

# RPKI Ecosystem Measurement

RIPE / Rotterdam

2023.05.23

Romain Fontugne, Amreesh Phokeer, Cristel Pelsser,  
Kevin Vermeulen, & Randy Bush

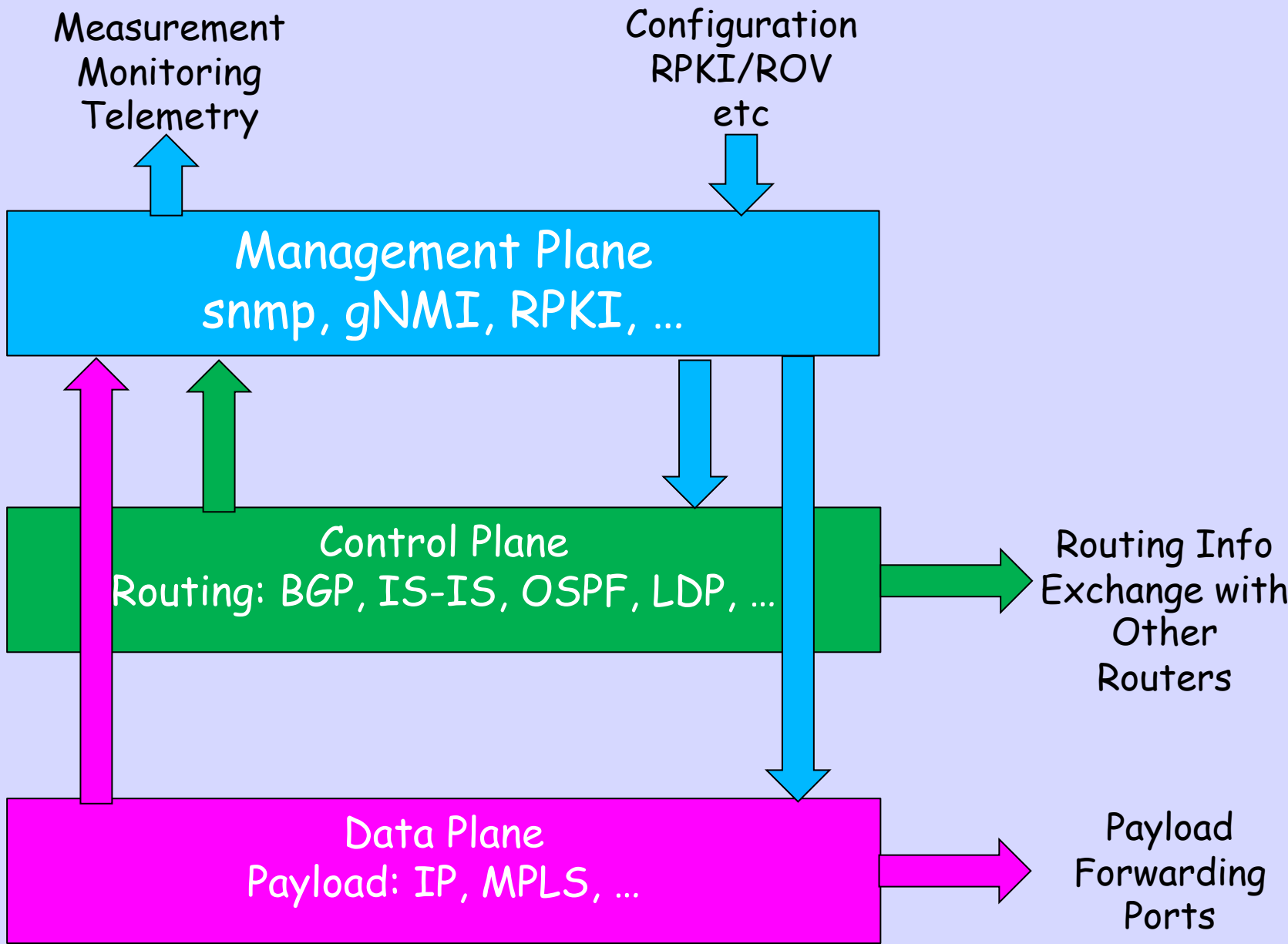
Romain had to present at  
PAM, an academic audience

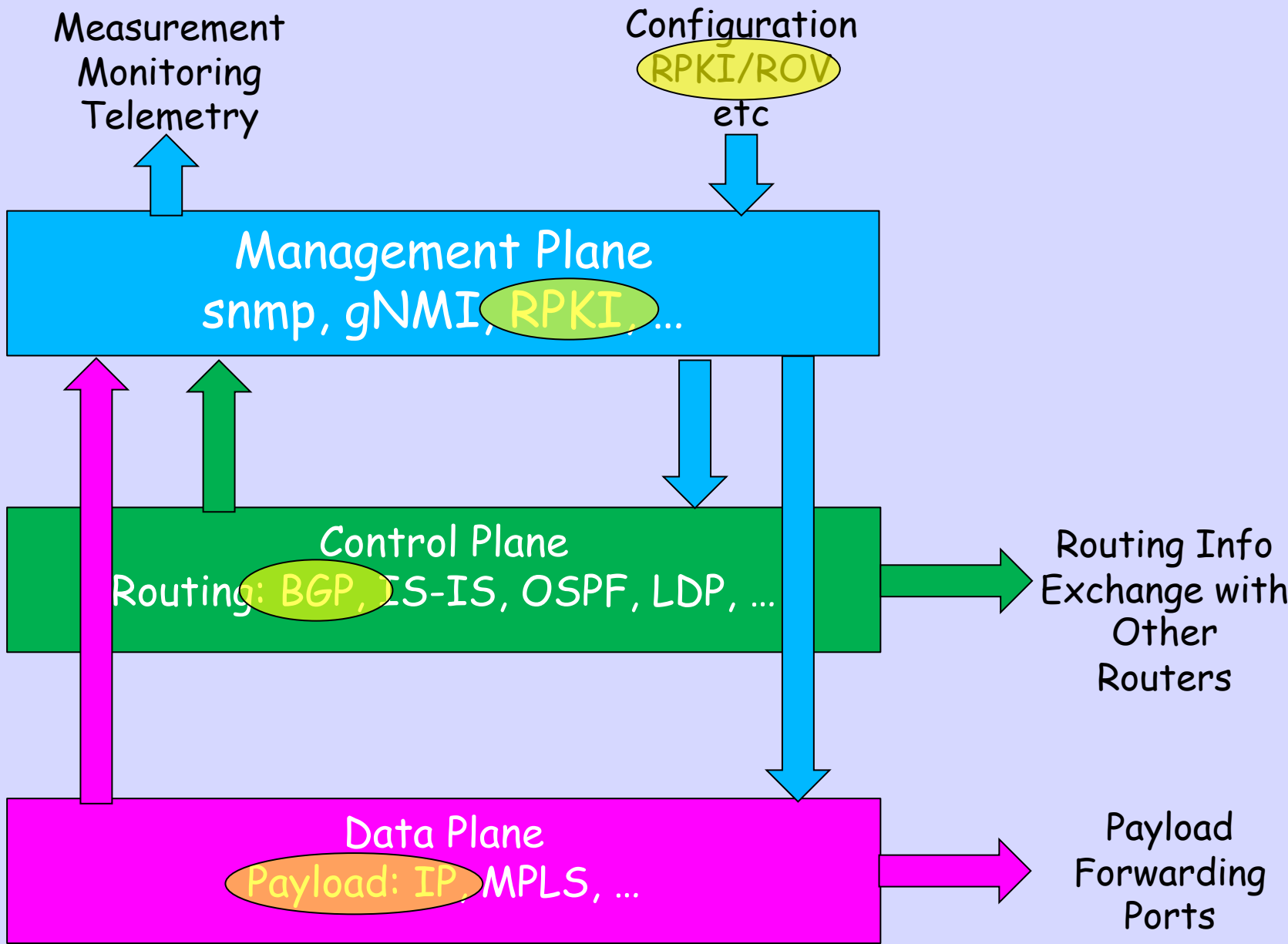
So first he had to describe  
the RPKI

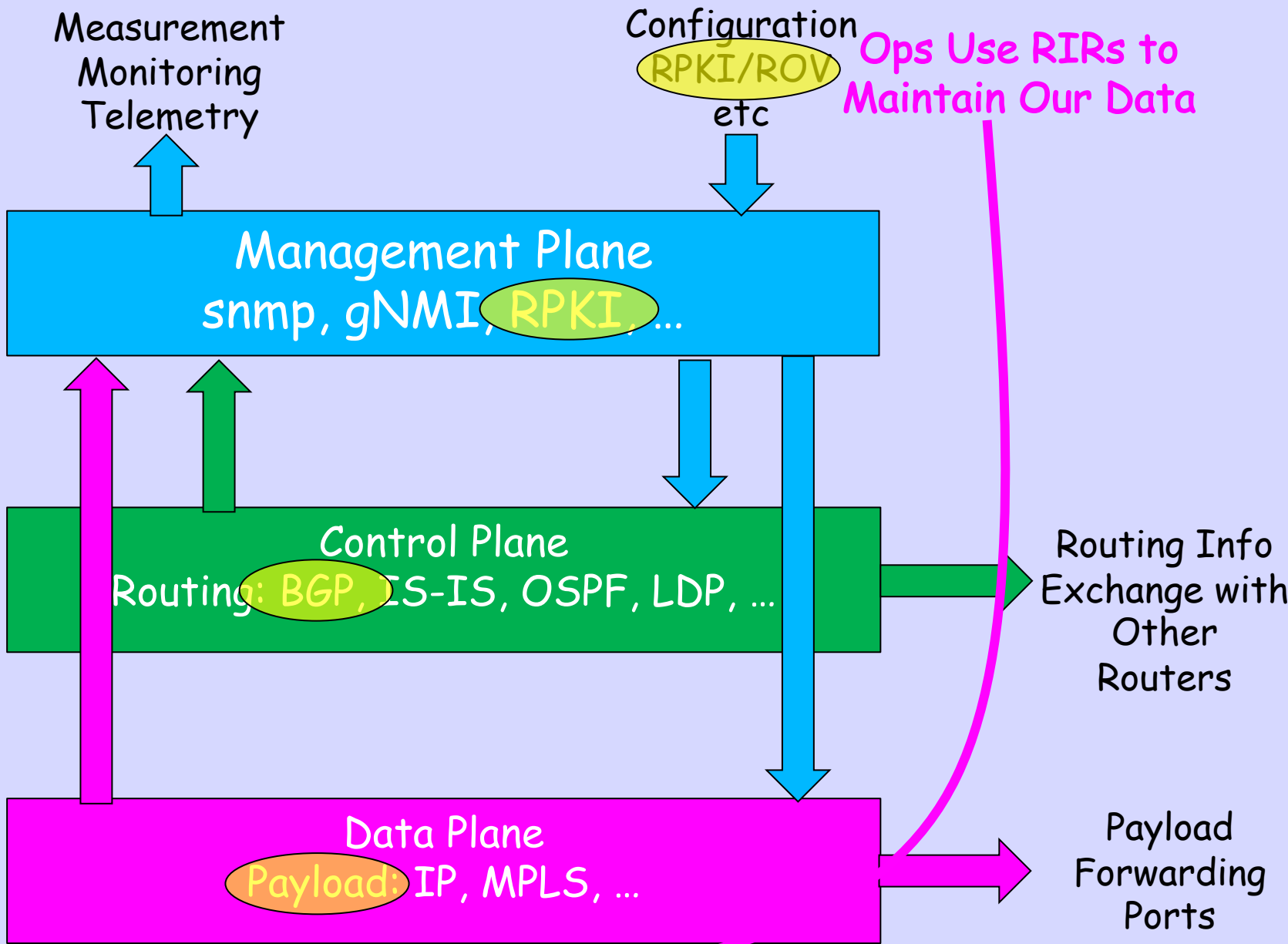
# RPKI is Complex



*Into the Future with the Internet Vendor Task Force A Very Curmudgeonly View or Testing Spaghetti — A Wall's Point of View*  
ACM SIGCOMM Computer Communication Review Volume 35, Number 5, October 2005



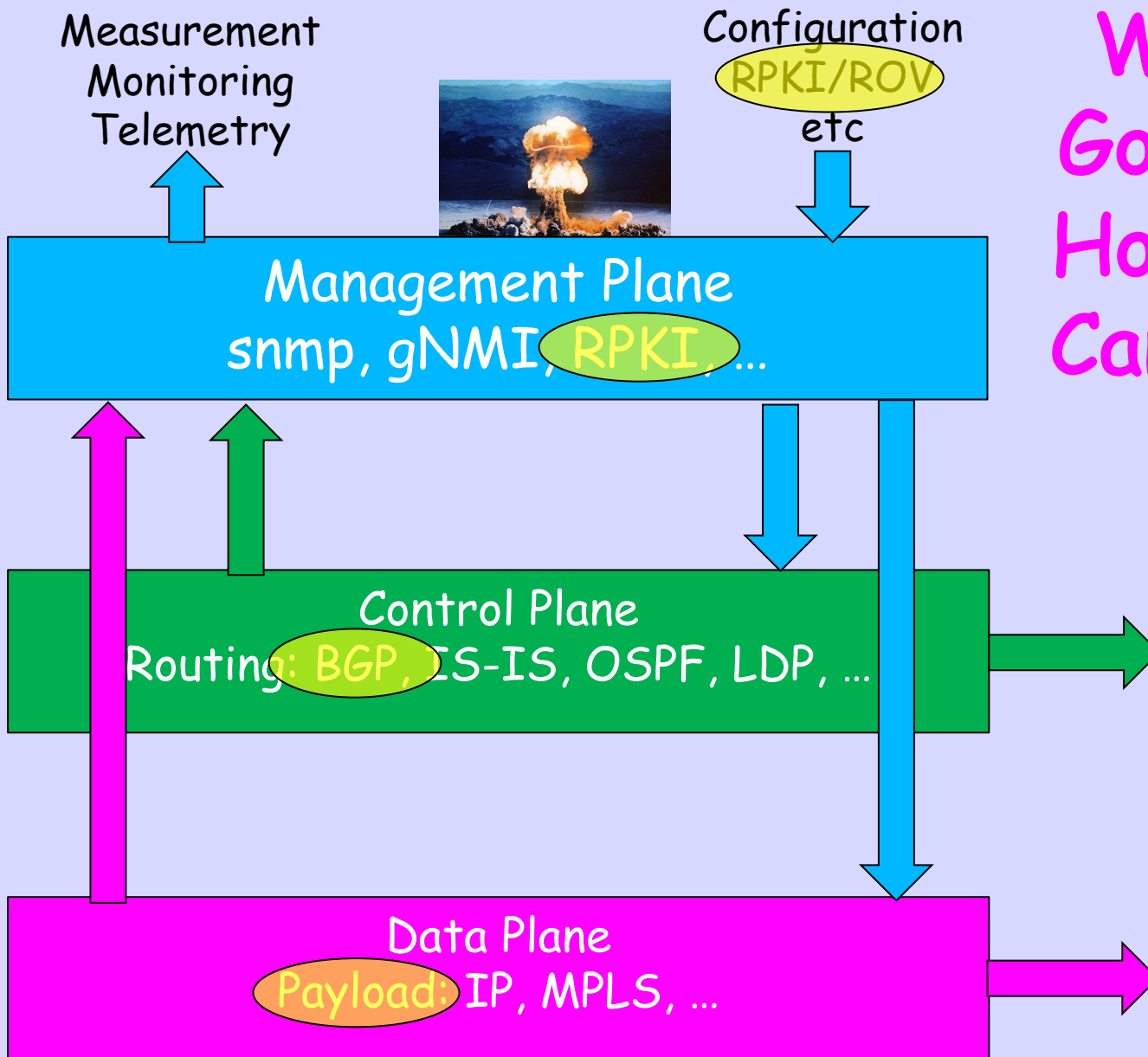




Ops Use RIRs to Maintain Our Data

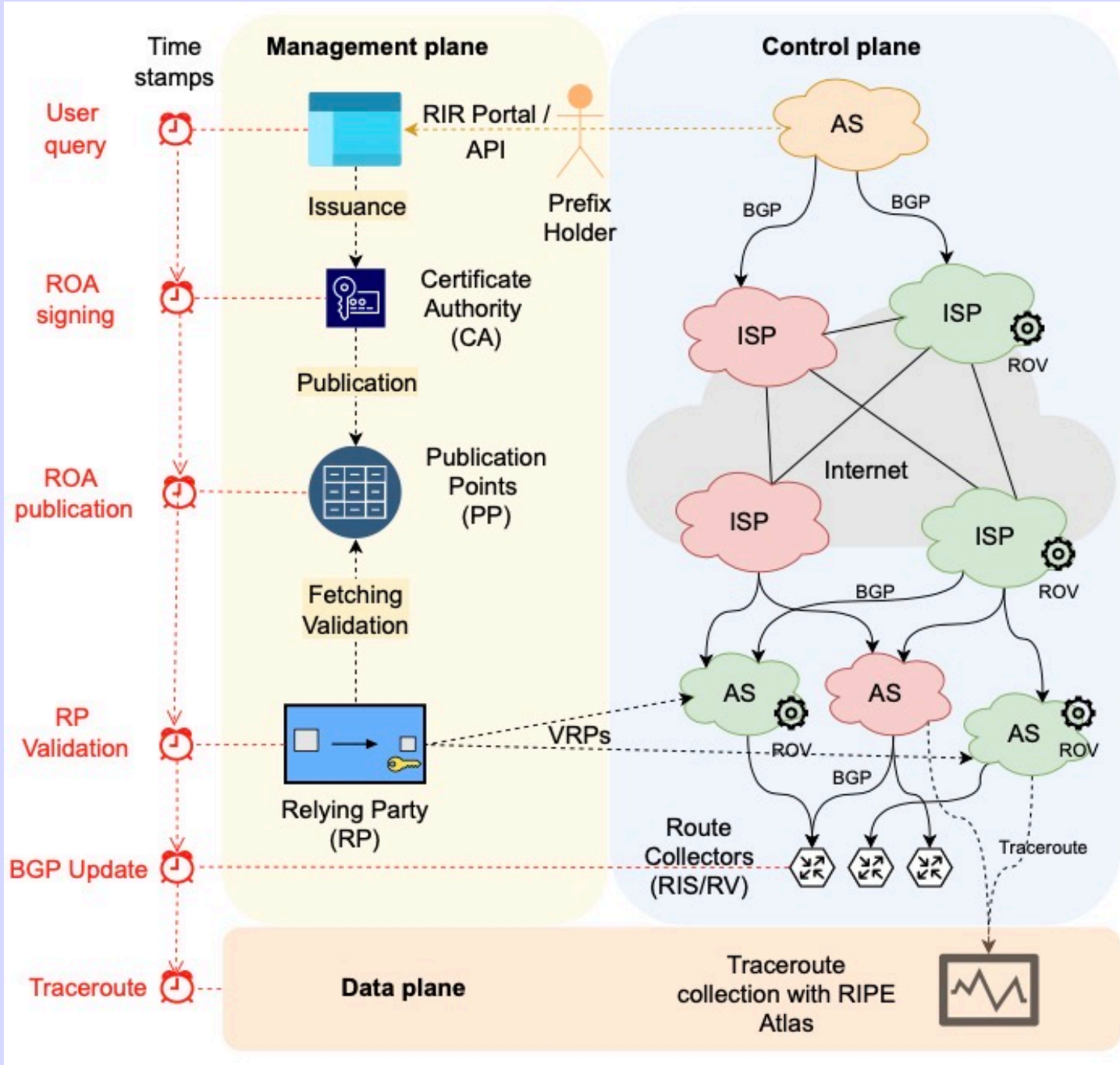
The Money is Here 😊

When this  
Goes Wrong  
How Quickly  
Can I Fix it?



So Let's  
Measure





# The Experiment(s)

# Prefixes

- Each of the Five RIRs loaned us a set of IPv4 /24s and IPv6 /48s
- Prefixes were announced from one AS with ROV upstreams and some direct IX peers which were non-ROV
- Another set of RIPE prefixes from 3 ASs fed by non-ROV upstreams
- Measurements taken over eleven months

# ROA Beacons

- Used API or GUI screen-scraper at each RIR to Create and Delete ROAs
- Control /24s and /48s have non-varying 'good' ROAs, always Valid
- Test /24 and /48 always have an Invalidating ROA
- Then We Announced a Validating ROA once per day for half a day

# ROA Creation Delay (min)

	Sign*	NotBefore*	Publication†	Relying Party†	BGP‡
AFRINIC	0 (0)	0 (0)	3 (2)	14 (13)	15 (16)
APNIC	10 (13)	10 (13)	14 (16)	34 (38)	26 (28)
ARIN	- (-)	- (-)	69 (97)	81 (109)	95 (143)
LACNIC	0 (0)	- (-)	54 (32)	66 (42)	51 (34)
RIPE	0 (0)	0 (0)	4 (4)	14 (13)	18 (18)
After fix:					
ARIN	- (-)	- (-)	8 (9)	21 (22)	28 (23)

- APNIC always waits for 20 minute batches (mean 10 min)
- ARIN and LacNIC were signing in GMT (HSM)
  - But publishing in Local Time; therefore
  - NotBefore appeared to be hours before publication
  - We reported, they hacked a work-around

# ROA Creation Delay

- Creation times vary significantly across RIRs, with medians ranging from a few minutes to over an hour for new ROAs to reach the publication points
- And we know of at least one NIR (not RIR) that only publishes once per day!
- Originally, APNIC only committed to once a day

# Measurement Relying Party

- One instance of RP software
- See Philip Smith's measurements on how RPs vary 😞
- We did not run RPKI-Rtr, because we were more interested in effect on BGP
- Some RPs have HeadOfLineBlocking trying to fetch from bad Publication Points

# RIPE/RIS Collectors

- Recorded Control and Test at RIPE/RIS
- If Control missing, that measurement is discarded
- This measures control plane, BGP, effect
- Used two collectors, RRC00 and RRC01. Studies have shown that's enough
- Has all the biases discussed for years

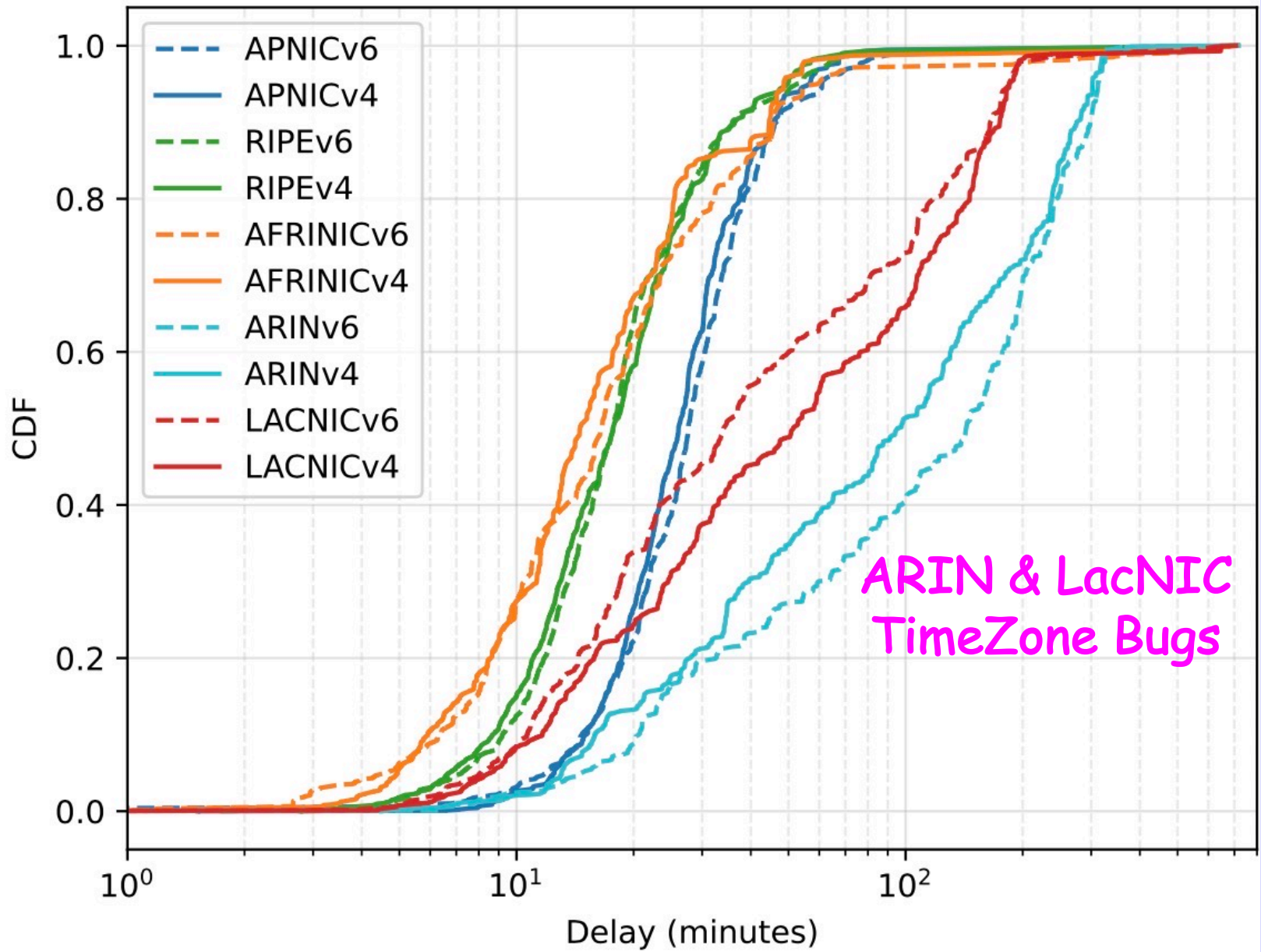


# ROA Revoke Delay (min)

	Revocation*	Relying Party†	BGP‡
AFRINIC	0 (0)	13 (14)	34 (38)
APNIC	10 (12)	31 (36)	51 (56)
ARIN	0 (0)	14 (16)	45 (51)
LACNIC	0 (0)	18 (20)	48 (49)
RIPE	0 (0)	14 (13)	41 (50)

Additional APNIC delay possibly due to RP hanging  
Plus APNIC has that 20 minute batching delay

# User query to BGP update delay - All peers

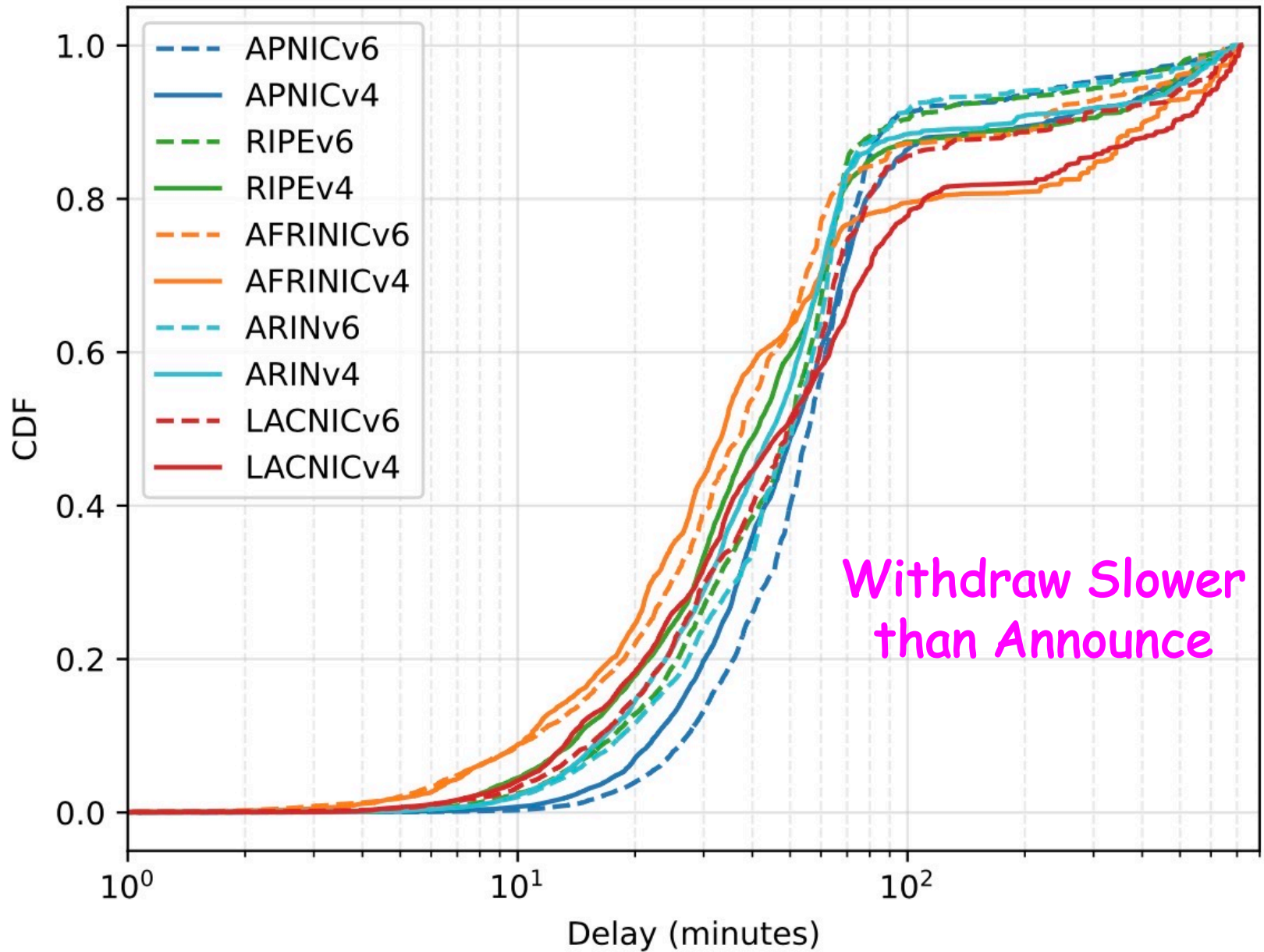


ARIN & LacNIC  
Timezone Bugs

# TimeZone Bugs

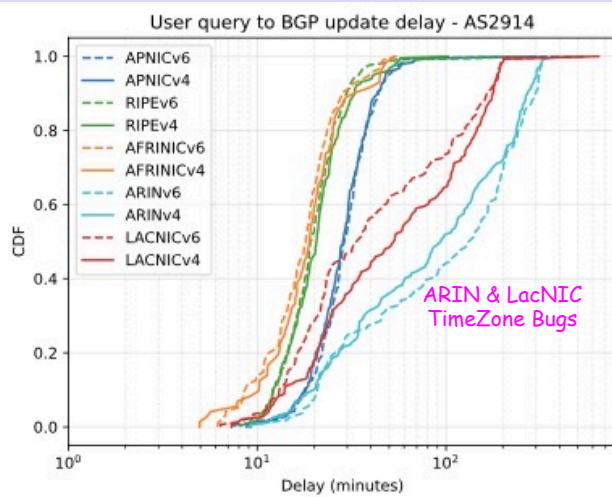
- Your HSM is Going to be in GMT
- That is a Fact of Life
- So Do Not Run Your Signer in any Time Zone other than GMT
- Or Your Signing Time and the NotBefore will be Mis-Aligned

# User query to BGP withdraw delay - All peers

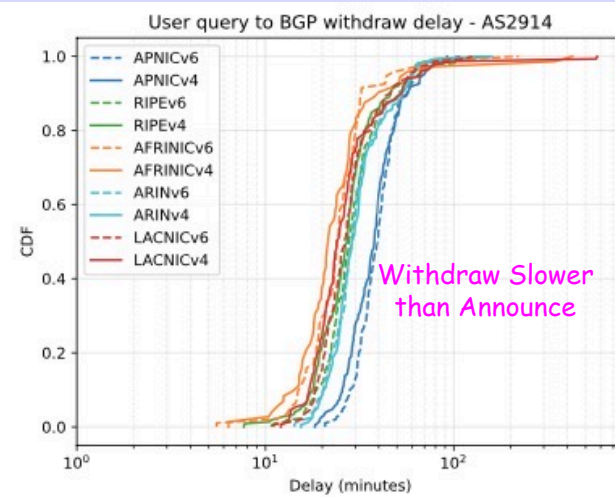


# Withdrawals are Slower

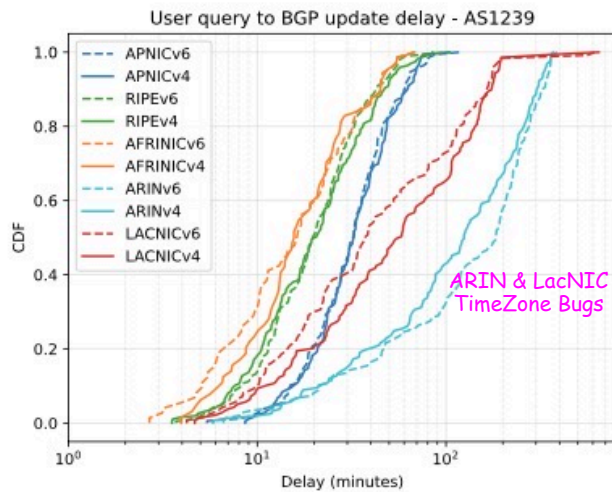
- ROV only needs one Validating ROA
- So only one cache needs to have a ROA for the router to Validate
- But all of the router's caches must have received the Withdraw from the PPs to Invalidate



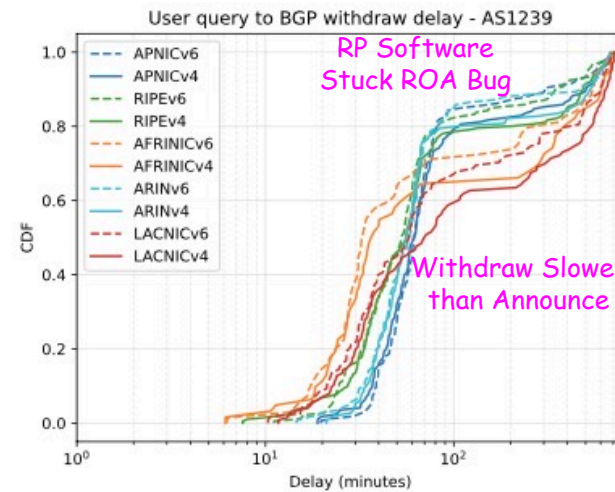
(a) ROA creation: NTT (AS2914).



(b) ROA deletion: NTT (AS2914).



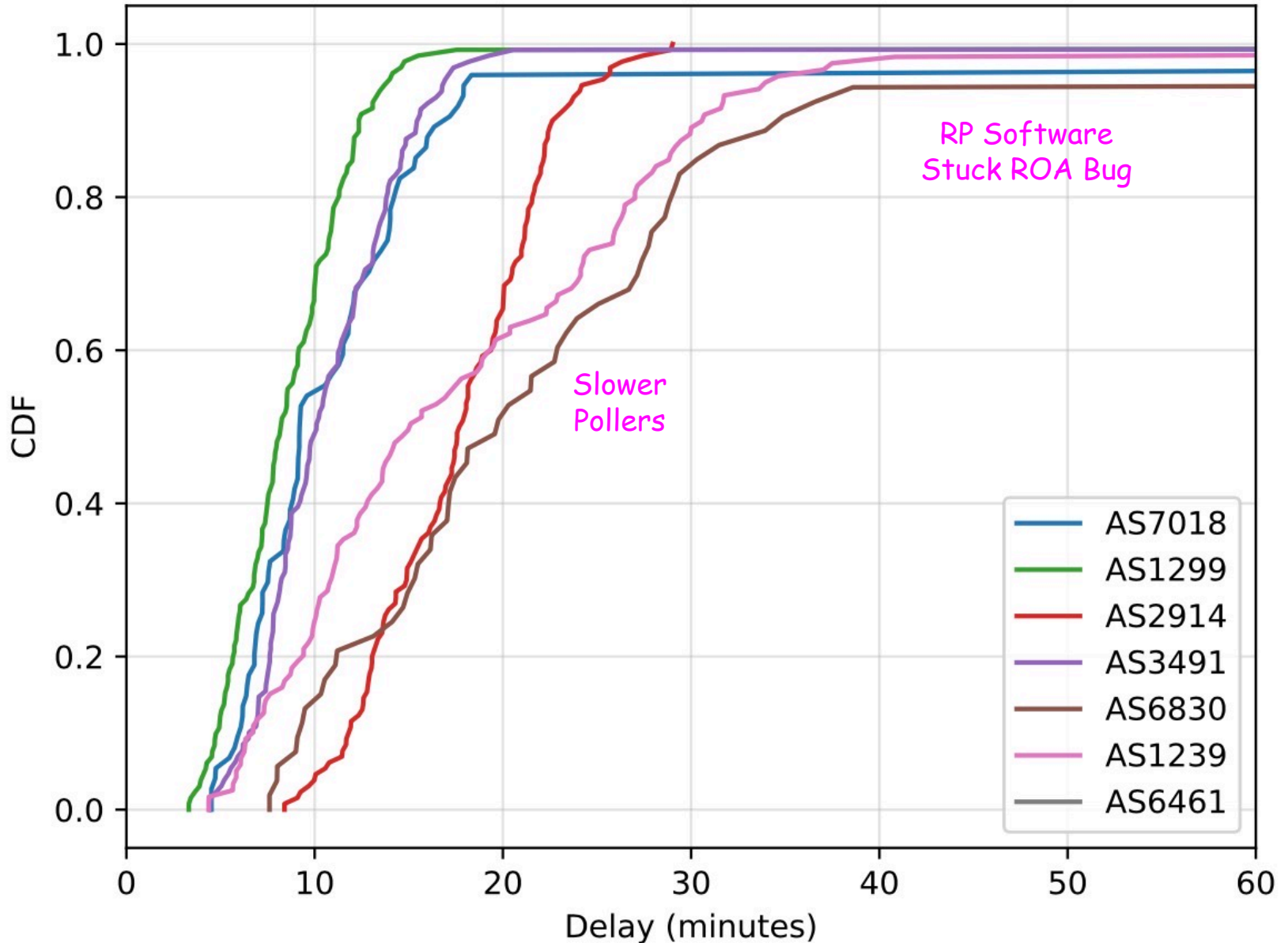
(c) ROA creation: Sprint (AS1239).



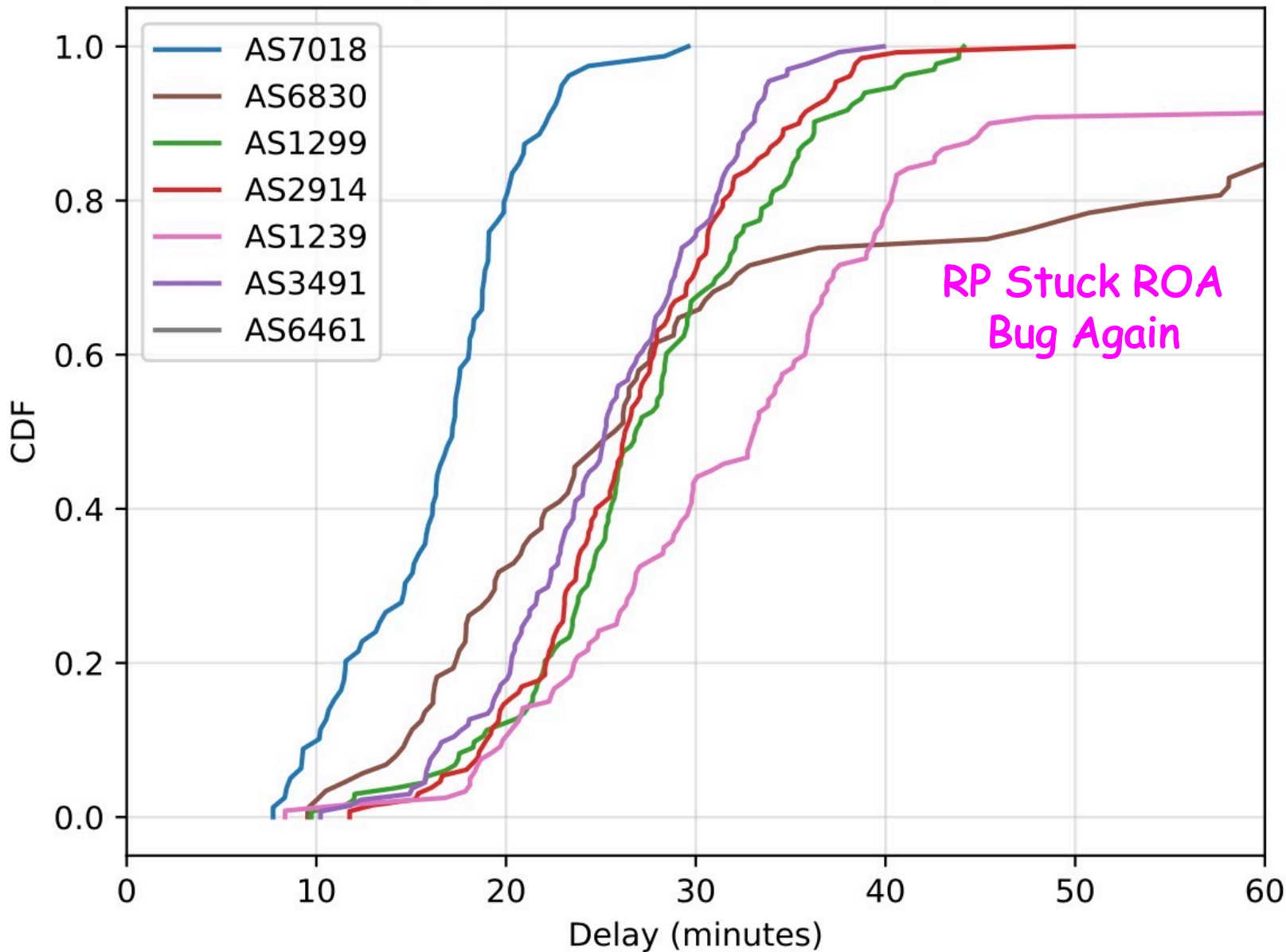
(d) ROA deletion: Sprint (AS1239).

Sprint's slower curve because RPs pull less frequently than NTT's, &/or sucky RP software  
 Sprint starts a bit earlier because routers poll RP caches more frequently than NTT's  
 Confirmed with friends at Sprint and NTT

# User query to BGP update delay - Tier1



# User query to BGP withdraw delay - Tier1



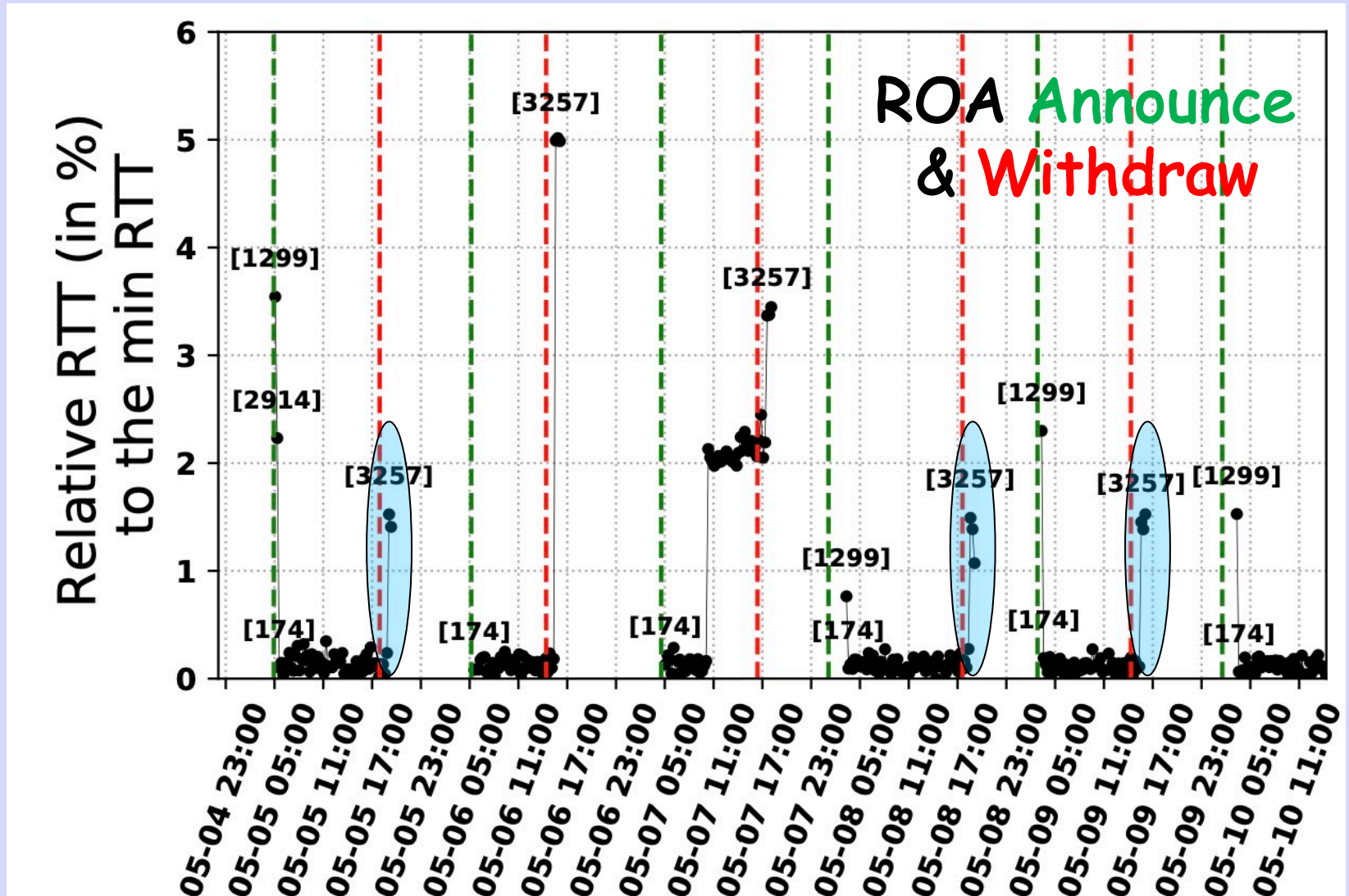
RP Stuck ROA  
Bug Again



# Data Plane Measurement

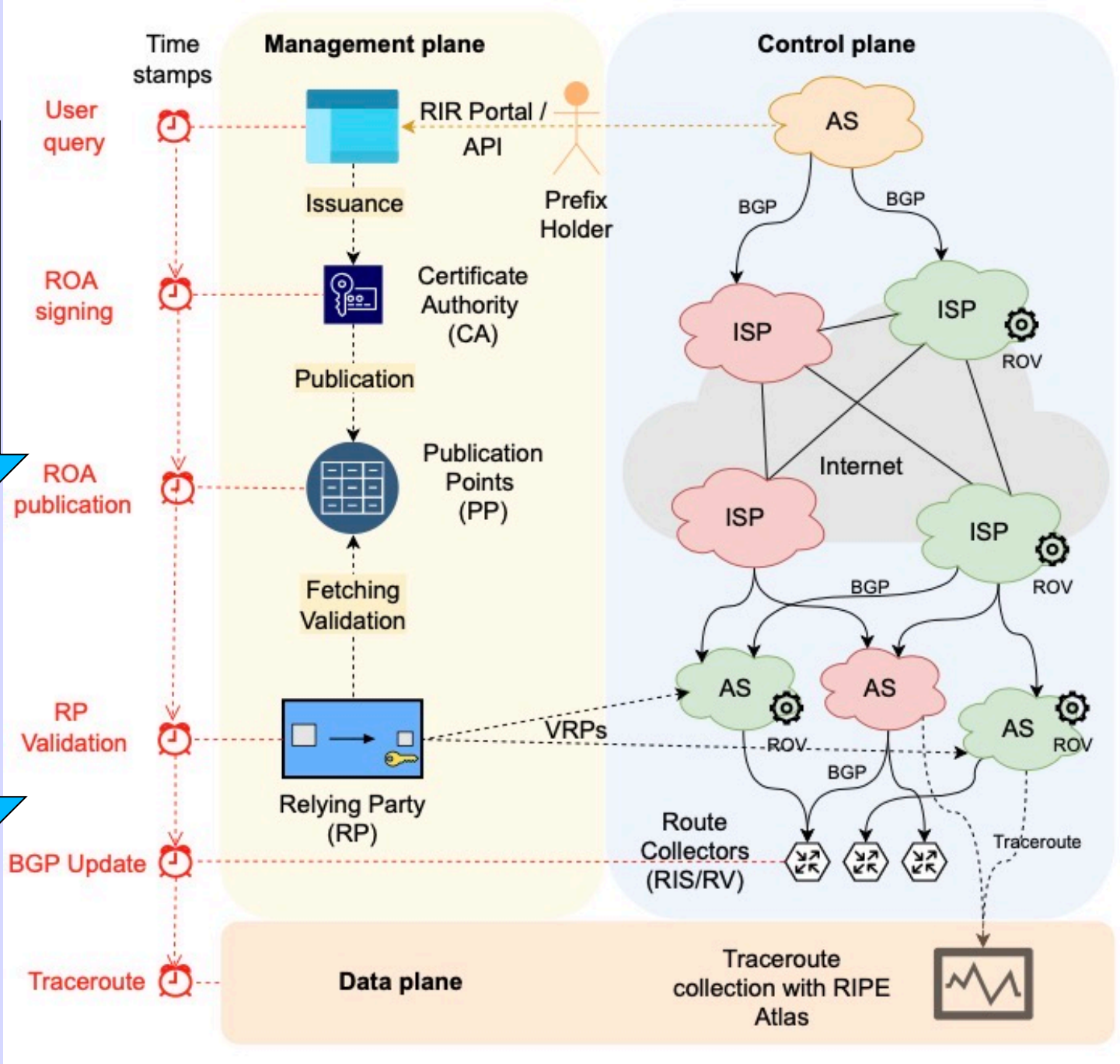
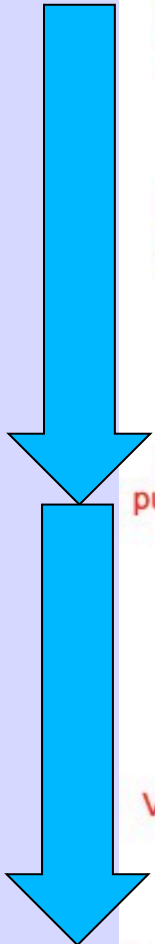
- Ran *traceroute* from Atlas Probes
- To the Test prefixes
- Every 15 minutes
- Result similar to BGP at RIPE/RIS, but
- Path hunting after a Withdraw is beautifully obvious

# Data Plane & Path Hunting



RIR Delay

ISP Delay



# ISP Polling Delay Is Big

	Sign*	NotBefore*	Publication†	Relying Party†	BGP‡
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Assume ARIN and LacNIC  
TimeZone anomalies are fixed

# Problems

- BGP propagates in minutes. RPKI propagates in  $O(\text{hour})$ . This has business impacts, e.g.
  - Time to Repair for a bad ROA
  - Time to authorize a DDoS mitigator
- Two RIRs with HSM in GMT and CAs in Local Time Zone. Reported and 'fixed'
- Some RPs Head of Line Block on Slow PPs
- ROA Anatomy varies between RIRs

# Limitations of Study

- Relying Party software:
  - Fixed fetch rate so poor resolution
  - Only one RP software package used
- Did not measure RP to Router. But that is Notify driven so *should be fast*
- Did not measure delegated CAs
- RIR API/Screen-Scrape Unreliable

# From the Paper in PAM 2023

## RPKI Time-of-Flight: Tracking Delays in the Management, Control, and Data Planes

Romain Fontugne<sup>1</sup>, Amreesh Phokeer<sup>2</sup>, Cristel Pelsser<sup>3</sup>, Kevin Vermeulen<sup>4</sup>,  
and Randy Bush<sup>1,5</sup>

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**Abstract.** As RPKI is becoming part of ISPs' daily operations and Route Origin Validation is getting widely deployed, one wonders how long it takes for the effect of RPKI changes to appear in the data plane.

<https://archive.psg.com/pam2023-rov-ecosystem.pdf>

# What We Can Do?

- CAs/RIRs Publish Very Frequently
- RPs Poll 10 mins or more frequently when using RRDP
- Caching and If-Modified-Since means the load on PPs is negligible
- RPs poll frequently, but not too frequently, if rsync. Maybe 30 mins
- Yes, this discourages rsync



# As Protocol Designers

- BGP is the only large scale 'push' protocol we have, but
- BGP Transport is
  - Dangerously Shared Fate
  - Unordered, Reordering is Guaranteed
- DNS does not handle Make Before Break  
draft-bates-bgp4-nlri-orig-verif (1998)

We Fantasize About a  
Flooding Protocol  
for the Inter-Provider  
Management Plane  
That Is  
Immune to Routing Attack

# A Warning

# Bert Hubert in 2018



MARCH 22, 2018

## **“The DNS Camel”, or, the rise in DNS complexity**

This week was my first IETF visit. Although I’ve been active in several IETF WGs for nearly twenty years, I had never bothered to show up in person. I now realize this was a very big mistake – I thoroughly enjoyed meeting an extremely high concentration of capable and committed people. While RIPE, various NOG/NOFs and DNS-OARC are great venues as well, nothing is quite the circus of activity that an IETF meeting is. Much recommended!

# But 18 Years Earlier

## The DNS Today Are we Overloading the Saddlebags on an Old Horse?

Randy Bush <randy@psg.com>  
IETF / San Diego 00.12.13

The computing scientist's main challenge  
is not to get confused by the  
complexities of his own making  
-- E. W. Dijkstra

# Permissionless Research

## Thanks To

Arrcus  
Cisco  
Equinix  
Google  
Juniper  
NTT  
Sprint

For Donated

- Rack Space
- Bandwidth
- Routers
- Switches
- Servers
- Etc. Etc.

# Questions?

And Position Statements Pretending  
to be Questions 😊