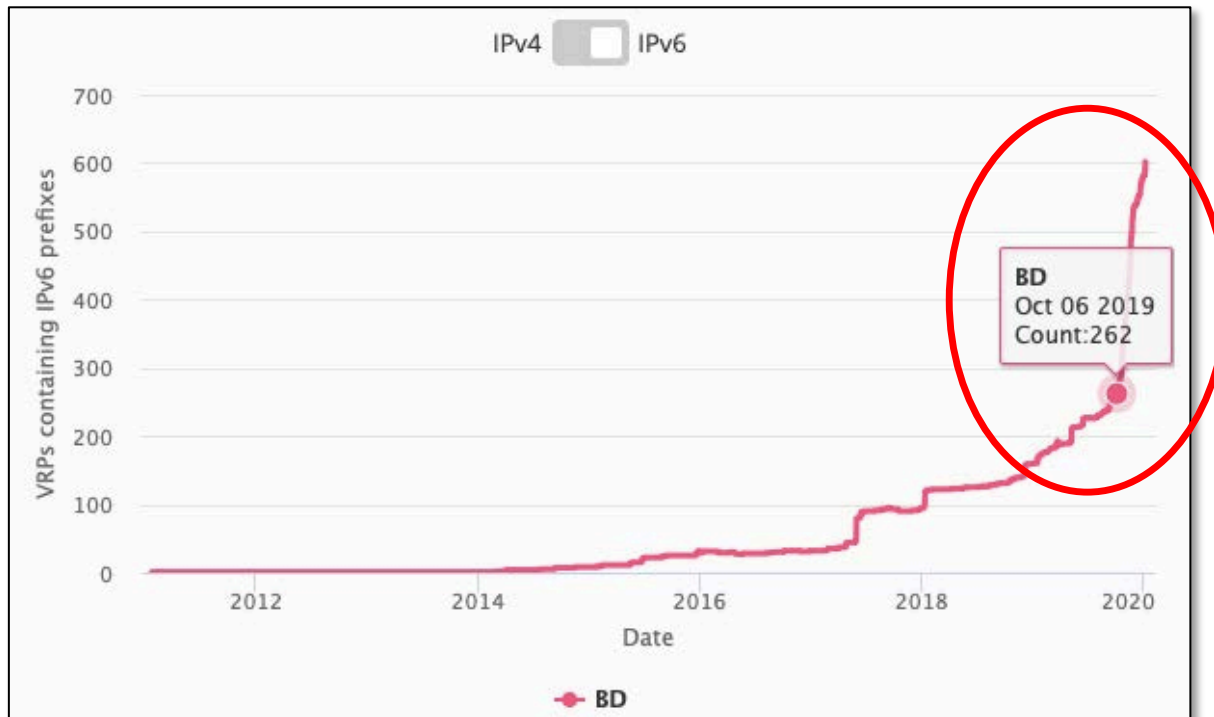
The impact of awareness campaign
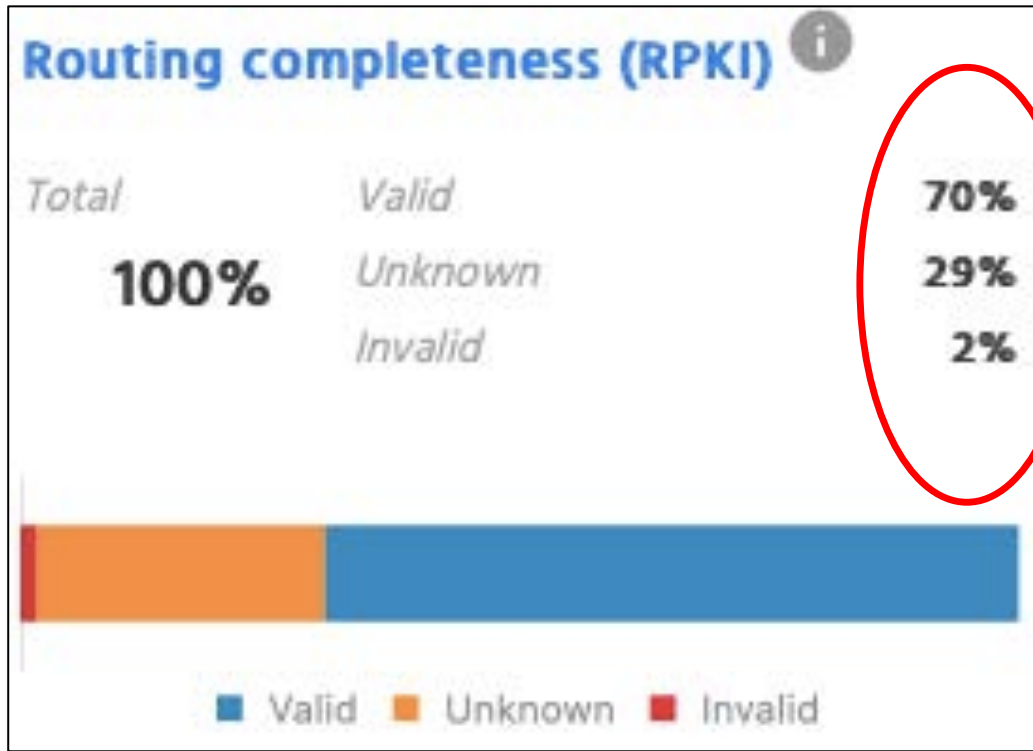
Routing completeness (RPKI) ⓘ

Total		
	Valid	70%
100%	Unknown	29%
	Invalid	2%

■ Valid ■ Unknown ■ Invalid

Dec 2019

Routing completeness (RPKI) ⓘ

Total		
	Valid	72%
100%	Unknown	27%
	Invalid	1%

■ Valid ■ Unknown ■ Invalid

Jan 2020

Source: https://observatory.manrs.org

The impact of awareness campaign

Source: https://stat.ripe.net/BD#tabId=routing

The impact of awareness campaign

The impact of awareness campaign

Source: https://stat.ripe.net/BD#tabId=routing
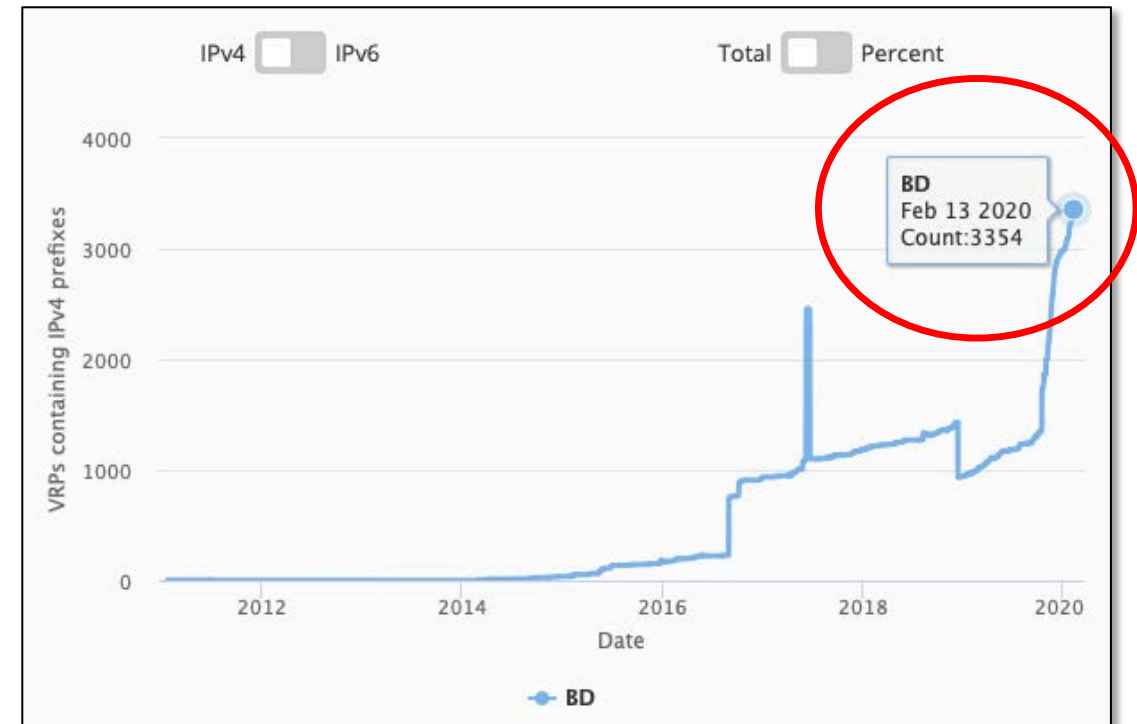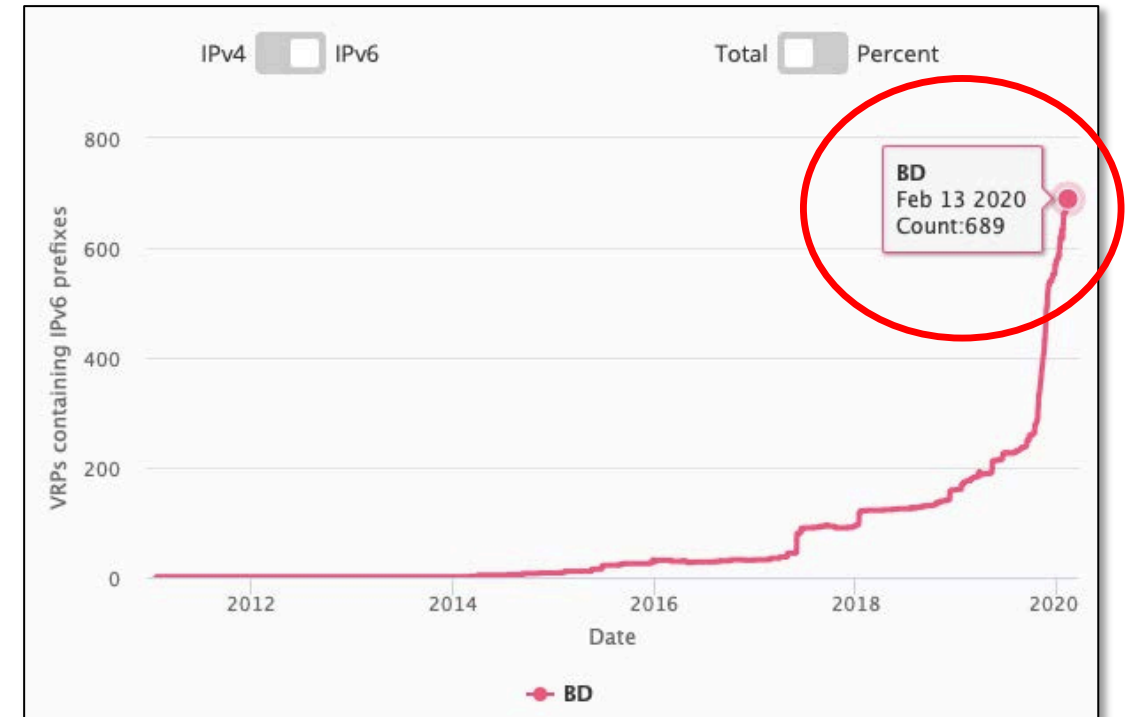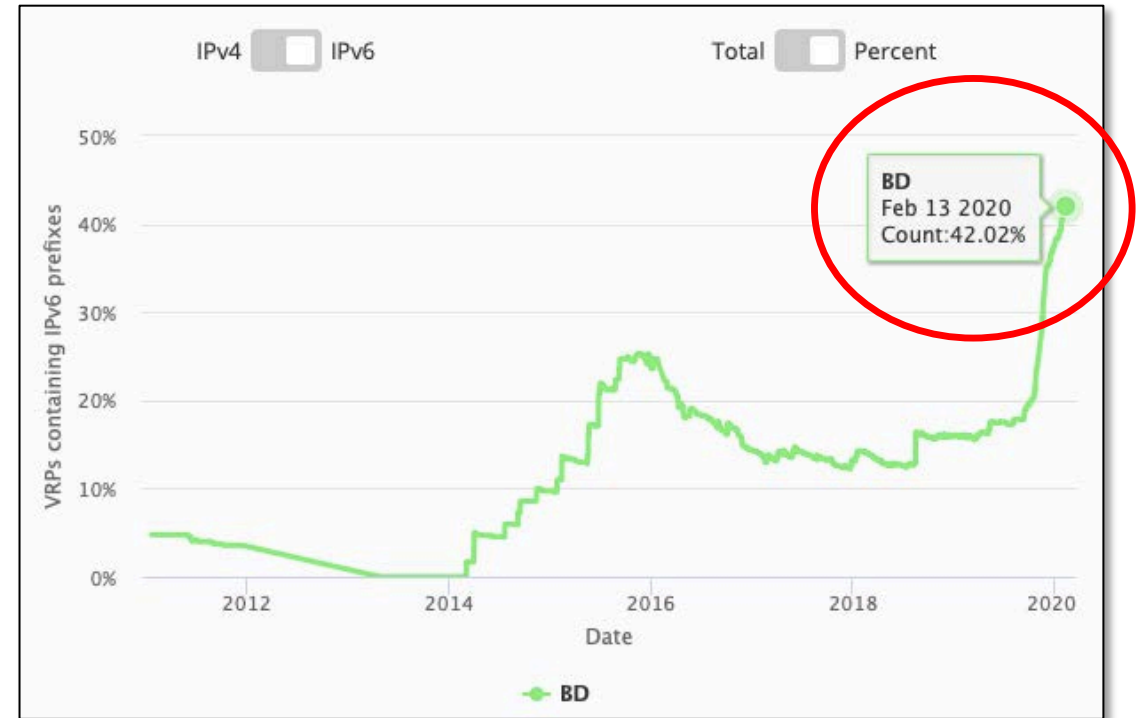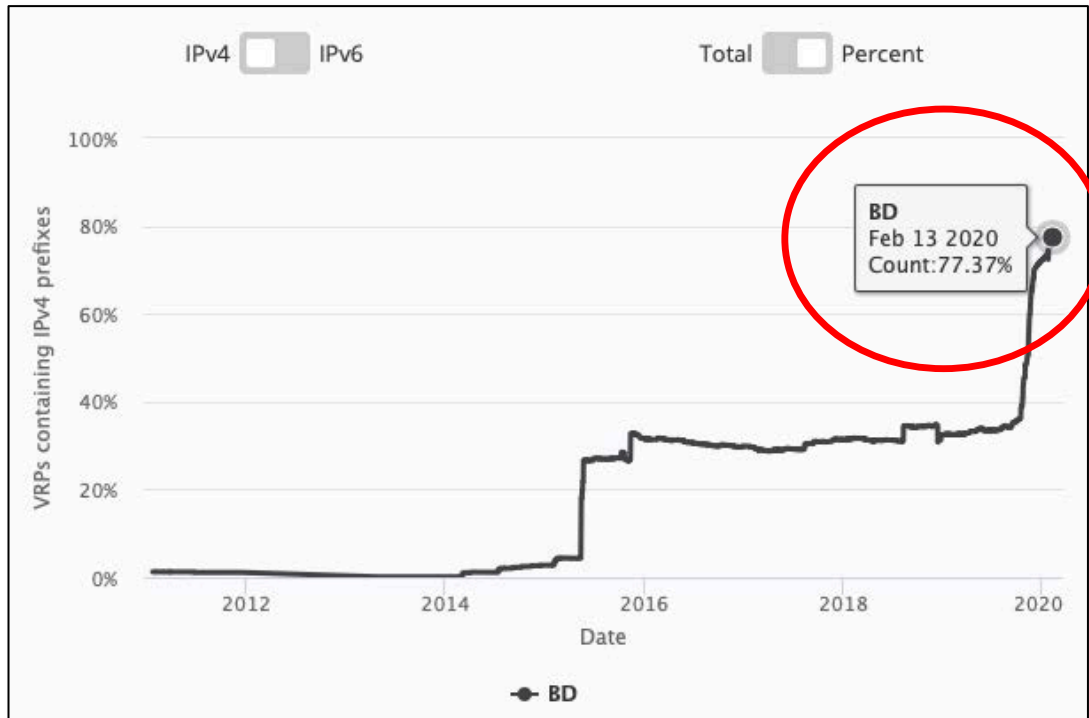
More organizations to start ROV

- BdREN (AS 63961)
- Summit Communications (AS 58717)
- BD Link (AS 58668)
- Link3 Technologies (AS 23688)
- Cybergate (AS 58599)

Considerations about ROA and ROV

Creating ROA

- Not a good idea to create ROAs up to /24 if not announced in BGP
- Better to create ROAs for specific prefixes that are announced in BGP

Creating ROA


```
awal@Awals-MacBook-Air ~> whois -h whois.bgpmon.net " --roa 17494 103.110.212.0/22"
0 - Valid
-----------------------
ROA Details
-----------------------
Origin ASN:        AS17494
Not valid Before: 2019-11-12 05:41:59
Not valid After:  2020-10-31 00:00:00   Expires in 323d5h27m43s
Trust Anchor:      rpki.apnic.net
Prefixes:          2407:5000:88::/48 (max length /48)
                   203.112.192.0/19 (max length /24)
                   2407:5000::/32 (max length /40)
                   103.110.212.0/22 (max length /24)
                   123.49.0.0/18 (max length /24)
                   180.211.128.0/17 (max length /24)
awal@Awals-MacBook-Air ~> whois -h whois.bgpmon.net " --roa 45588 103.110.212.0/22"
2 - Not Valid: Invalid Origin ASN, expected 17494
```

VS

```
awal@Awals-MacBook-Air ~> whois -h whois.bgpmon.net " --roa 17494 123.49.0.0/18"
0 - Valid
-----------------------
ROA Details
-----------------------
Origin ASN:        AS17494
Not valid Before: 2019-11-12 05:41:59
Not valid After:  2020-10-31 00:00:00   Expires in 323d5h31m22s
Trust Anchor:      rpki.apnic.net
Prefixes:          2407:5000:88::/48 (max length /48)
                   203.112.192.0/19 (max length /24)
                   2407:5000::/32 (max length /40)
                   103.110.212.0/22 (max length /24)
                   123.49.0.0/18 (max length /24)
                   180.211.128.0/17 (max length /24)
awal@Awals-MacBook-Air ~> whois -h whois.bgpmon.net " --roa 45588 123.49.0.0/18"
0 - Valid
-----------------------
ROA Details
-----------------------
Origin ASN:        AS45588
Not valid Before: 2019-11-12 05:42:00
Not valid After:  2020-10-31 00:00:00   Expires in 323d5h31m13s
Trust Anchor:      rpki.apnic.net
Prefixes:          123.49.0.0/18 (max length /24)
                   2407:5000:88::/48 (max length /48)
                   2407:5000::/32 (max length /40)
                   180.211.128.0/17 (max length /24)
                   203.112.192.0/19 (max length /24)
```

You may sign same prefix
with multiple ASNs but do if
you really really have to

Doing ROV

Validation with allowing invalids for BGP best path selection

VS

Validation without allowing invalids for BGP best path selection

ROA for Small ISPs and Enterprises

- Have own Internet resources?
  - Creating ROA is straightforward using RIR's resource management portal
- Got assignment for LIR?
  - Have public ASN?
    - Ask the LIR to create ROA with your ASN and verify
  - Don't have public ASN?
    - Ask the LIR to create ROA for the assigned prefix and verify

ROV for Small ISPs and Enterprises

- Have BGP with transits and peers?
  - Receive full routes from neighbors?
    - Implementing ROV using validator cache is straightforward
  - Receive partial routes with default from neighbors?
    - Ask transits to do ROV for you
    - And, implement ROV using validator cache to validate peer and IX routes
  - Receive default route only
    - ROV wouldn't fit, however, you may ask transits to do ROV in their routers ☺
- Have static routing with transits?
  - ROV wouldn't fit, however, you may ask transits to do ROV in their routers ☺

Still thinking why we need ROA and ROV?

- Check the issues discussed in first couple slides
- Reduce the opportunity of routing incidents, prefix hijacks, route leaks, DDoS, outages
- You wouldn't want to be a target of those incidents
- Help improve global routing infrastructure security
- Help each other to maintain routing hygiene
- We are engineers working hard to make Internet better, remember?

We all can help improve global routing security

- Create/fix ROAs for your prefixes
- If you are a transit provider, ask you clients to do the same
- If you're receiving BGP full route, implement ROV
- Share this among other colleagues in the community
- Help others fix their ROAs
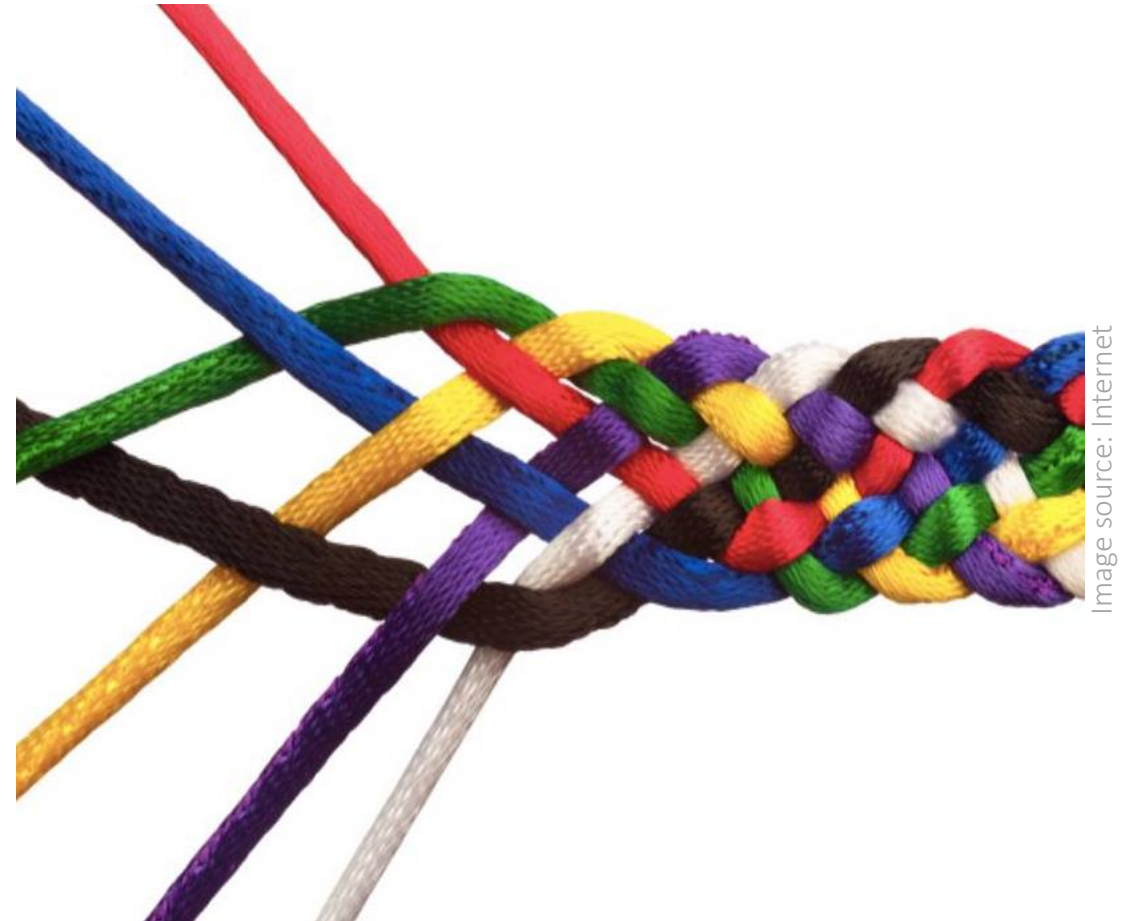
Image source: Internet

Let's check your own ASN

- Go to https://bgp.he.net , search for your AS number and check v4 and v6 prefixes

Or,

- Use whois on unix terminal:

```
whois -h whois.bgpmon.net " --roa ASN Prefix"
```

- If you find issues with ROA, please fix it

https://blog.apnic.net/2019/09/11/how-to-creating-rpki-roas-in-myapnic/

References

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3. https://www.manrs.org/manrs

4. https://blog.cloudflare.com/rpki-details/

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7. https://blog.apnic.net/2019/10/28/how-to-installing-an-rpki-validator/

8. https://blog.apnic.net/2019/09/11/how-to-creating-rpki-roas-in-myapnic/

9. https://www.apnic.net/wp-content/uploads/2017/12/ROUTE_MANAGEMENT_GUIDE.pdf

10. https://www.cirt.gov.bd/জাতীয়-ডাটা-সেন্টারে-আরপি/

Questions?