

Route Flap Damping: Through a Glass Darkly

ACDCN 2020

2020 Jan 20

*Clemens Mosig, Randy Bush , Cristel Pelsser ,
Thomas Schmidt, Matthias Wählisch*

Agenda

- Background
 - BGP, ASs, Propagation, Best Path Hiding
 - Visibility, Collectors, and ViewPoints
 - Update Noise, Route Flap Damping
- The Bad Boys Room: *What We See vs Why*
- Experimental Set-up: Beacons, Collectors
- Preliminary Results
- Open Issues

Starting Point

Internet routing is about **reachability**.

Some mechanisms suppress routes and thus reachability

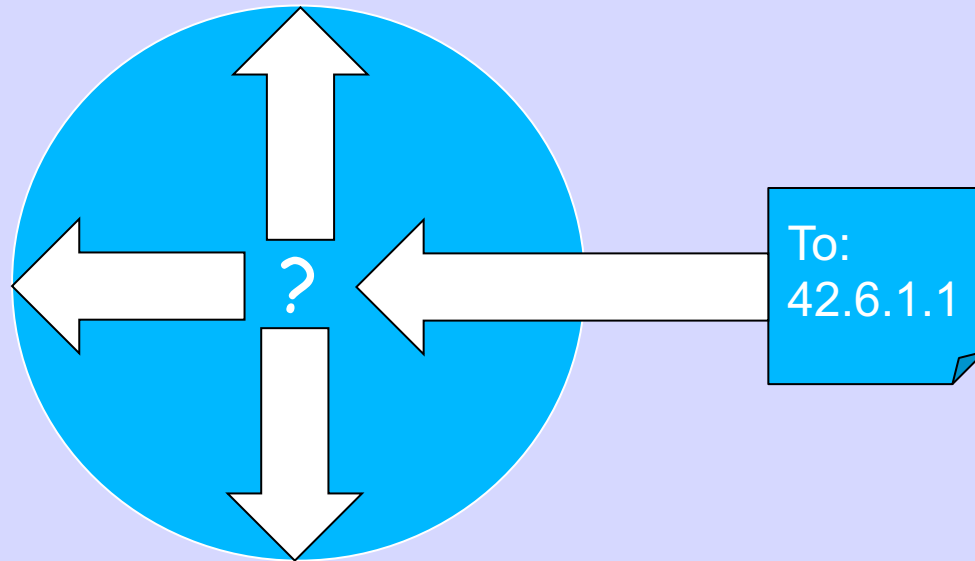
Is this good, bad, or ugly?

Can we measure the reason for suppression?

Border Gateway Protocol

There are $O(10^6)$ routers on the Internet

How does a router decide where to send a packet?



Forwarding Table

IP Address Outgoing Interface Packet Forwarding is
The *Data Plane*

1.2.3.4

B

4.3.2.1

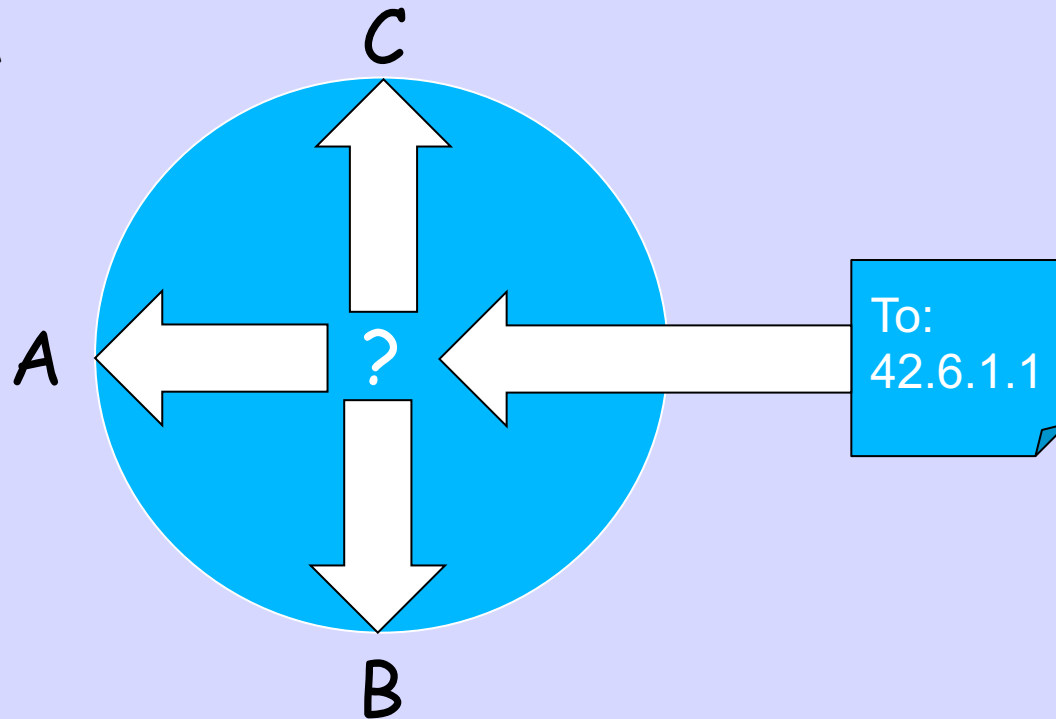
C

42.6.1.1

A

7.11.12.13

B



Control Plane: BGP

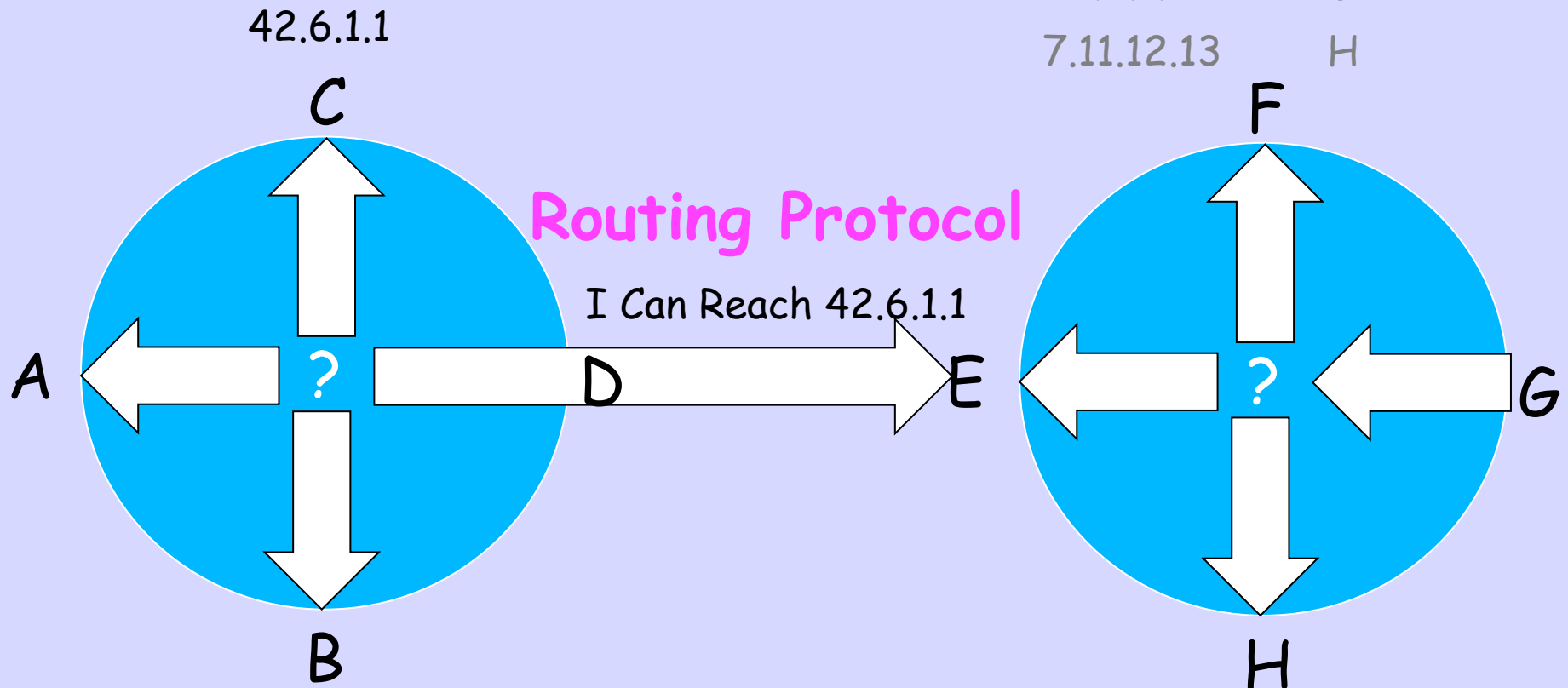
IP Address Destination

1.2.3.4 F

4.3.2.1 G

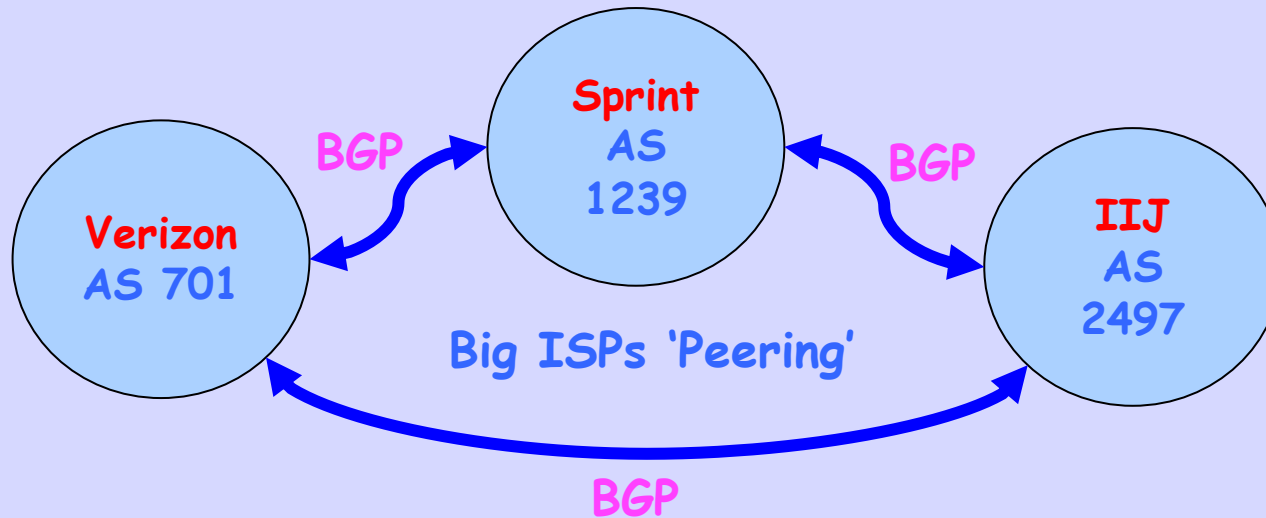
42.6.1.1 D

7.11.12.13 H



Autonomous System (AS)

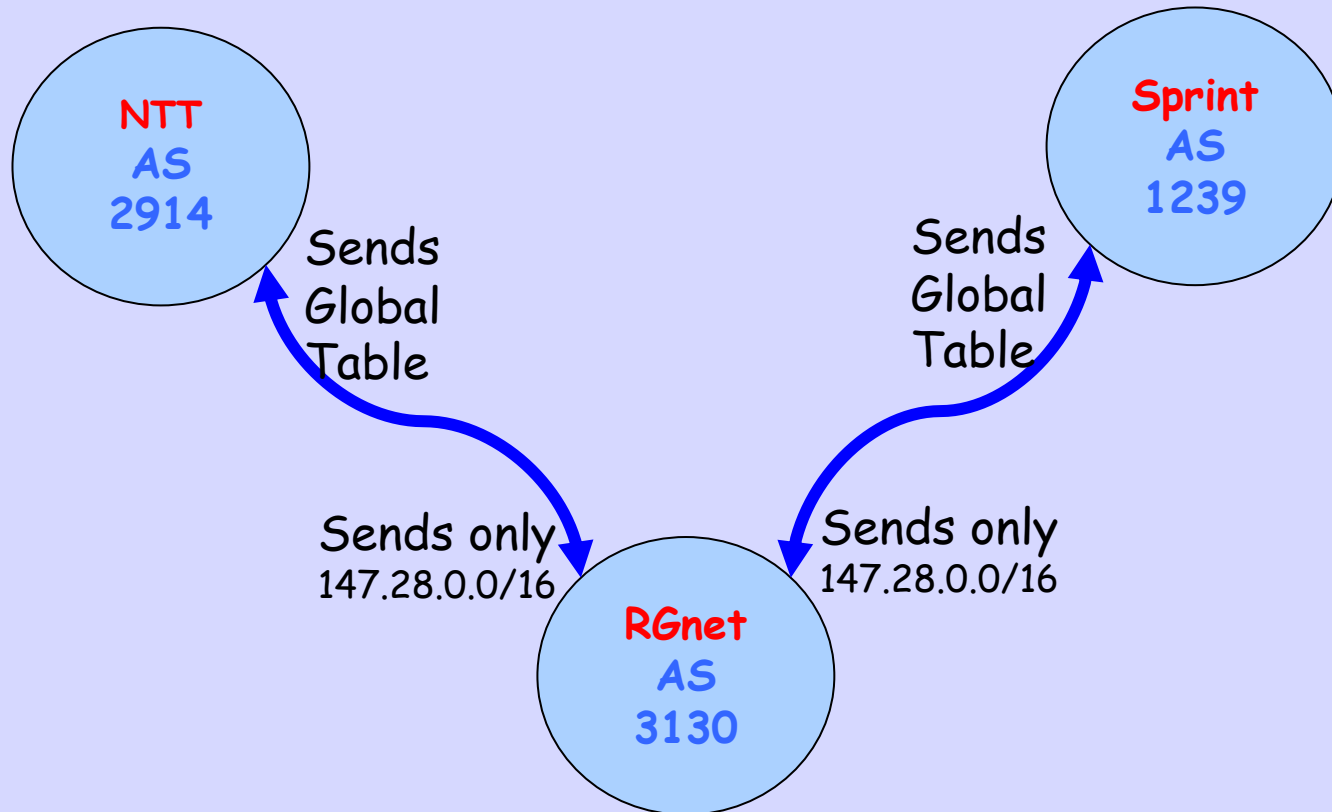
Big ISPs



Border Gateway Protocol

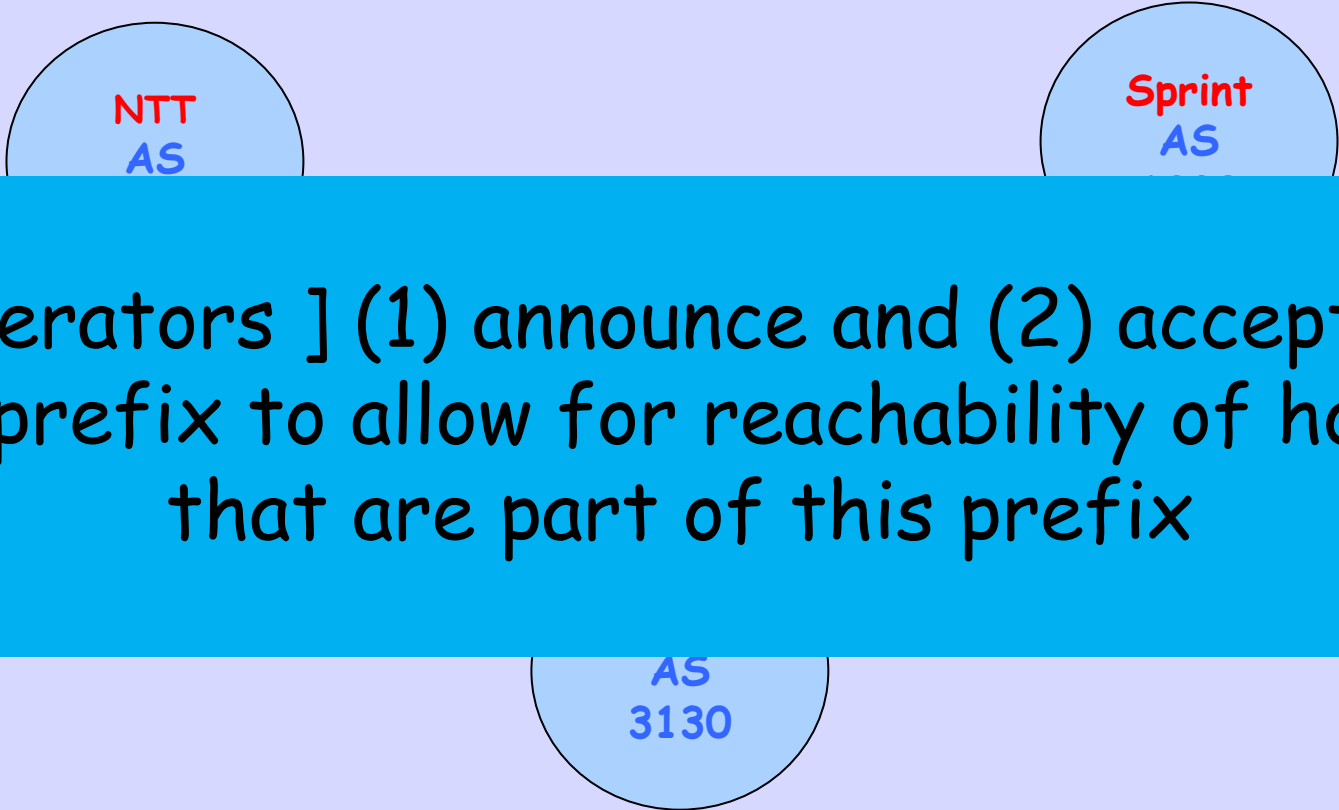
Autonomous System (AS)

An End Site



Autonomous System (AS)

An End Site



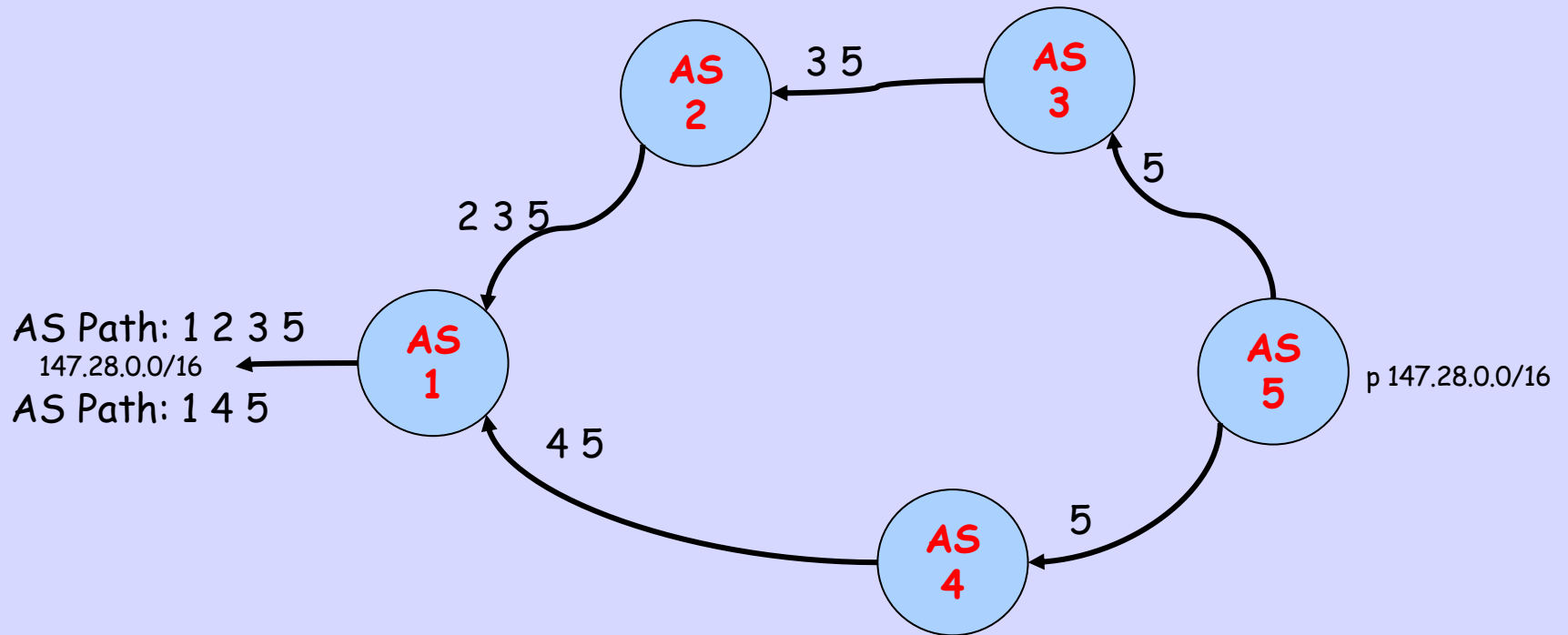
NTT
AS

Sprint
AS

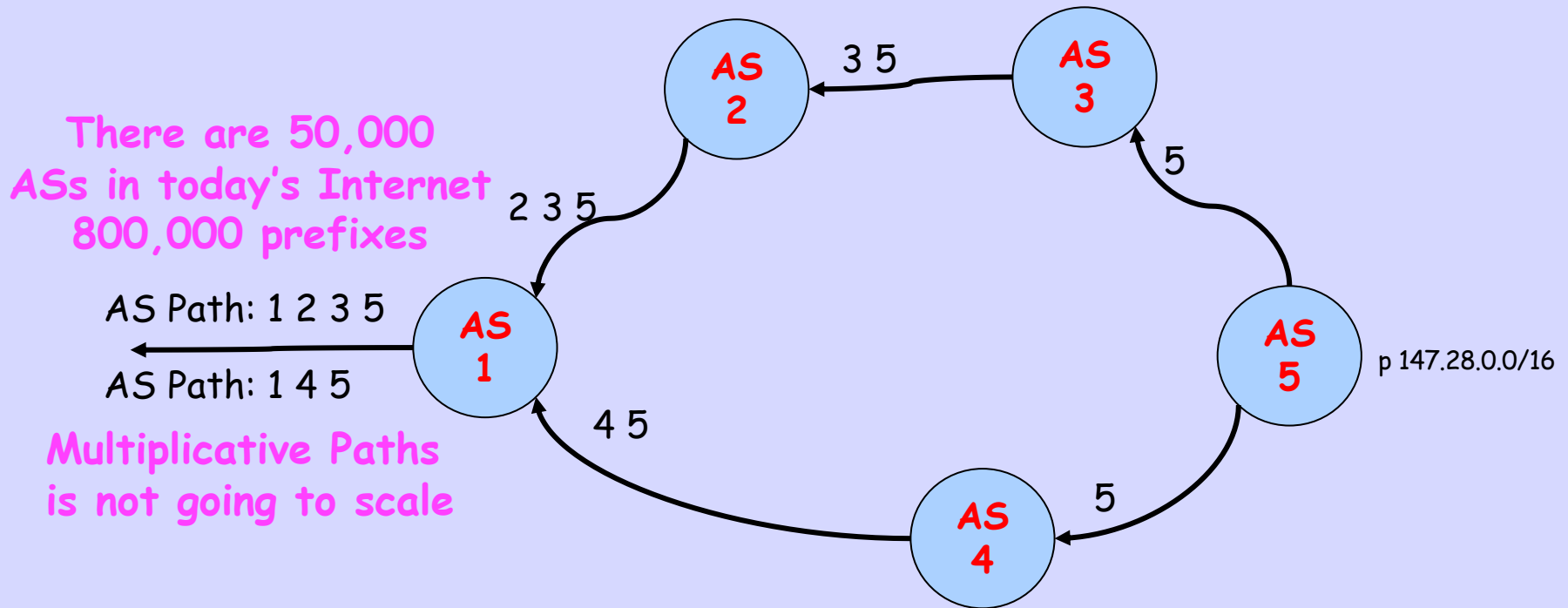
Operators] (1) announce and (2) accept an IP prefix to allow for reachability of hosts that are part of this prefix

AS
3130

AS Paths



A Scaling Problem



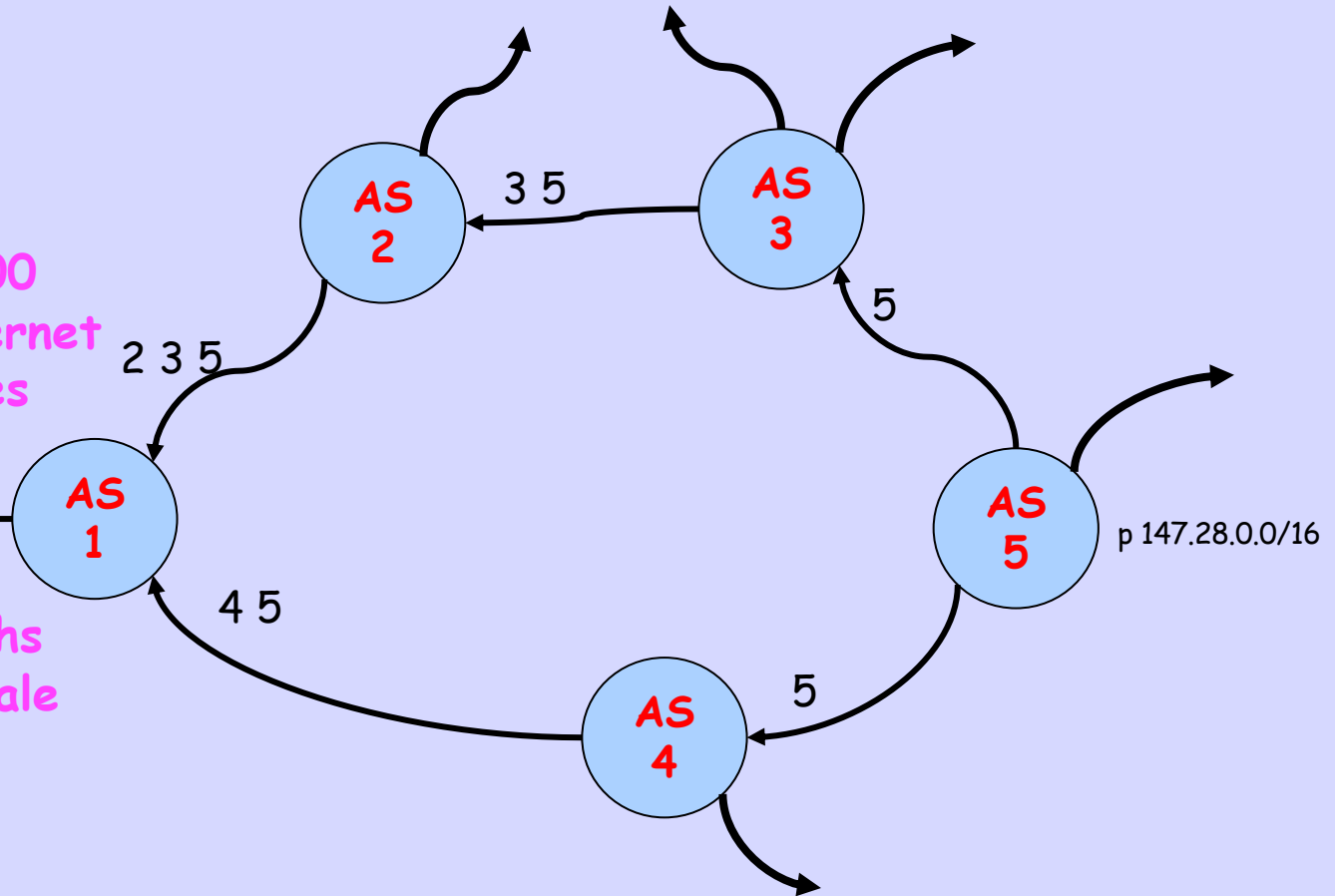
Especially Given

There are 50,000
ASs in today's Internet
800,000 prefixes

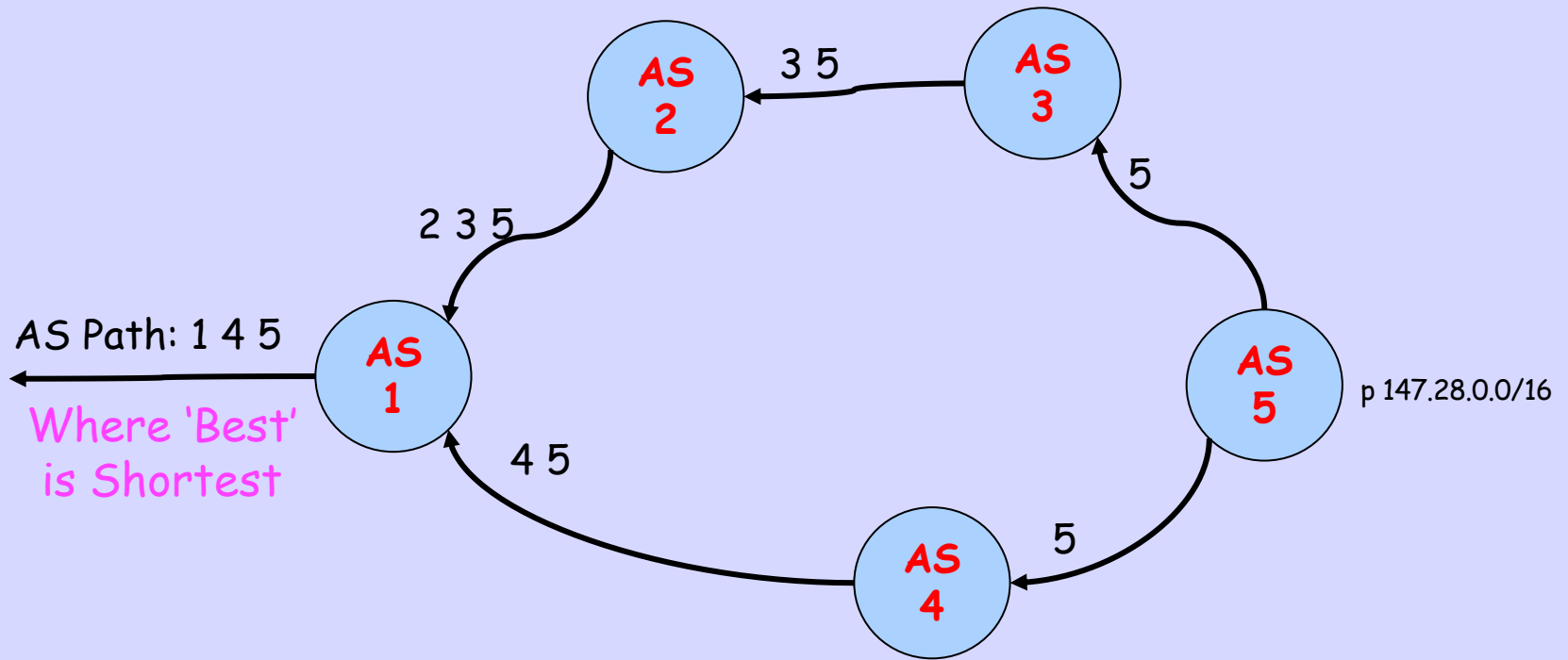
AS Path: 1 2 3 5

AS Path: 1 4 5

Multiplicative Paths
is not going to scale

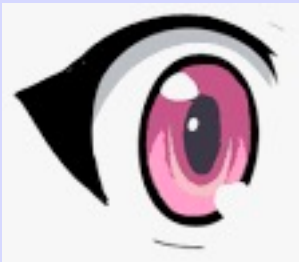


Announce Only 'Best' Path

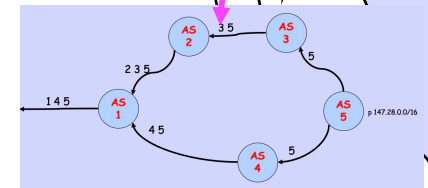


BGP is the world's best
Information Hiding Protocol

Topology Discovery?



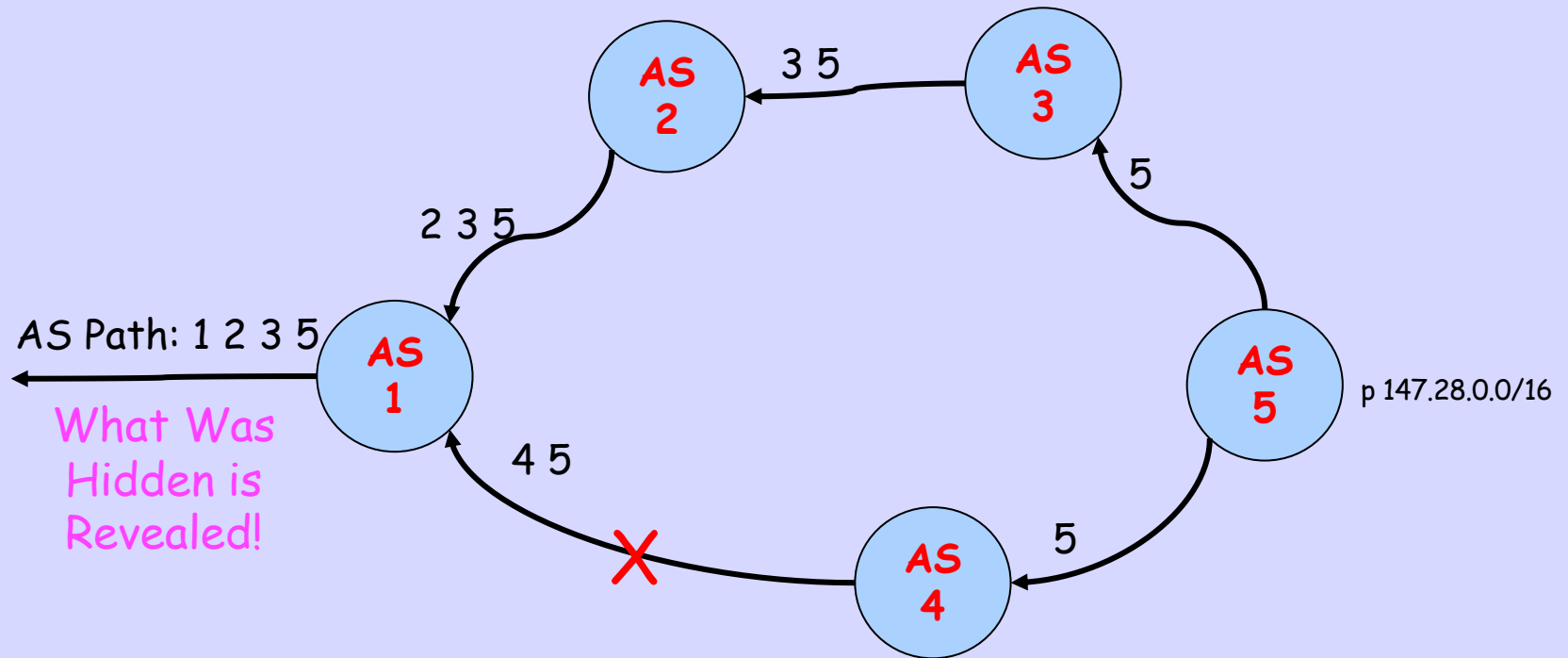
Global
Internet



you can't
see this

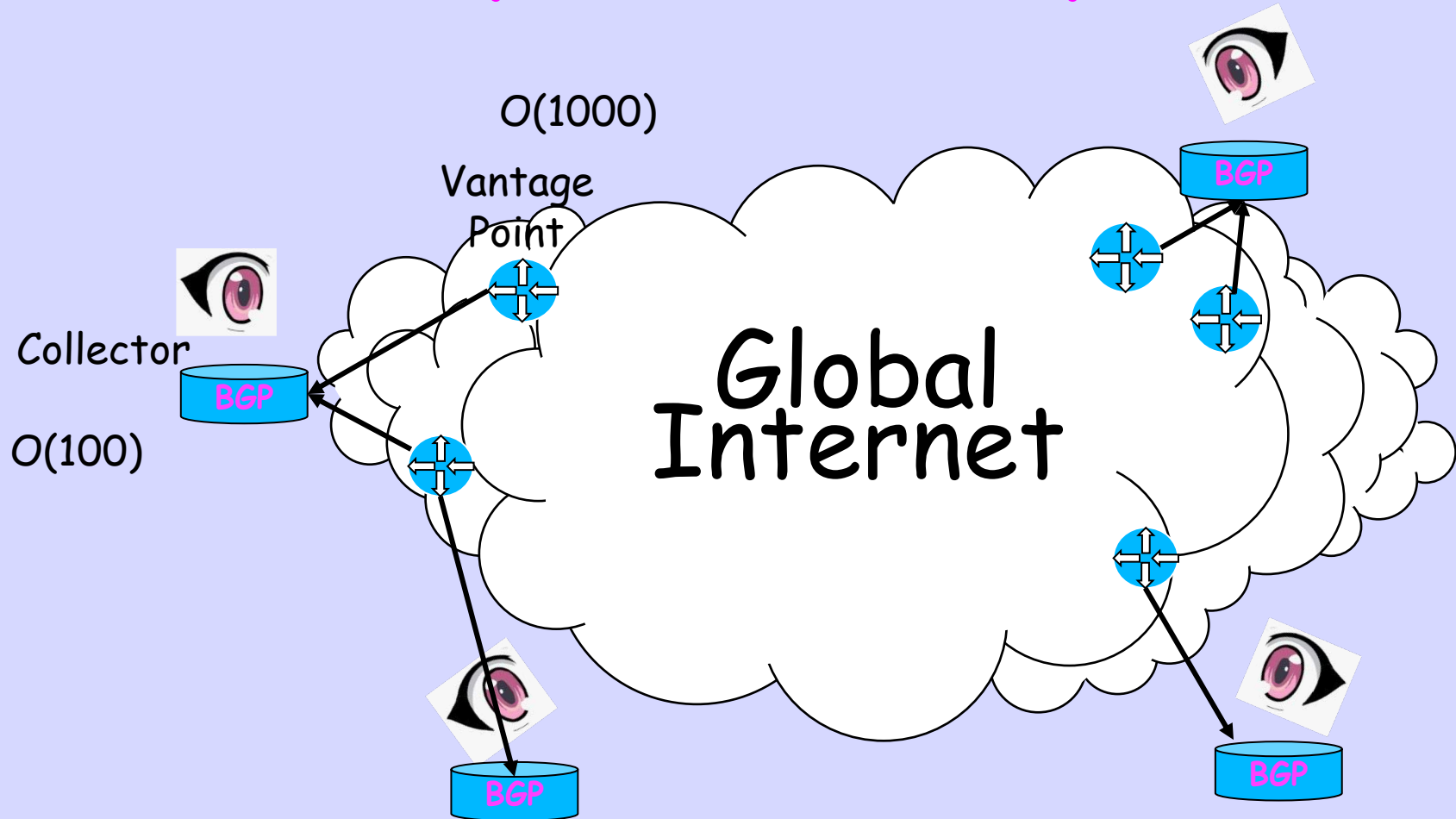
BGP: Awarding PhD theses since 1994
-- Simone Ferlin

New Best Path



BGP Collectors

RIPE/RIS, RouteViews, & Isolario



We have a Lot of Data
But they are
Far from Complete,
and it is not Stable

Room for More Theses

10 Lessons from 10 Years of Measuring and Modeling the Internet's Autonomous Systems

Roughan, Willinger, Maennel, Perouli, & Bush

(synopsis: you can not do this rigorously and reliably)

IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, VOL. 29, NO. 9, OCTOBER 2011

AS Core: Visualizing IPv4 Internet Topology at a Macroscopic Scale in 2017

https://www.caida.org/research/topology/as_core_network/2017/

Internet Topology Zoo



<https://www.topology-zoo.org/>

A Subject Change

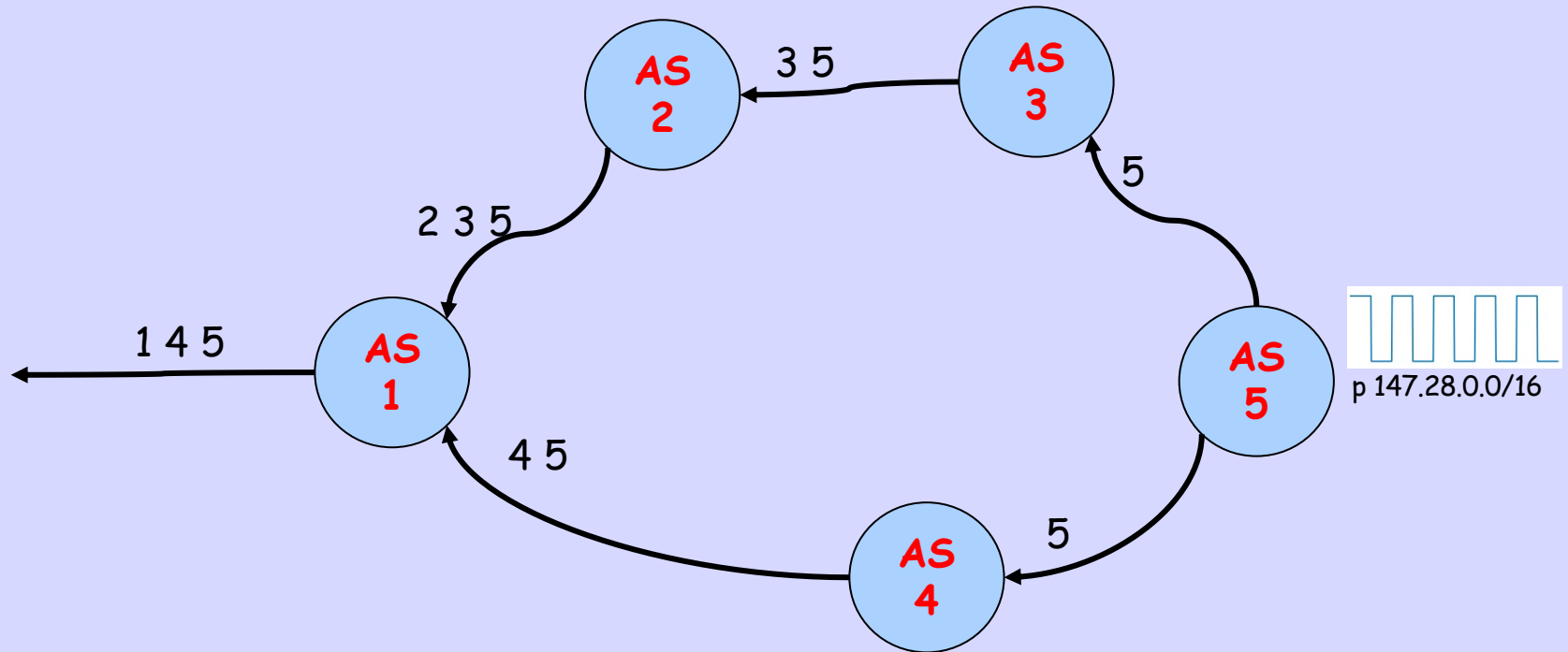
Kitties Make Me Calm



So it's 1997,
and Sean Doran's
global backbone
routers are
falling over

'Churn',
all the BGP
Announcements
were Eating his CPU

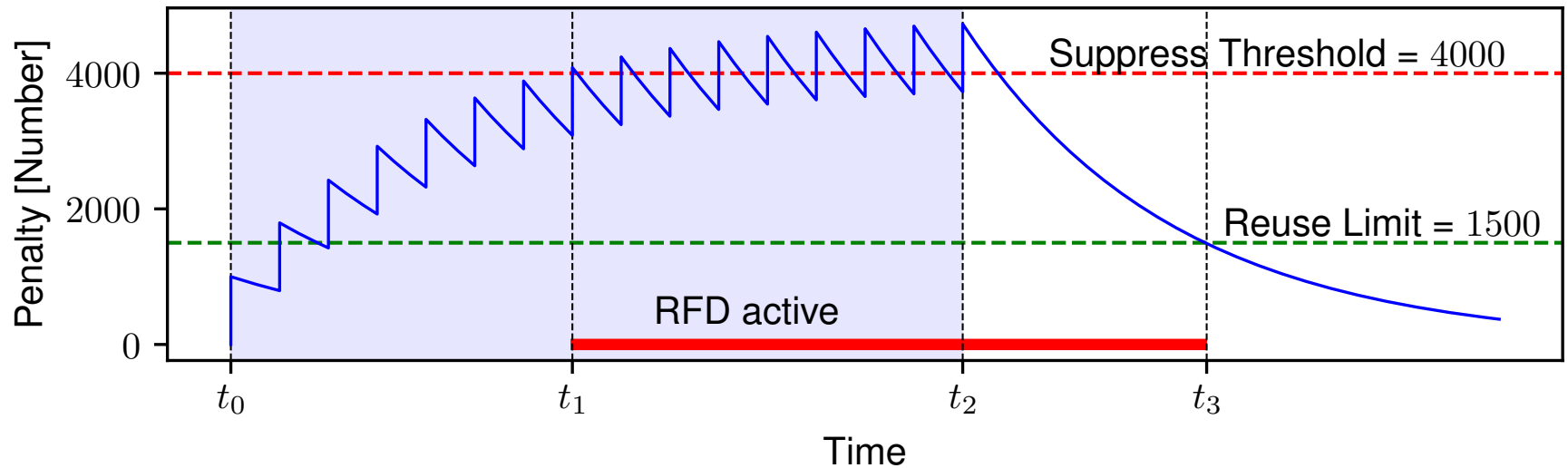
Some Folk are Noisy!



Very Noisy!

Let's Damp Noisy Signals!

Route Flap Damping (RFD)



Villamizar, Chandra, & Govindan
BGP Route Flap Damping RFC2439 1998

Barber, Doran, Karrenberg, Panigl, & Schmitz
Recommendation For Coordinated Route-flap Damping Parameters
ripe-178 1998

It Saved
Sean's Routers,
but ...

If a prefix is damped
the damping router
`black holes` packets
to that destination

Useful Prefixes Were Being Damped Affected Real Internet Reachability

Experiments using BGP signals had to delay hours between events

Bush, Griffin, Mao, Purpus, & Stutsbach
Happy Packets: Some Initial Results INFOCOM 2005

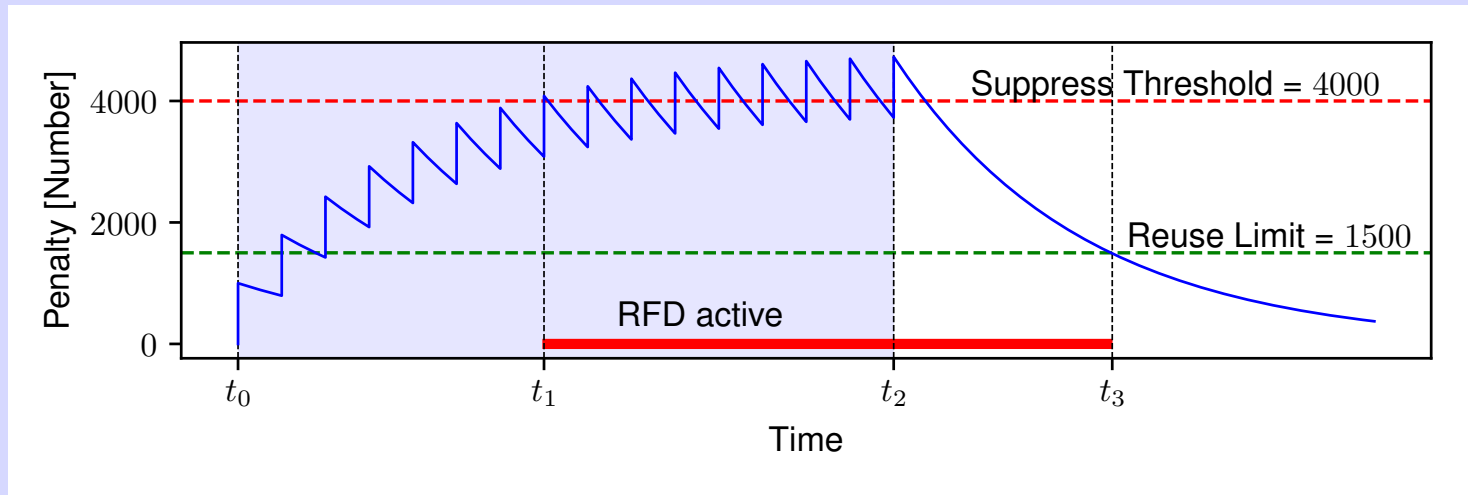
"The application of flap damping in ISP networks is NOT recommended."

Smith & Panigl RIPE-378 2006
Route Flap Damping Considered Harmful

Route Flap Damping was Turned Off by Many Operators*

* Not Measured! ☹️

Change the Parameters!



Pelsser, Maennel, Mohapatra, Bush, & Patel
Route Flap Damping Made Usable PAM 2011

Bush, Pelsser, Kühne, Maennel, Mohapatra, Patel, & Evans
Recommendations on Route Flap Damping, 2013 - ripe-580

Pelsser, Bush, Patel, Mohapatra, & Maennel
Making Route Flap Damping Usable RFC7186 2014

Gossip is
Operators Started to
Deploy RFD Again*

* Not Measured! ☹

But because RFD is
Deployed Sporadically,
and with Different
Parameters,
We do not Get a
Consistent View

Another Subject Change



The Bad Boys' Room

Some years back, in a talk, a friend dropped (paraphrased)

"Of ~750,000 prefixes in BGP, we see 20,000 flapping extremely. But *which* 20,000 varies day to day."

He then charged on with more exciting but unexplained observations.

Needing to know *Why*, we fall down the rabbit hole. Let's call it "research." 😊

But when we Tried
to Measure *bad* boys
versus *good* boys
RFD Got in the Way!

Maybe it's time to
Actually Measure
Route Flap Damping

So Let's Flap and
See How and Where
it Propagates

RFD Beacons

Tokyo

147.28.32.0/24

Announce

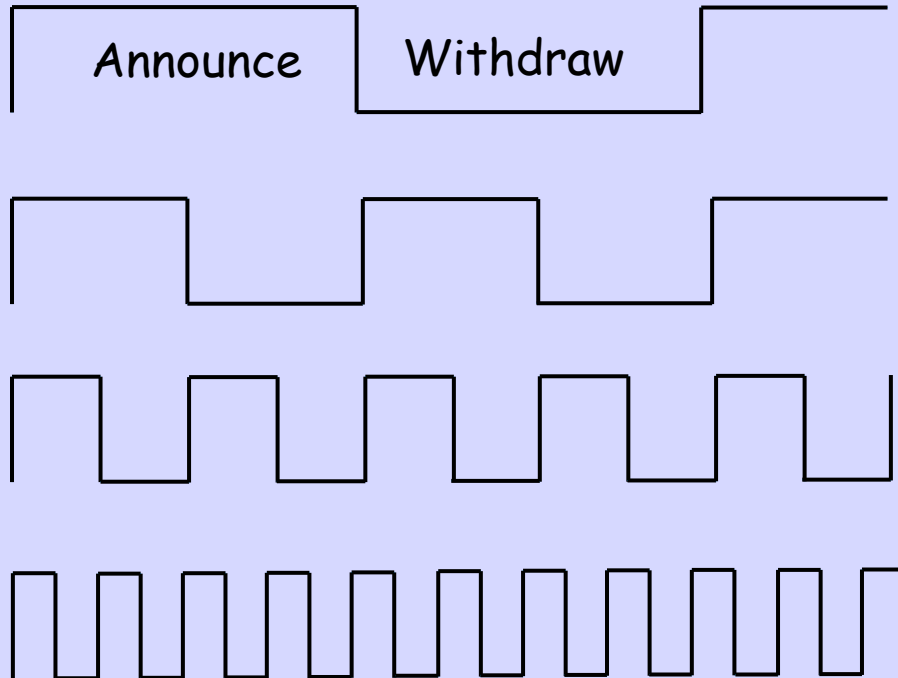
Withdraw

147.28.33.0/24

147.28.34.0/24

147.28.35.0/24

Router



See: <https://rfd.rg.net/beacons.html>

Beacons Deployed

Bangkok, TH

Johannesburg, ZA

København, DK

München, DE

São Paulo, BR

Seattle, US

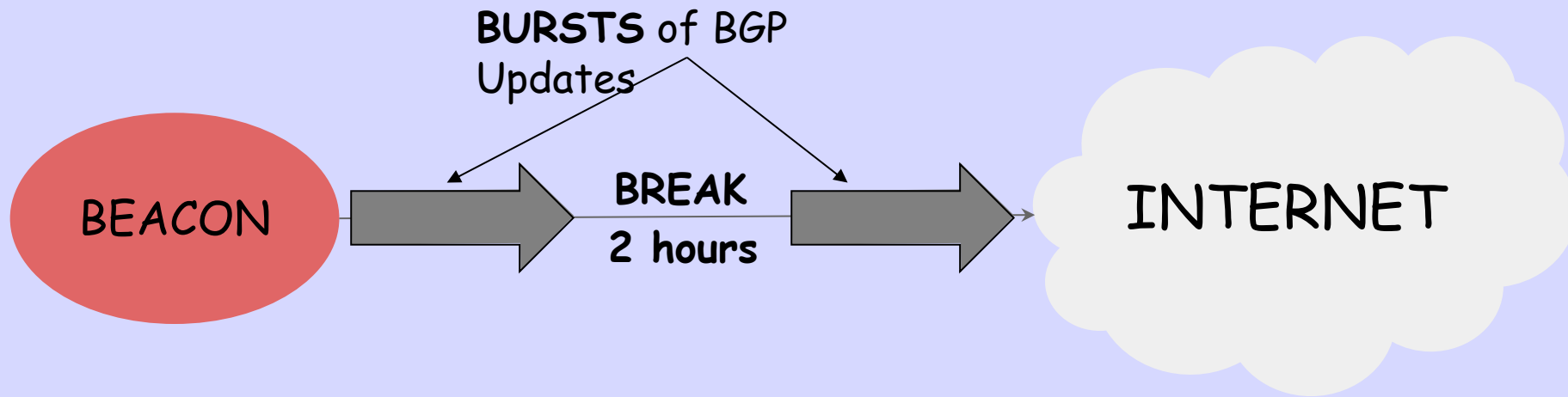
Tokyo, JP

Biased to the 'Clue Core' of the Internet

Let's Get a Clearer Result



Bursts and Breaks

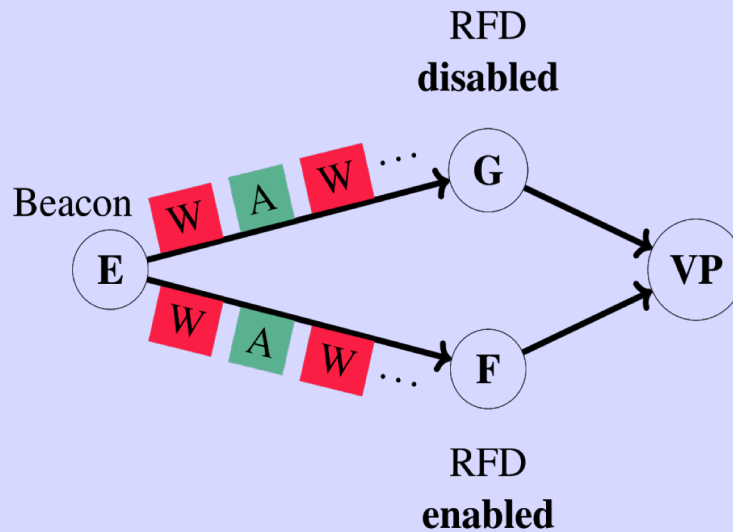


BGP Update Bursts should TRIGGER Route Flap Damping somewhere on the Internet

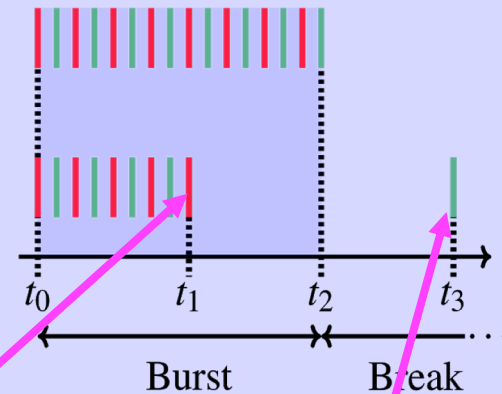
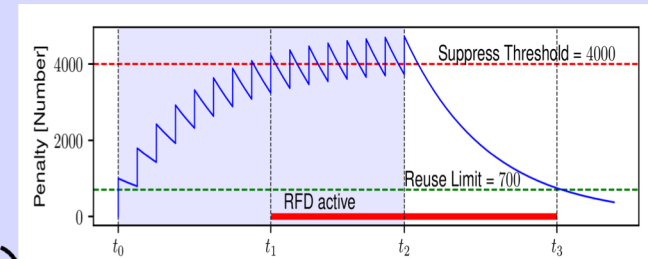
-> fast update intervals increase RFD, e.g., 5 min or 1 min

Breaks to RESET the penalty for our routes to 0

RFD Update Pattern



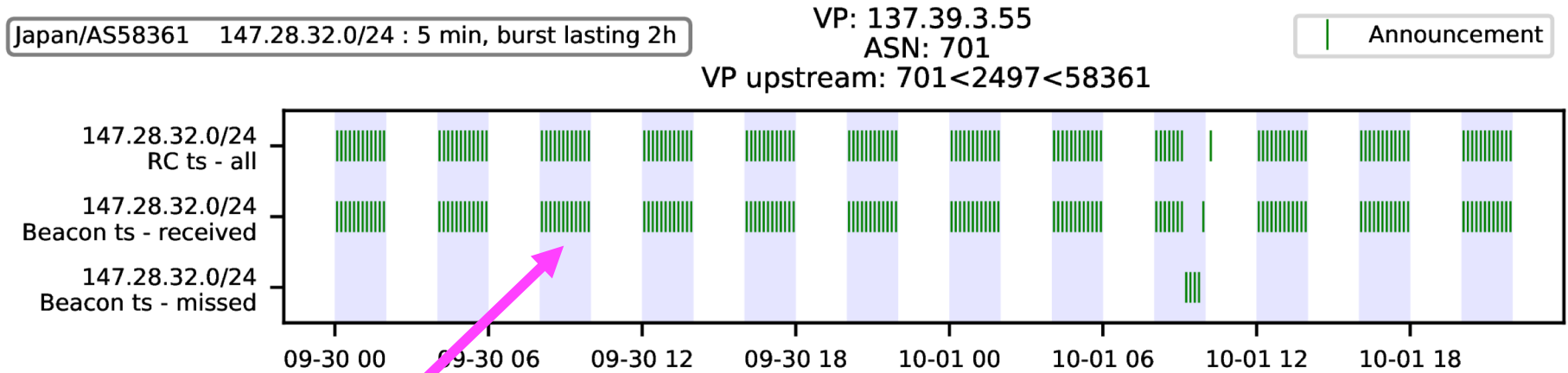
A:Announcement W:Withdrawal



penalty > suppress threshold

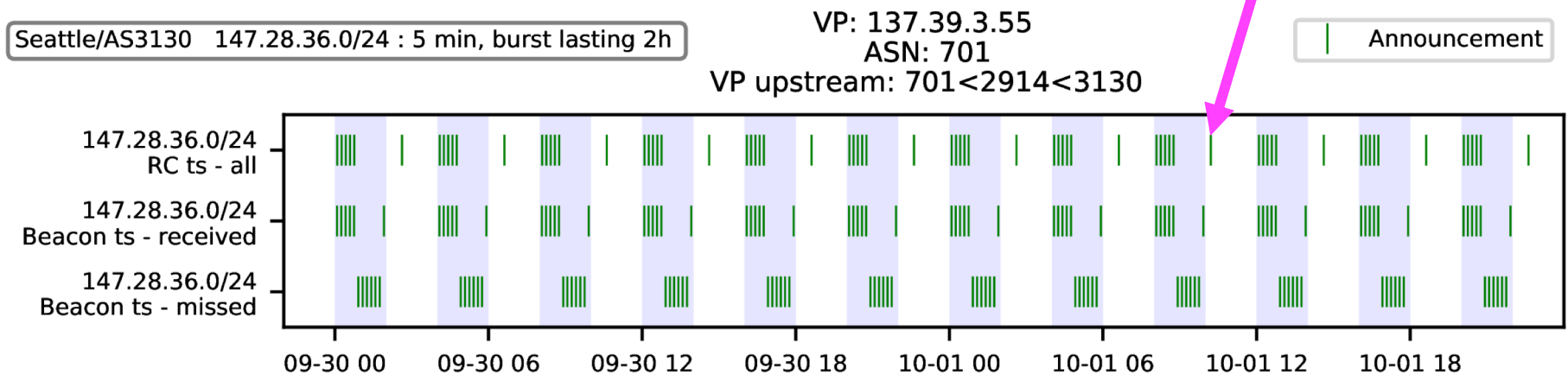
penalty < reuse limit

Update Pattern in Practice



All Updates received
=> no RFD

RFD Update Pattern



Resulting Path Information

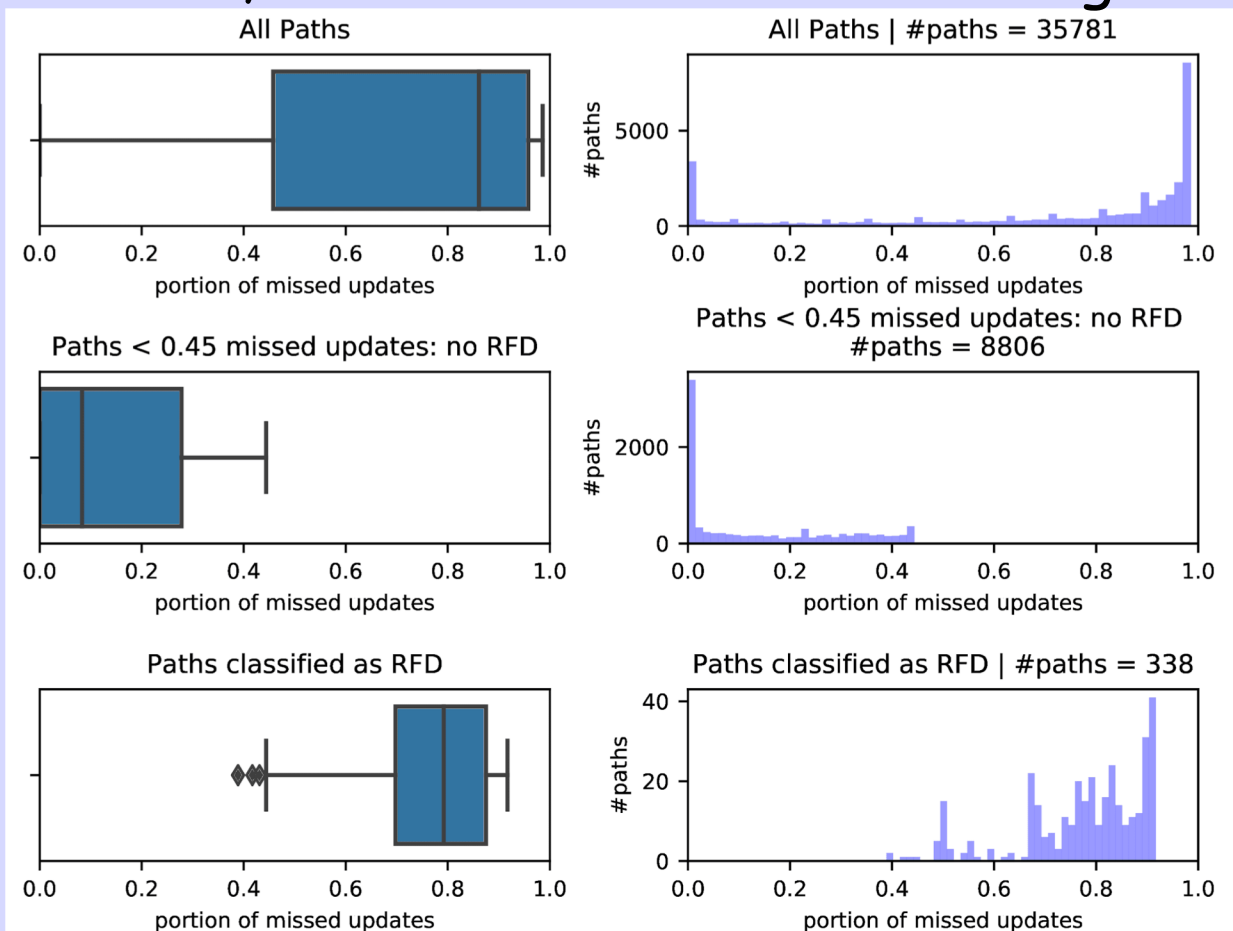
AS-paths are categorized into 3 types:

1. We see the RFD update pattern
2. We don't see the RFD update pattern and see "enough" updates
3. Not categorizable because we do not see "enough" updates

Most paths are seen only once or twice a day and are therefore not categorizable

Rare Paths

Most paths are seen infrequently, because best path selection does not lead to other paths, the prefix is dead, and are therefore not categorizable.



Most paths are rarely seen.

8806 (24%) paths show no RFD pattern

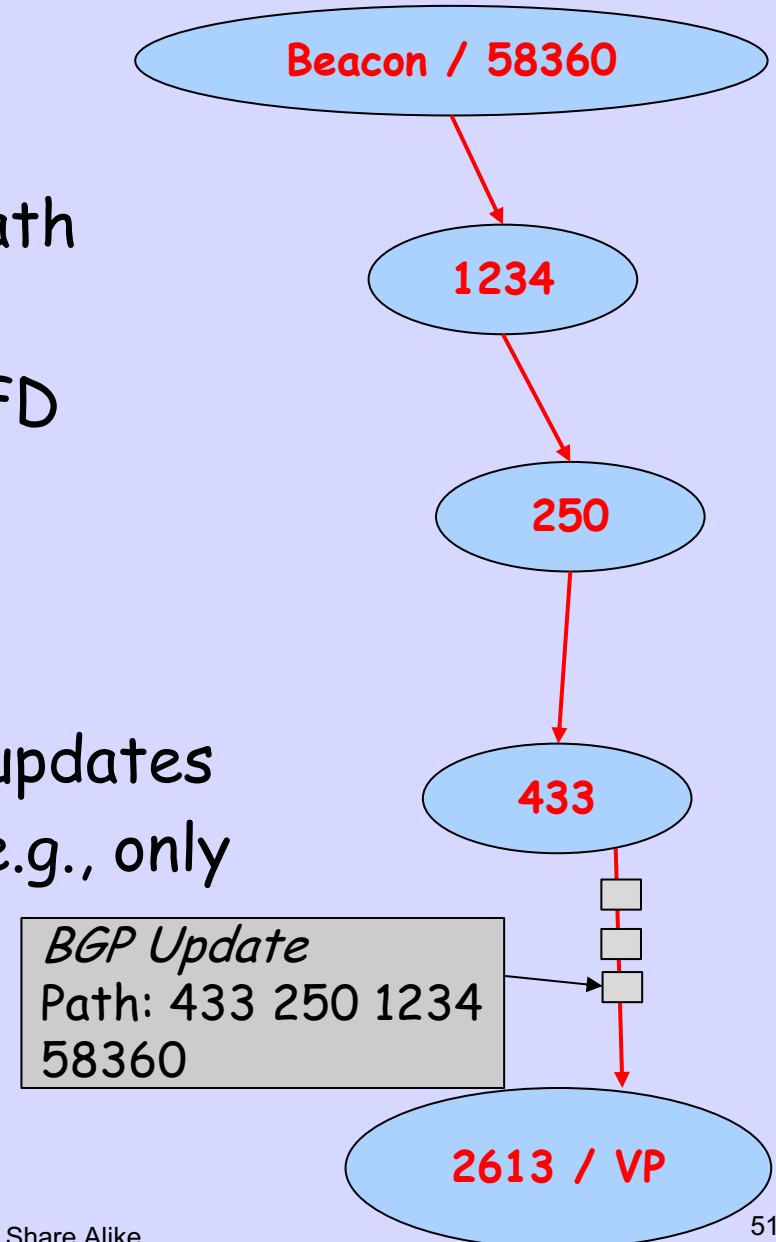


338 (1%) paths show RFD pattern

We want to know which
ASs use RFD

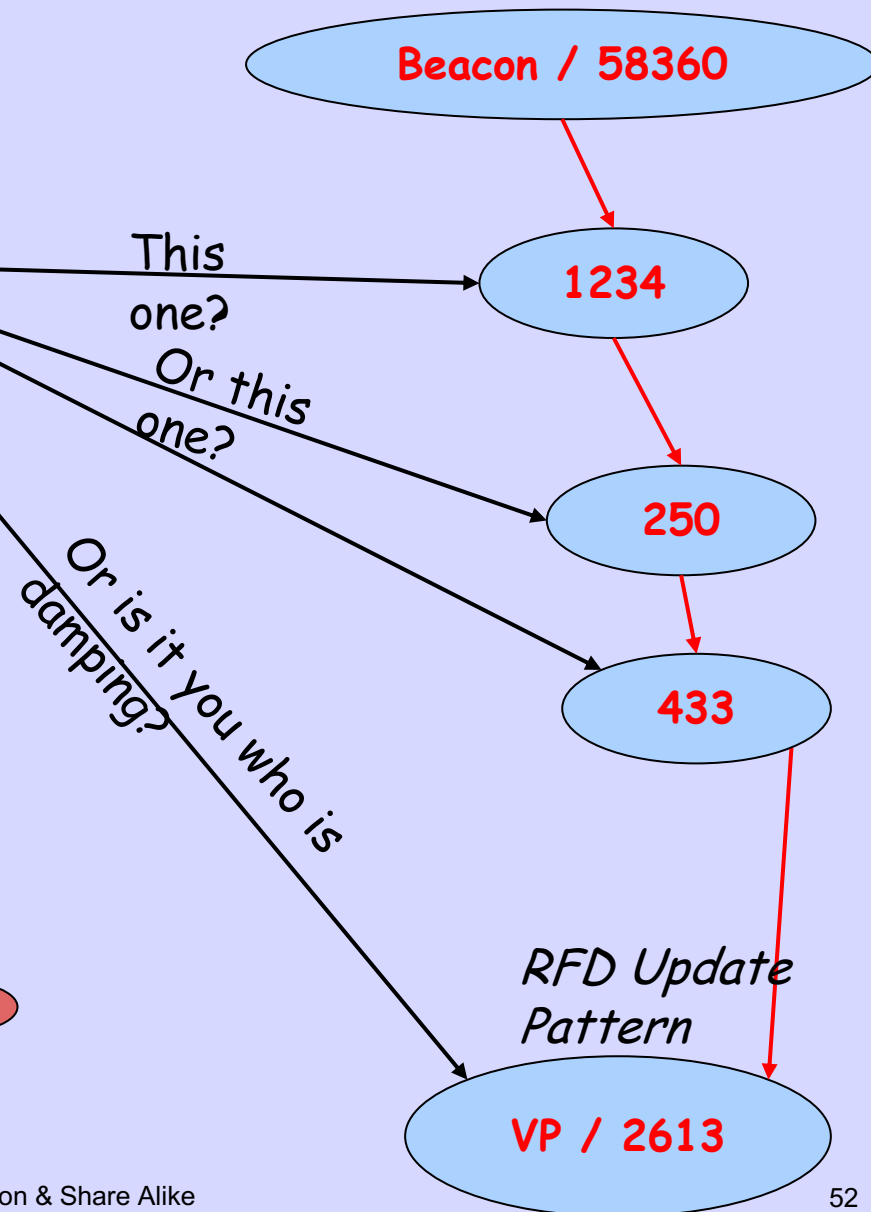
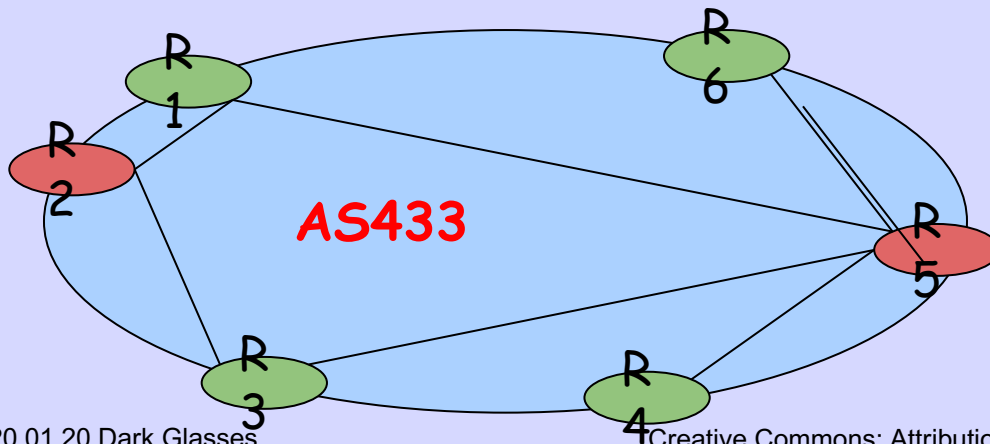
We see and know:

- Which ASs are on the damped path
- Some router on the path has RFD enabled on a damped path
- RFD is often used inconsistently throughout an AS, i.e., dampens updates from a few selected neighbors (e.g., only customers)



We DO NOT Know

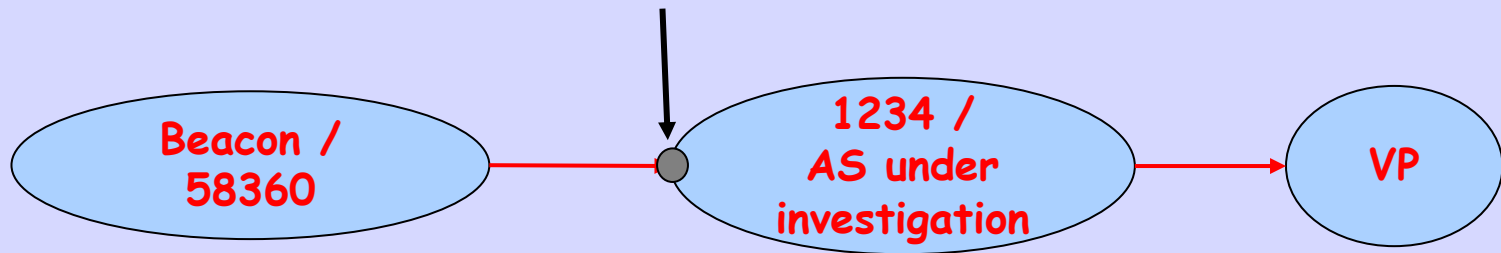
- Which specific ASs and routers use RFD
- Router level path within an AS
- RFD parameters used



**BUT: We want to know
which specific AS uses
RFD on a damped path!**

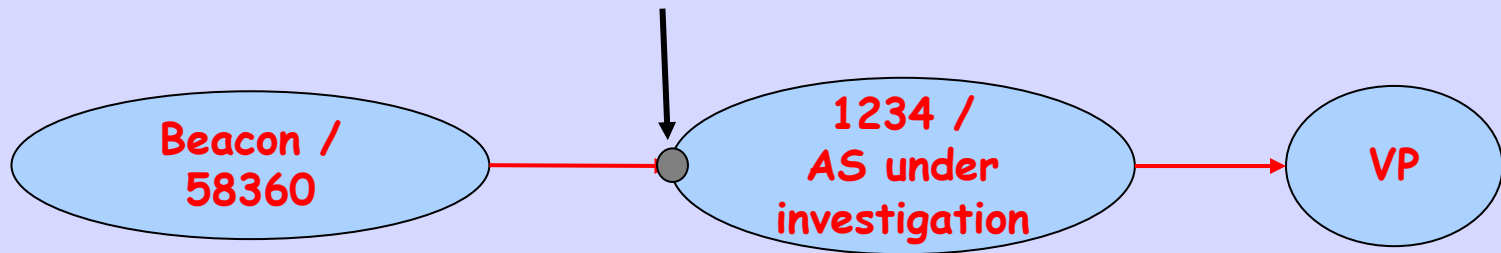
Ideal Solution Fantasy

With this setup we are able to tell whether this border router does RFD.



Ideal Solution Fantasy

With this setup we are able to tell whether this border router does RFD.



Given that there are 60 000 ASs on the Internet we cannot setup this many Beacons and VPs! :(

So we need
a different
approach, inferring
RFD from what we
can see today

Pinpointing Damping ASs

We use 3 different metrics which assign each AS a score between 0.0 (RFD disabled) and 1.0* (RFD enabled)

* maybe this is a variable threshold

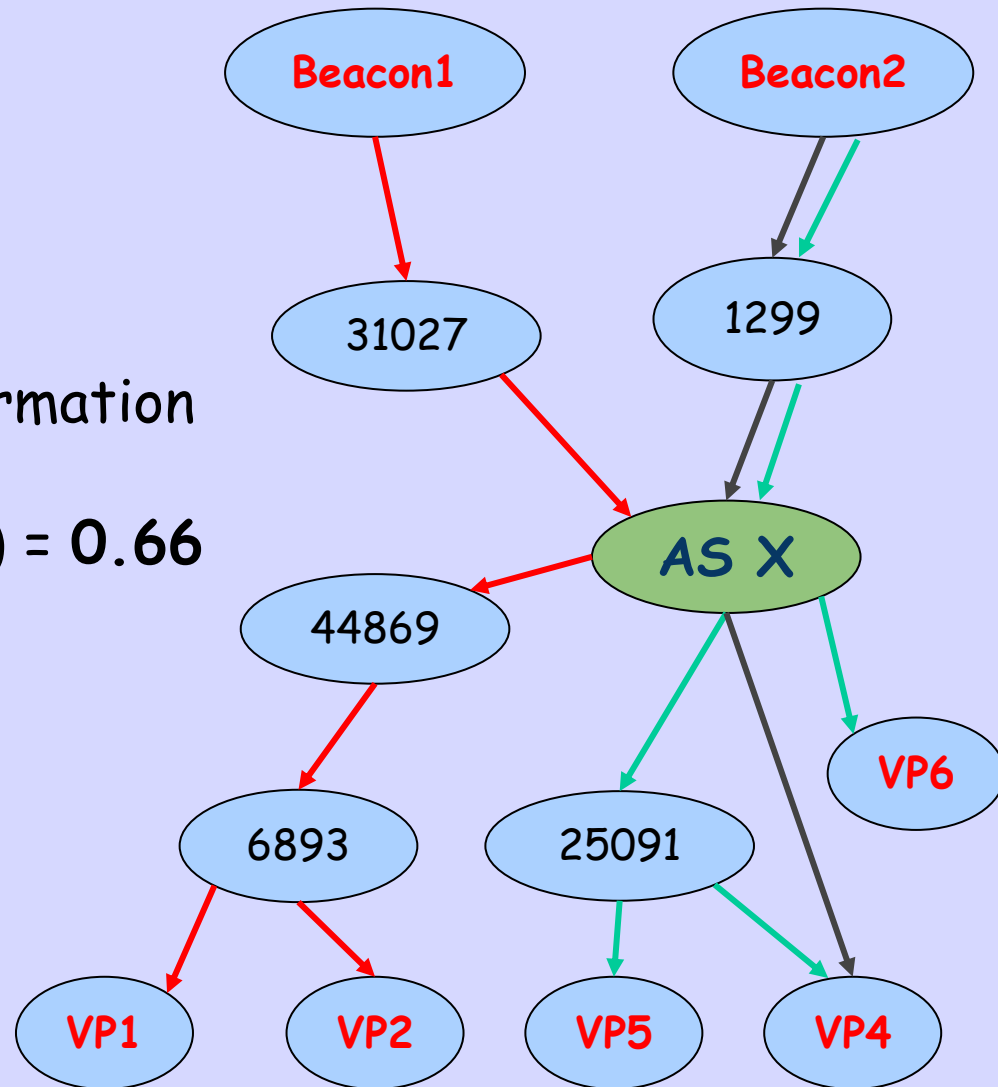
1: Ratio between #RFD-path / #All-paths

damped path → non-damped path → noisy path →

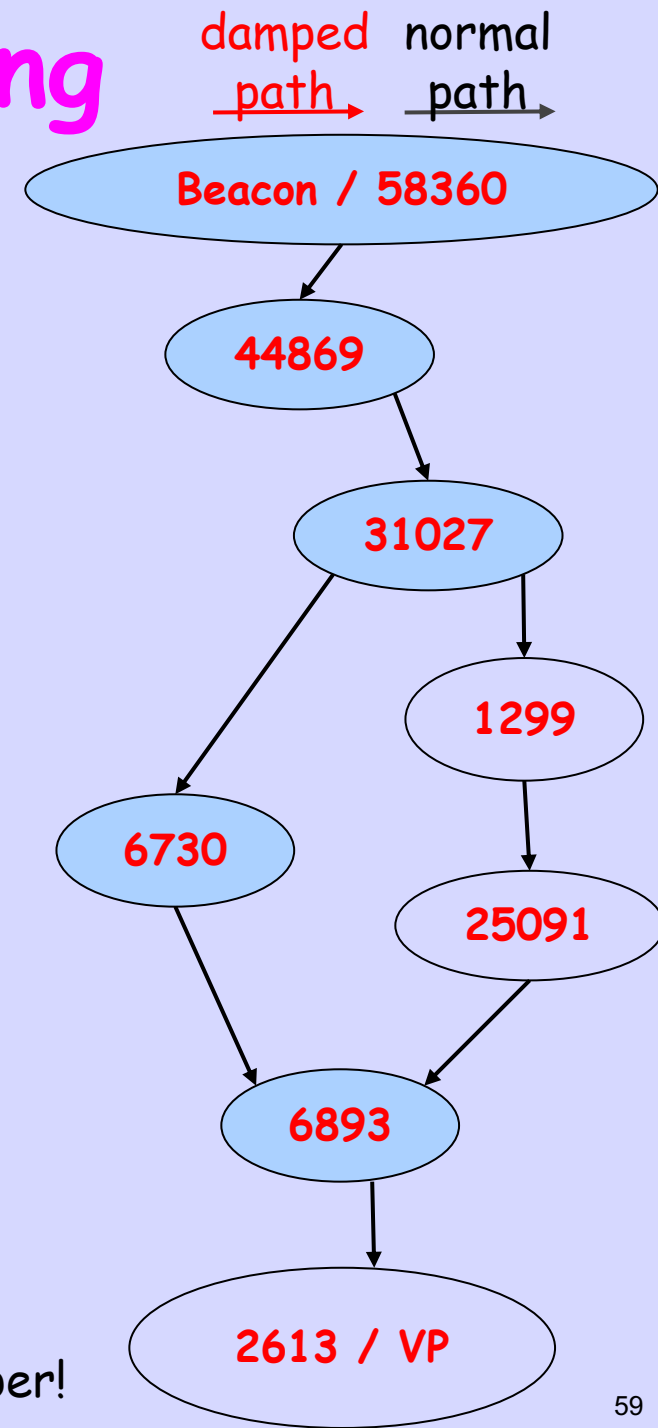
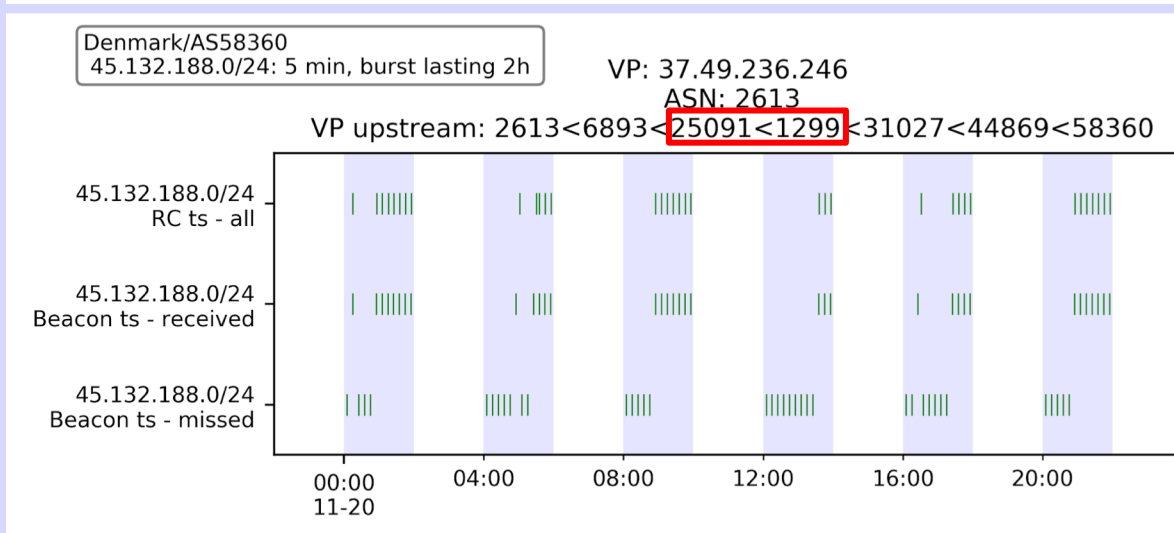
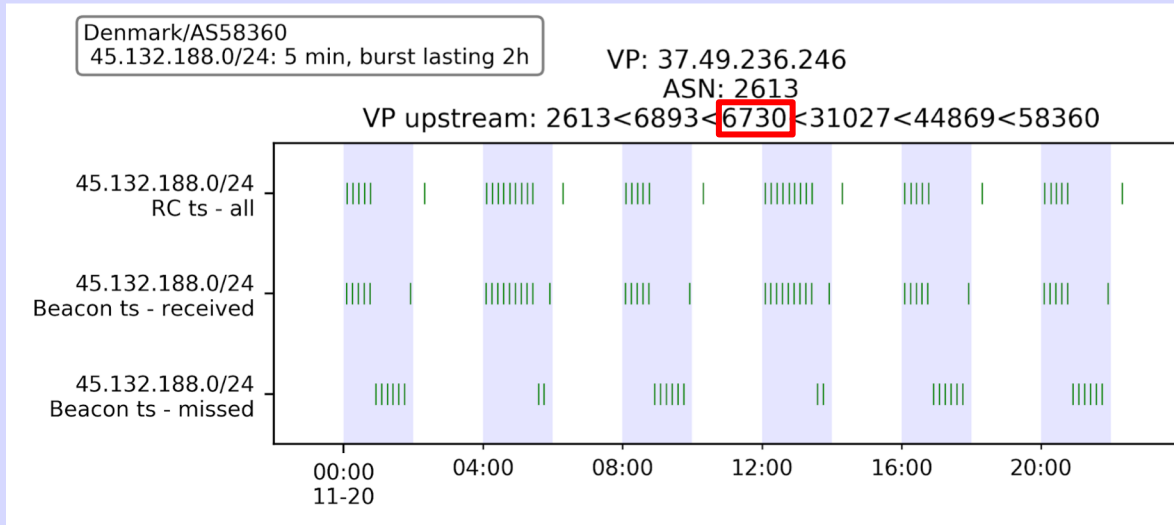
If **AS X** is on...

- 1) 2 damped paths (VP1 & VP2)
- 2) 1 non-damped paths (VP4)
- 3) 3 paths without enough information (VP4 VP5 VP6)

... the resulting score is: $2/(2+1) = 0.66$

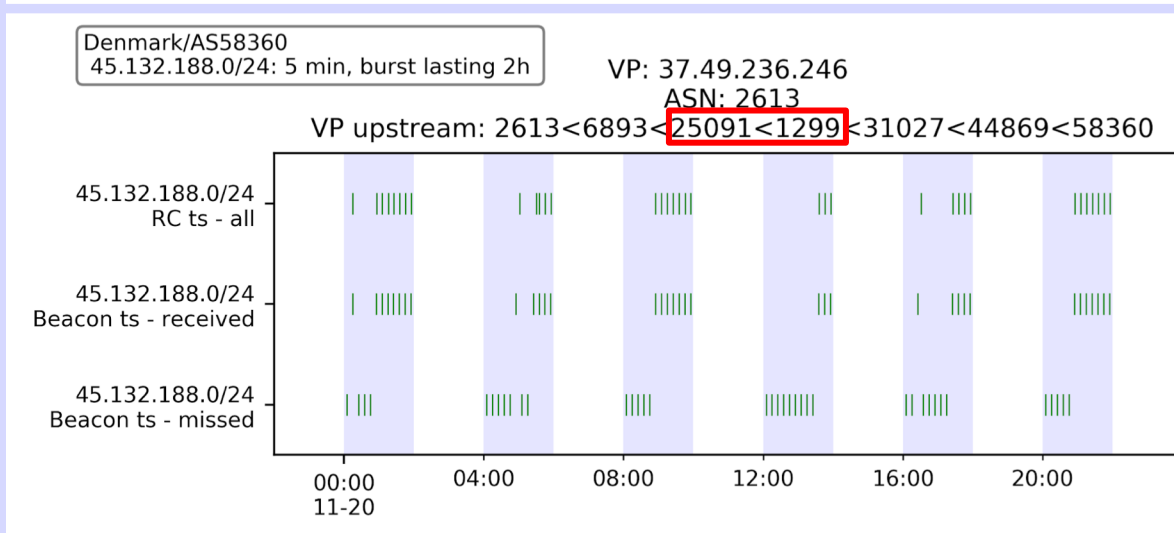
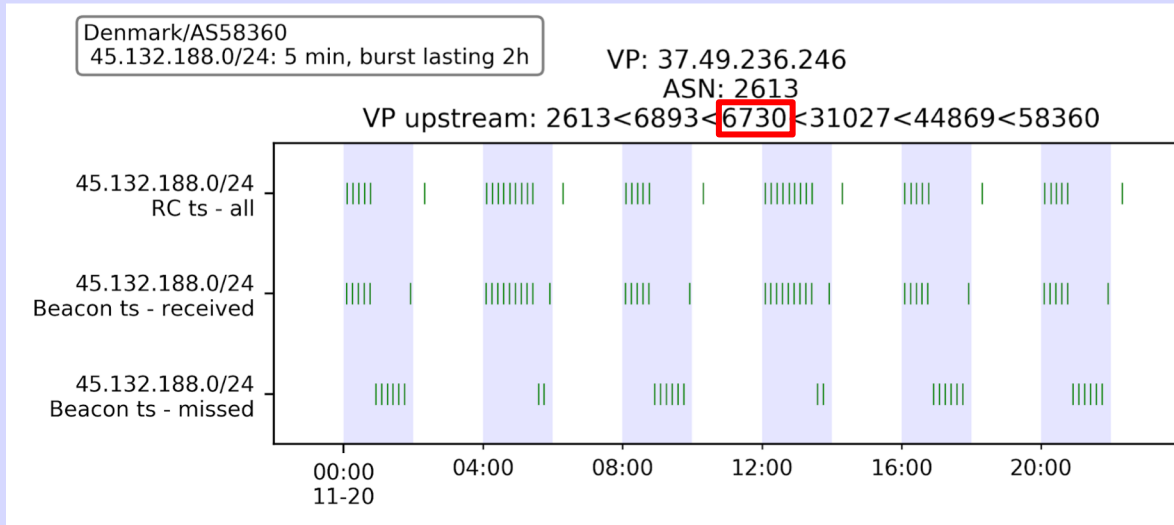


2: Inferring Damper using Alternative Paths (1)

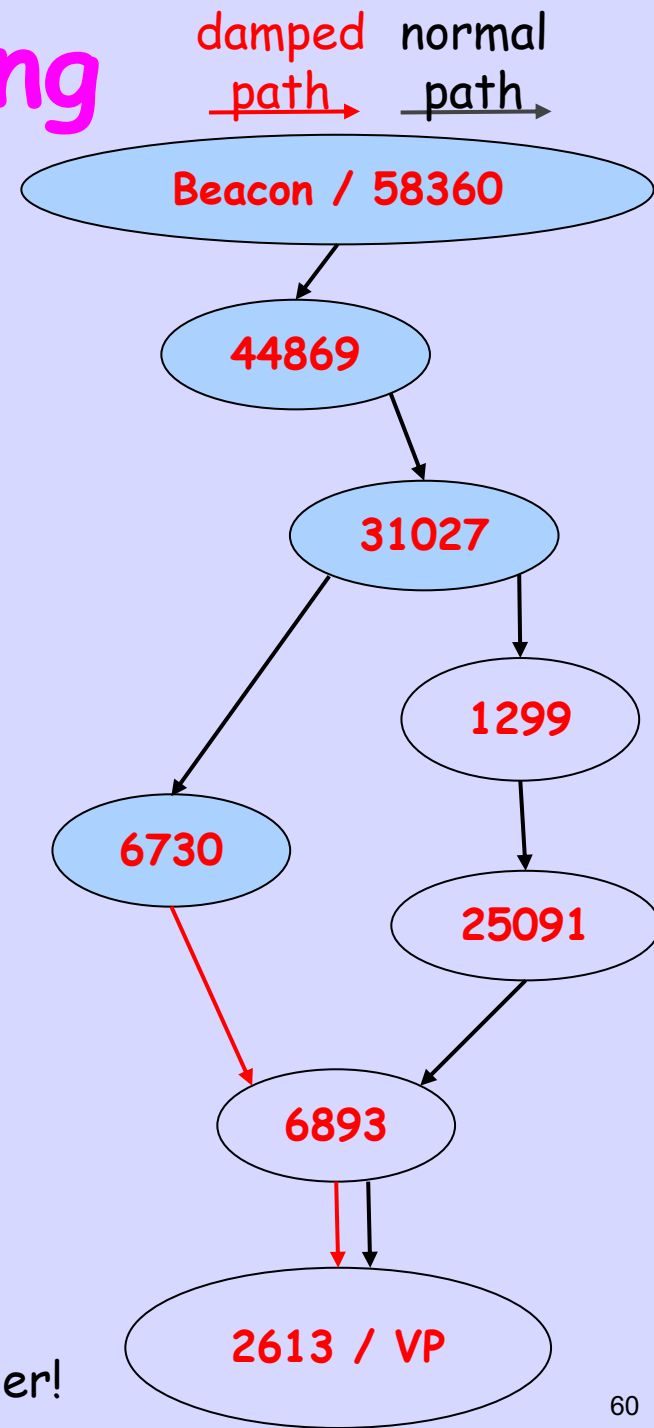


AS6730 is not on the alternative path therefore damper!

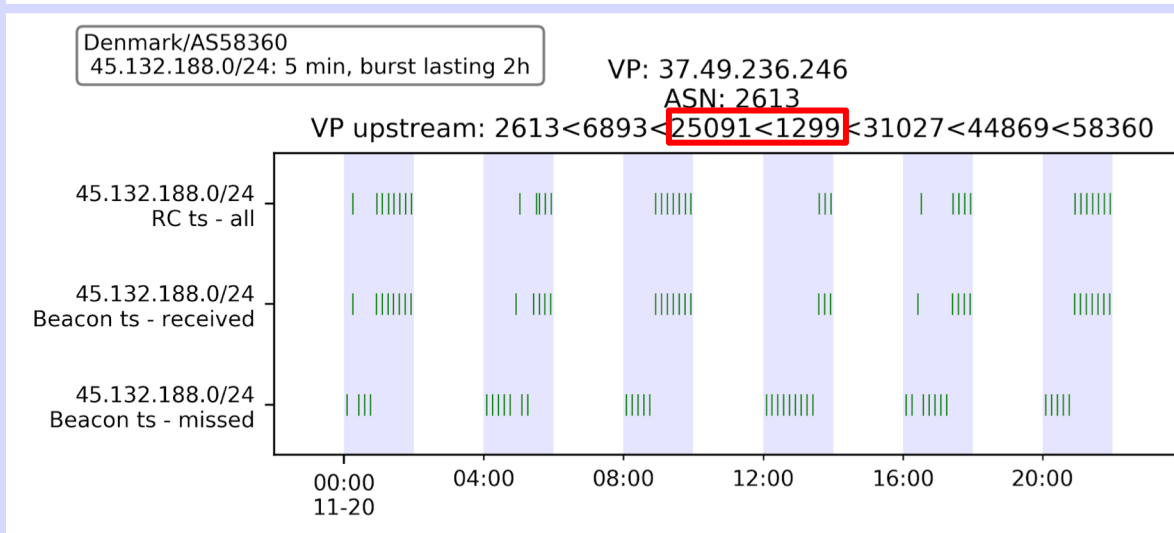
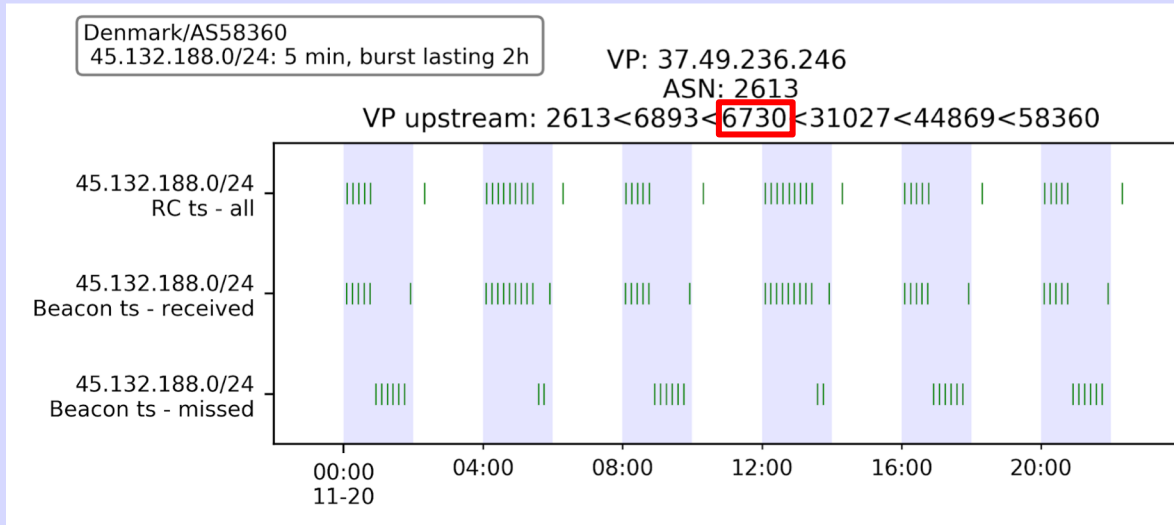
2: Inferring Damper using Alternative Paths (1)



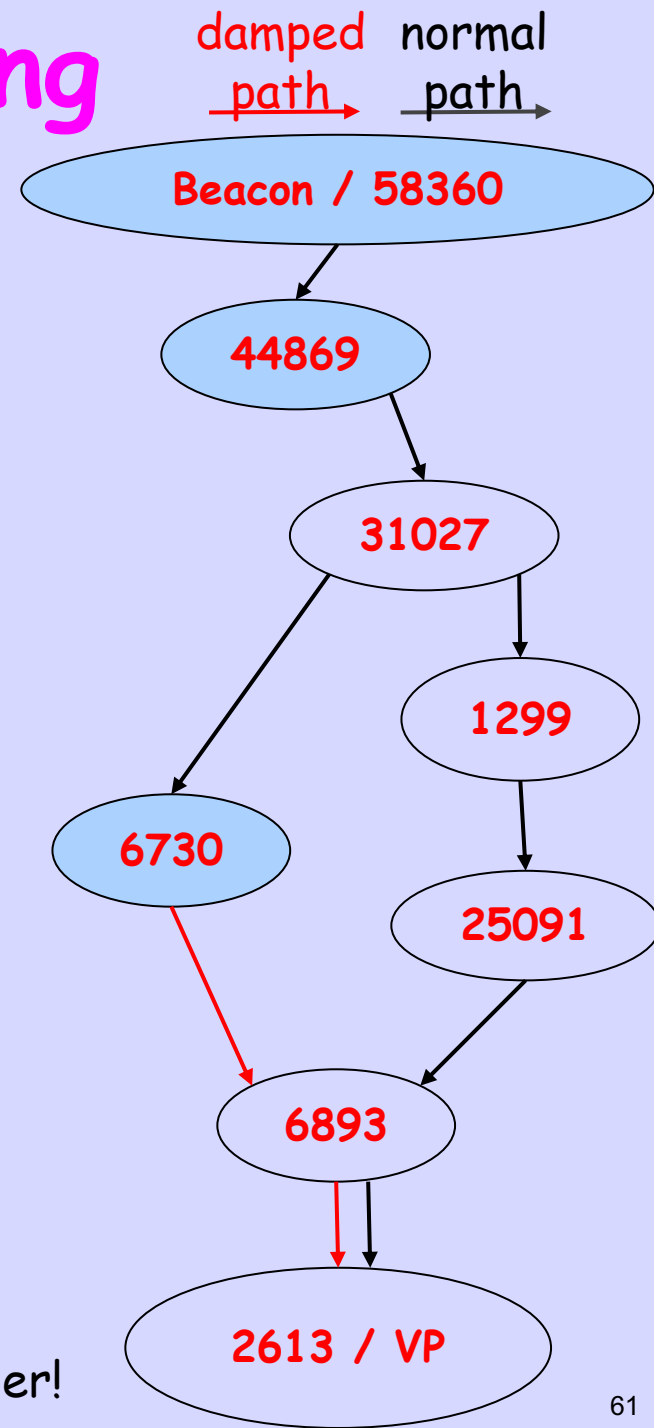
AS6730 is not on the alternative path therefore damper!



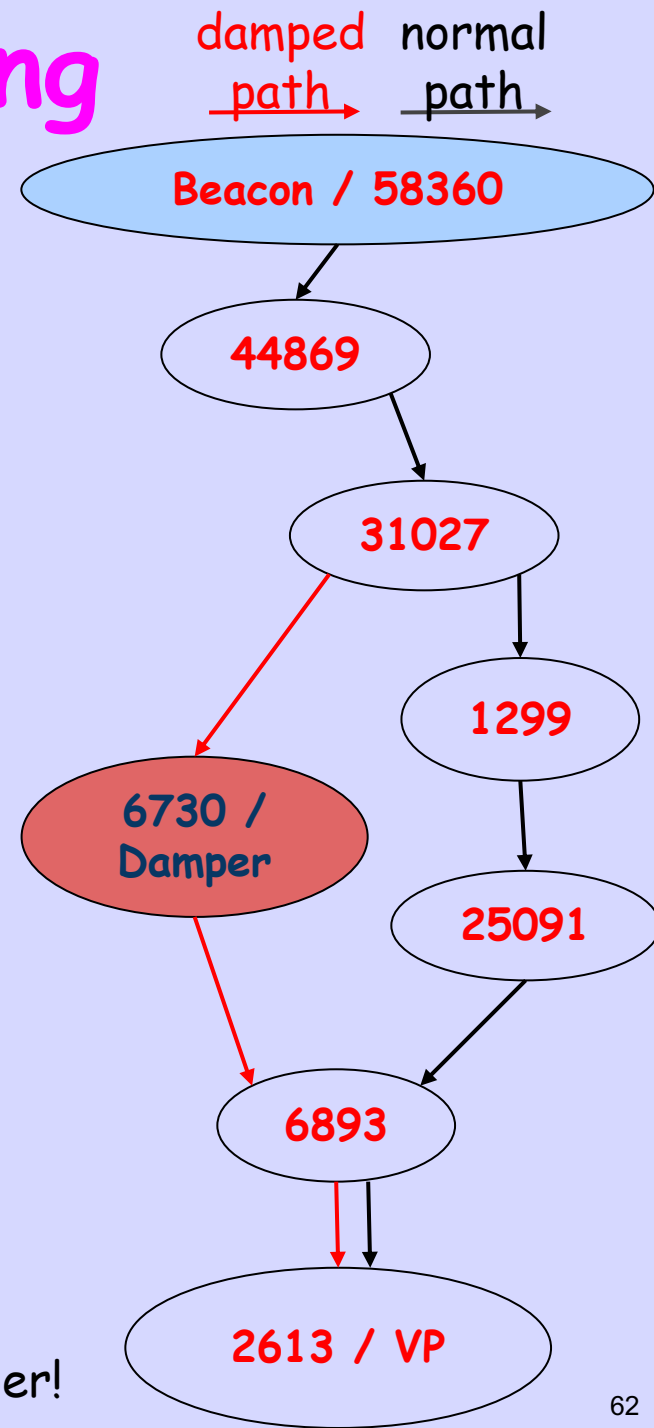
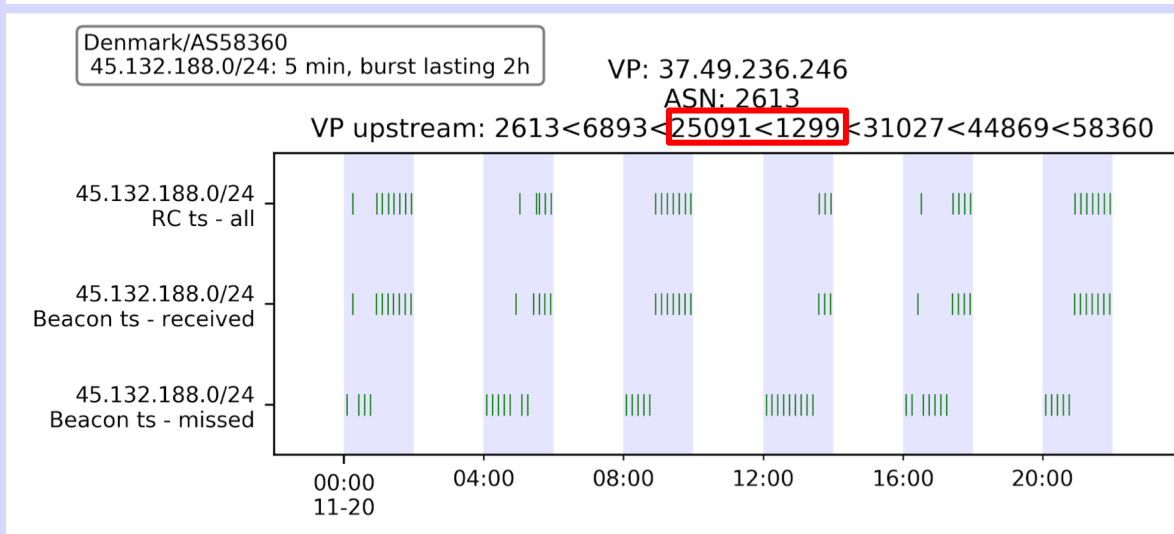
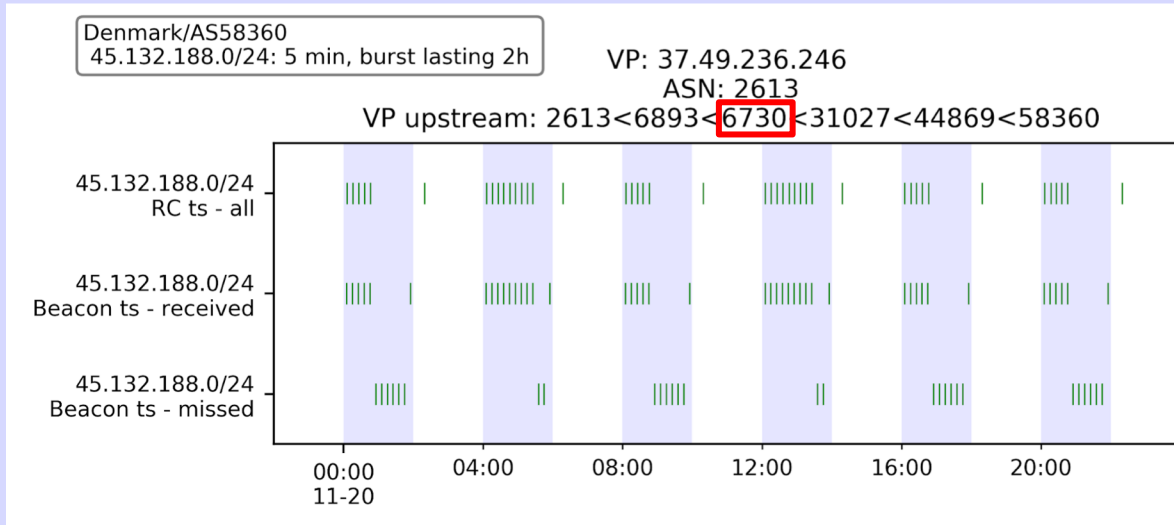
2: Inferring Damper using Alternative Paths (1)



AS6730 is not on the alternative path therefore damper!



2: Inferring Damper using Alternative Paths (1)



AS6730 is not on the alternative path therefore damper!

2: Inferring Damper using Alternative Paths (2)

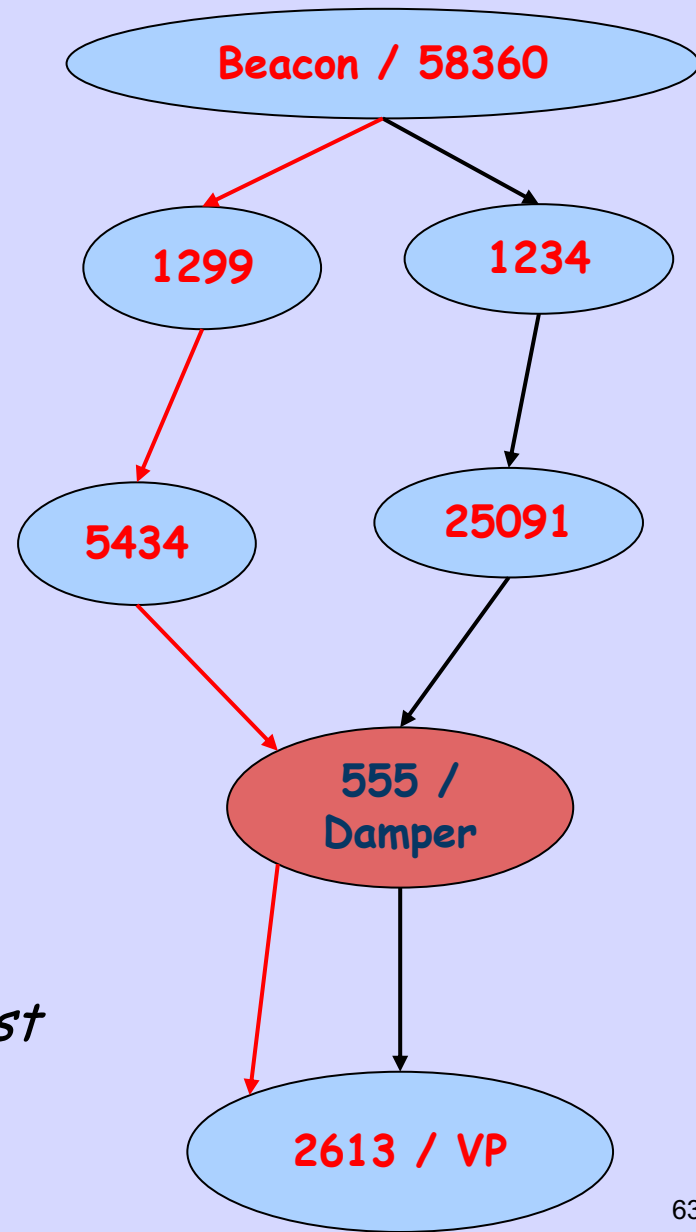
damped path → normal path →

If we have not received any alternative paths at the VP we apply a different method.

We won't receive updates after the damp because AS555 is the damper.

BUT: We know about the other links and know that we should have received an alternative path if any other AS was the damper.

If 5434 was the damper we should receive alternative paths at the VP. Therefore 555 must be the damper.

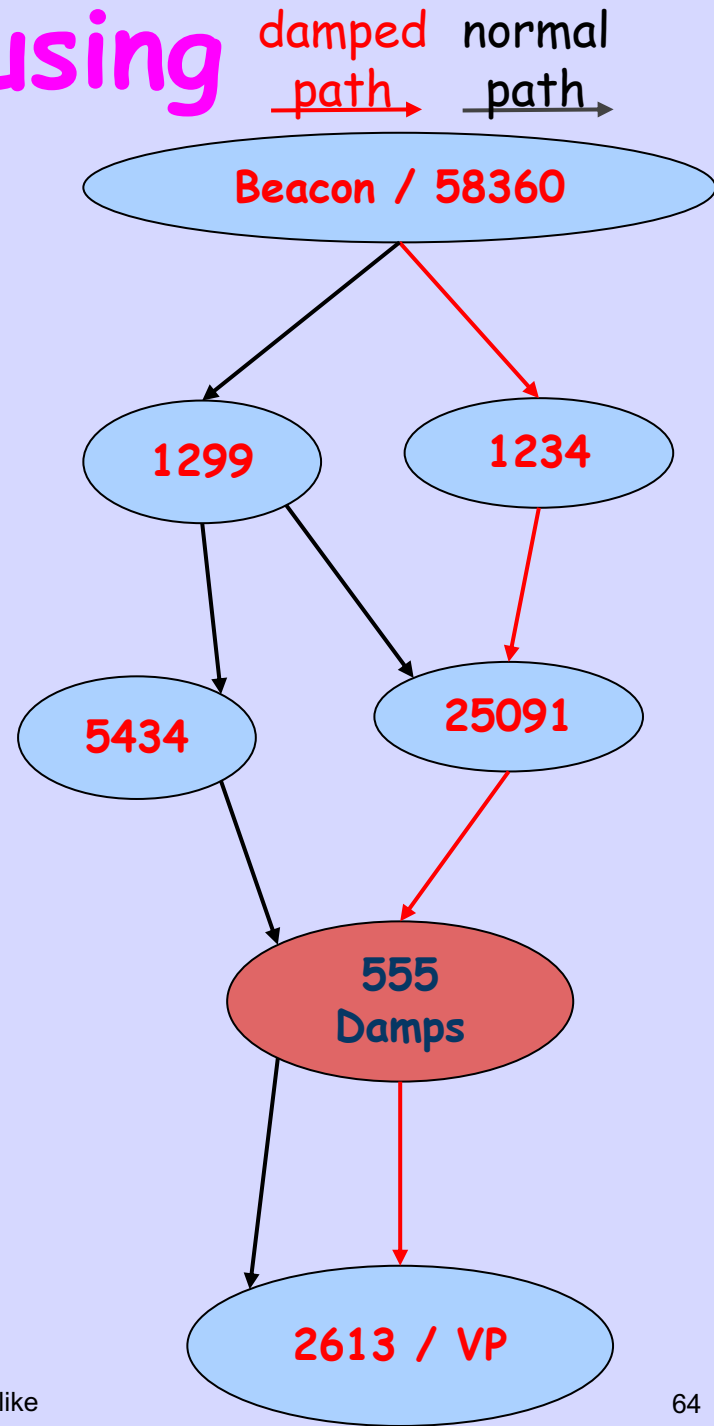


2: Inferring Damper using Alternative Paths (2)

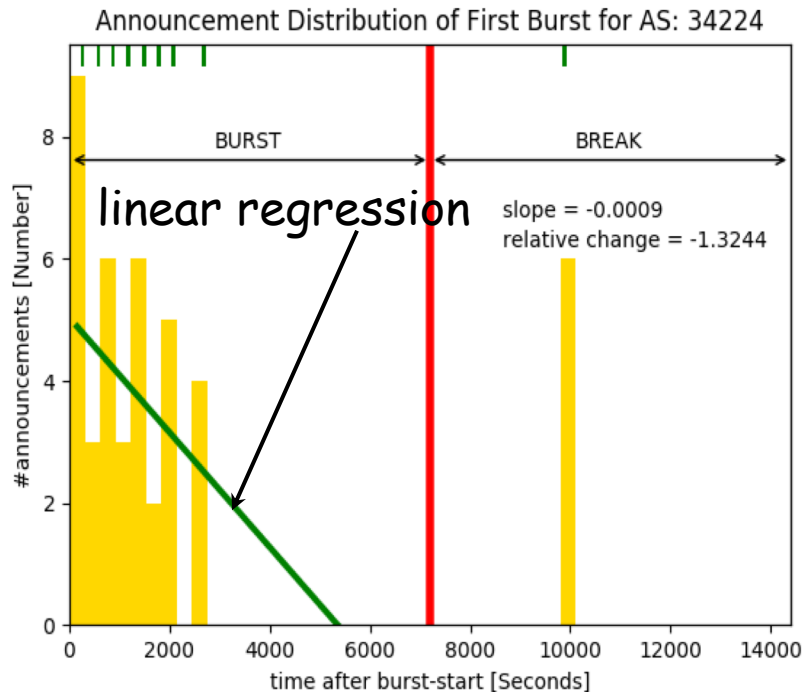
If we have received no alternative paths at the VP we apply a different method

We won't receive updates after the damp because 555 damps

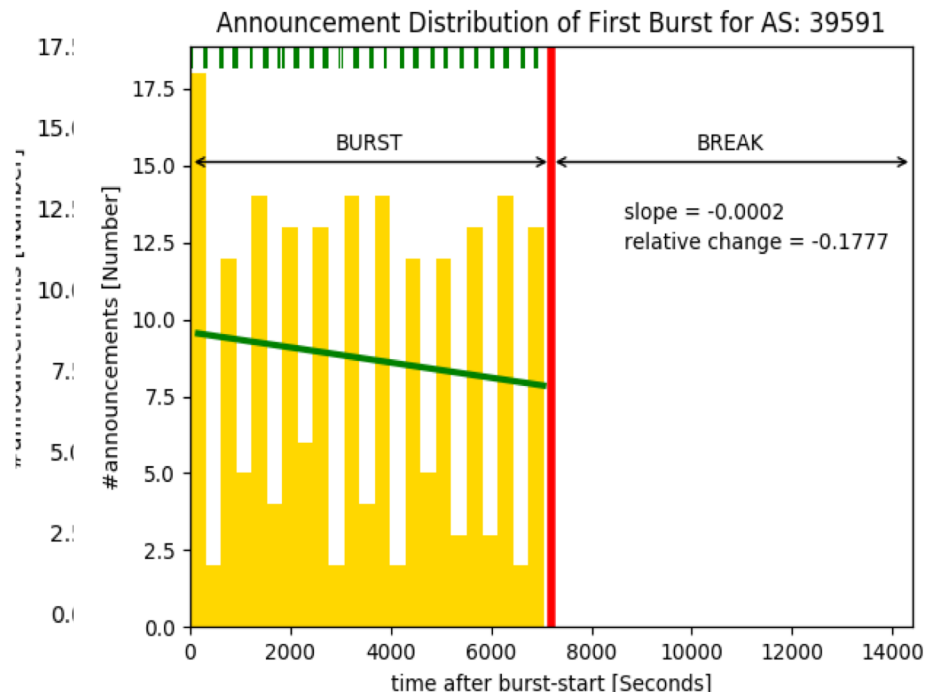
BUT: We know about the other links from other vantage points, and know that we should have received an alternative path if any other AS damped



3: Announcement Distribution across Bursts



RFD

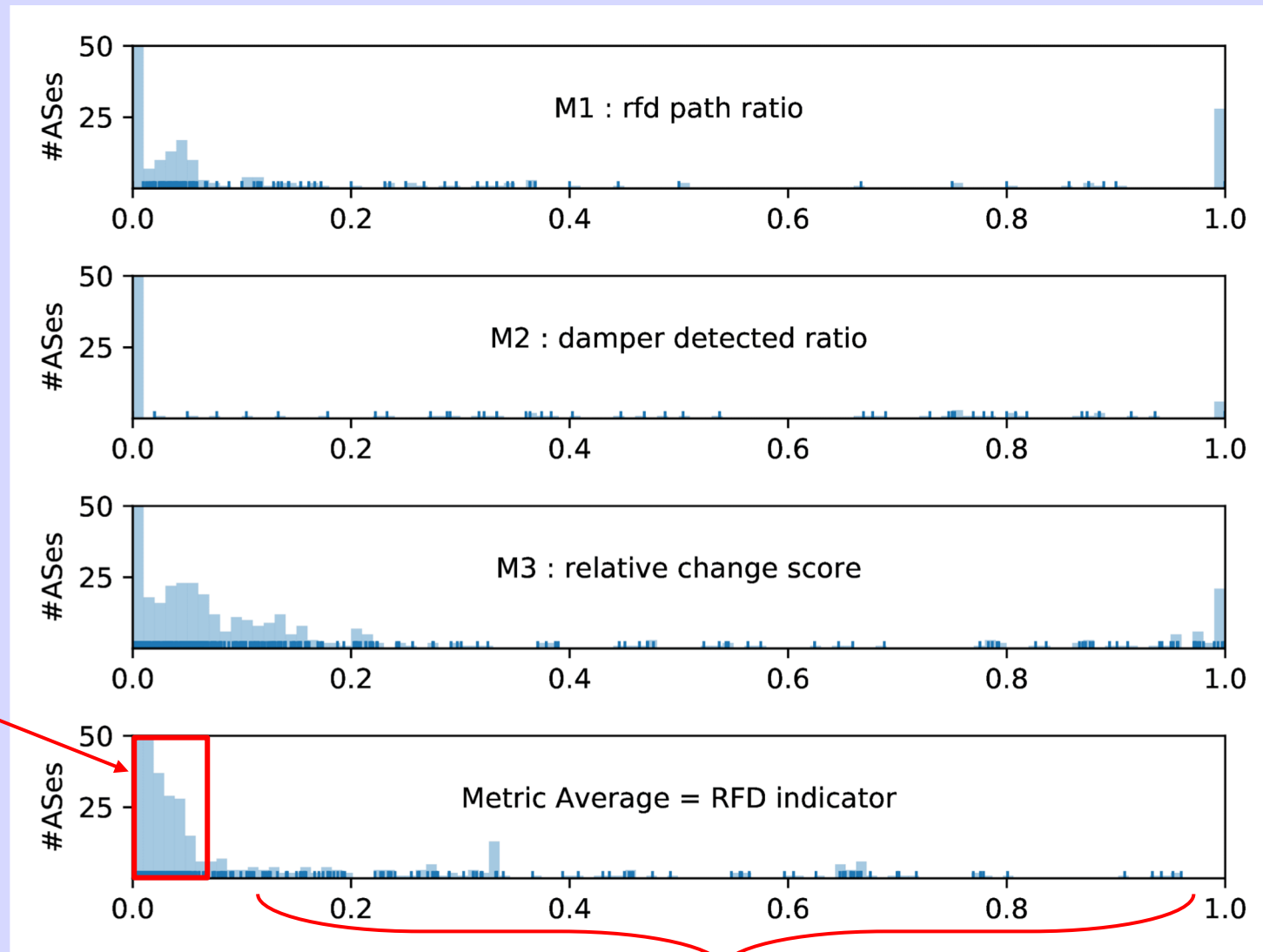


no RFD

Announcements in Break and steep line imply high RFD probability
Because damper finally reset during break

How do our Metrics
perform?

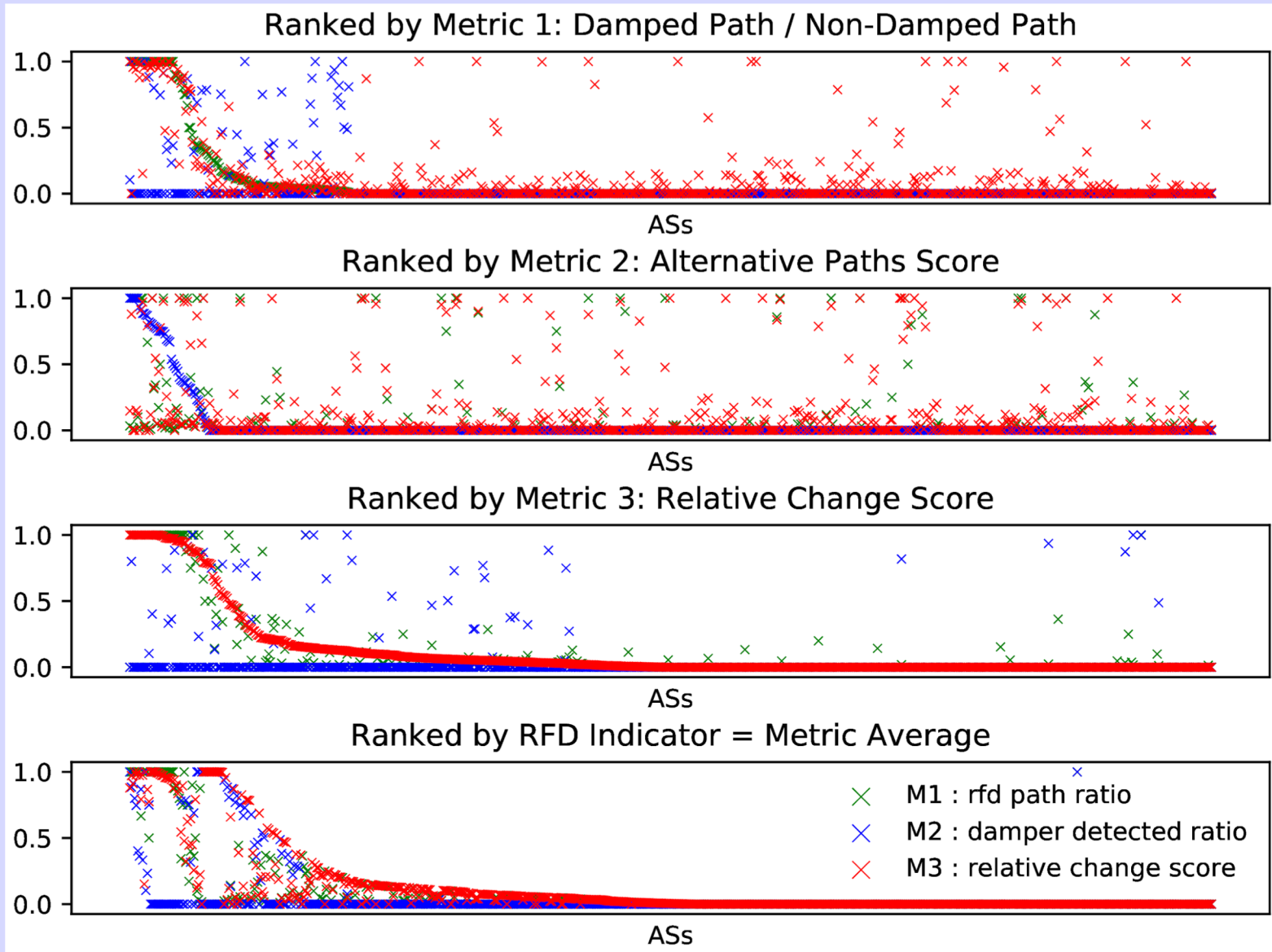
Distribution of Metrics



Most ASs get a score of 0 and do not use RFD.

116 of 678 ASs (17%)

Do the Metrics agree?



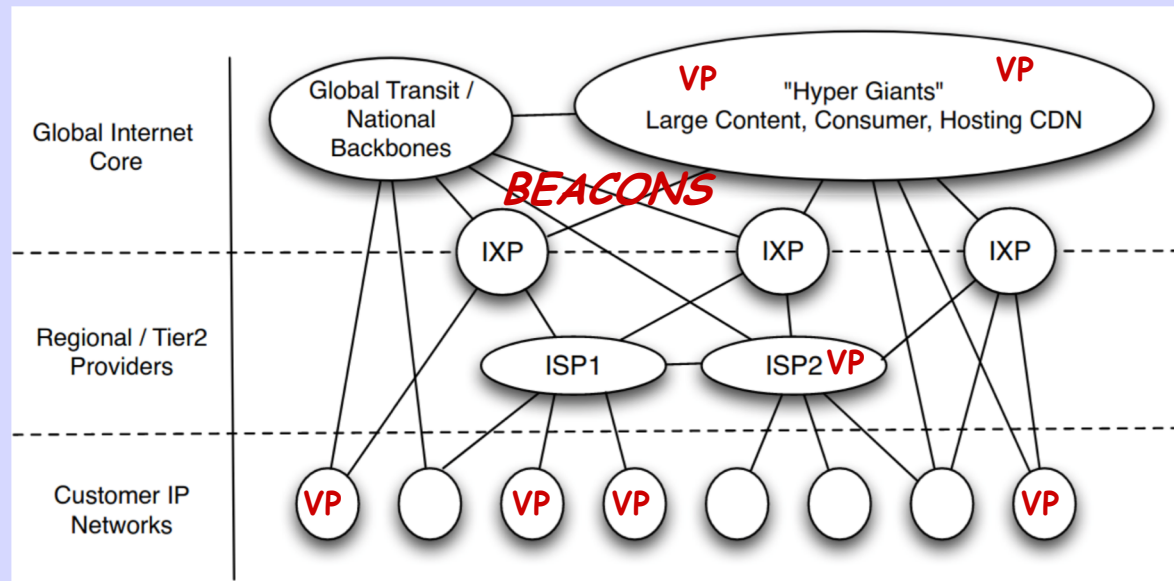
Limitations of the Infrastructure

We can make statements on **678 ASs** which is **1% of existing ASs***

Our Beacons are located close to the Internet Core.

Therefore the **signal travels mostly downwards** in the AS tree.

We are mostly measuring how providers & peers are being damped. We can't measure ASs that only damp edge customers.



G. Labovitz, et al.: Internet Inter-Domain Traffic, ACM SIGCOMM 2010

* Origin-only ASs present in the Internet Routing Table: 57317. (APNIC)

Who is damping?

Based on our current metrics we are estimating that ~17%* of all ASs are using RFD.

Most ASs confirmed our findings.

Examples are: Swisscom, GTT, NTT, Verizon, AARNET ...

Was it Clearer?



Hypothesis

- We only see 20,000 bad boys because RFD hides the others
- But cycling through changes in damping states changes which ones we can see at any time
- Is the bad boy limit an effect of RFD and AS topology?

Thanks to Our Sponsors

- Our Institutions: Freie Universität Berlin, Internet Initiative Japan, l'Université de Strasbourg, Universität Hamburg
- Beacon Hosts: BKNIX, Fibia P/S, IIJ, NIC Brasil, RGnet, Seacom, SpaceNet
- Colo, Equipment, Bandwidth: Arrcus, Cisco, Google, Juniper, NTT, RGnet, Sprint

Meanwhile, inside the box, Schrodinger's cat plans its revenge.

no kitties
were
harmed
in this
research

