Weaponizing BGP Using Communities

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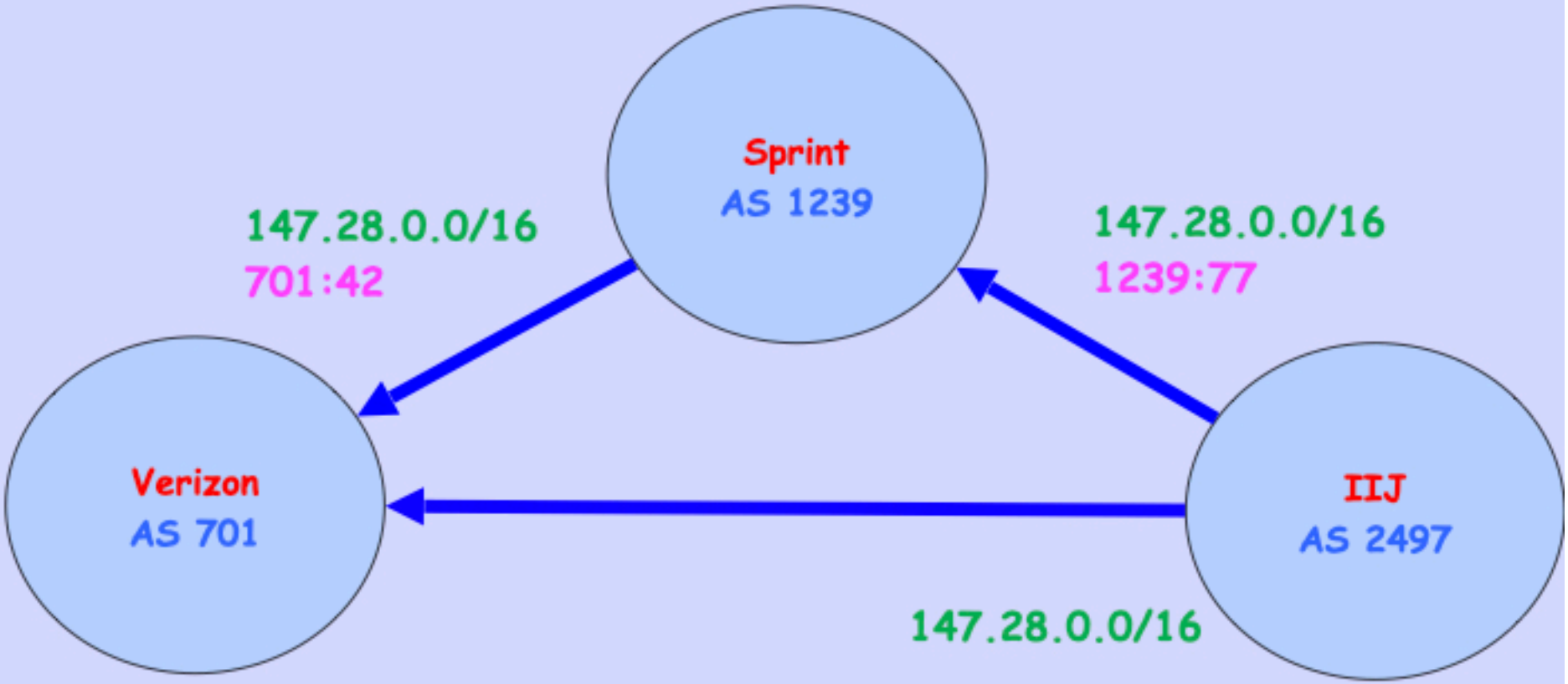
BGP Was Not Complex Enough

Operators Wanted Signaling on Top of Signaling

Add BGP Communities



Syntax

AS#:number

But

AS#

May really be Anything

And

:number

May really Mean

Anything

Undefined Semantics

We have a syntax, AS:<blarg>

But there are no formal semantics, just convention and common practice

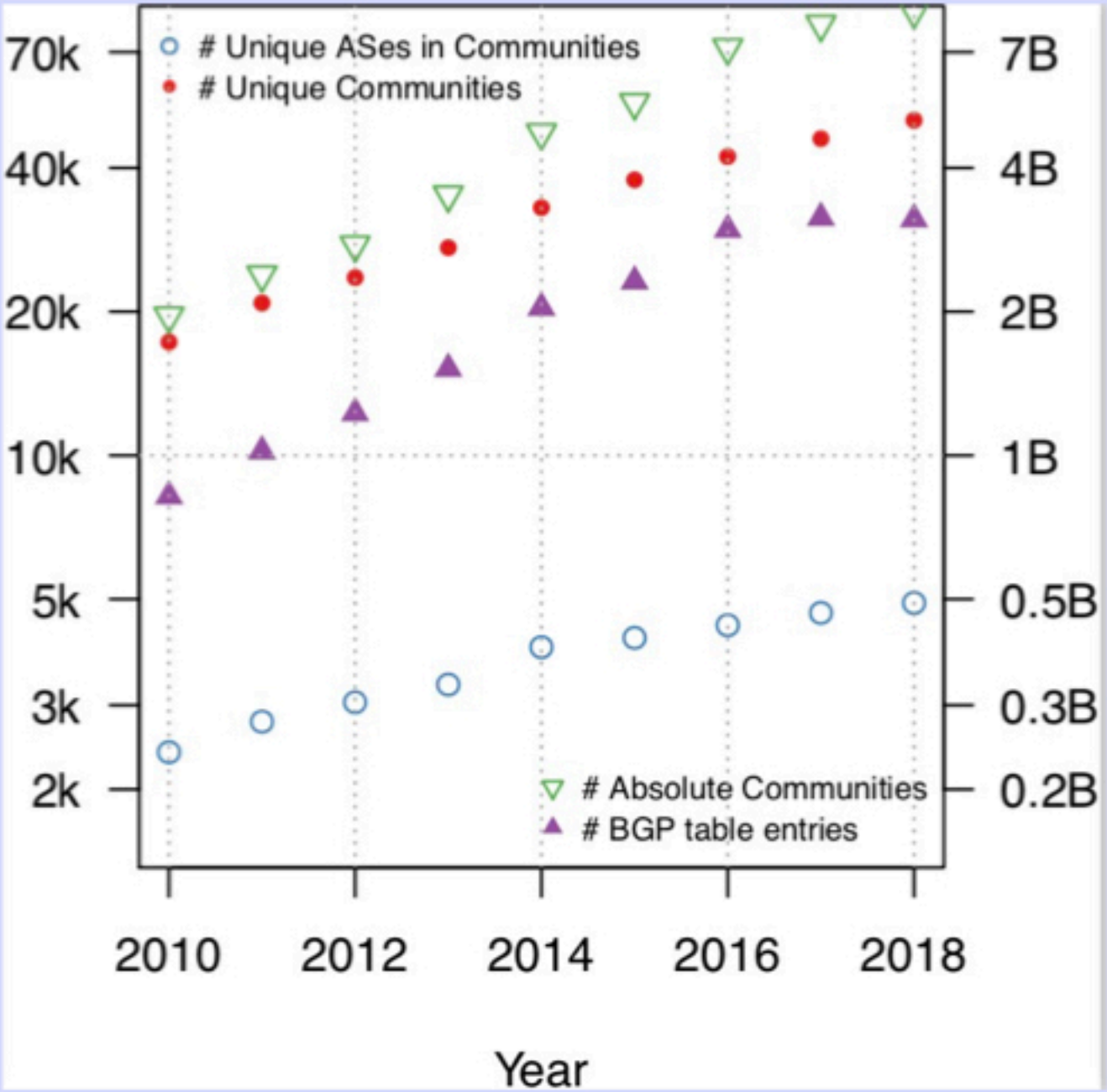
We're putting semantics in comments

```
i = 0; /* i = 42 */
```

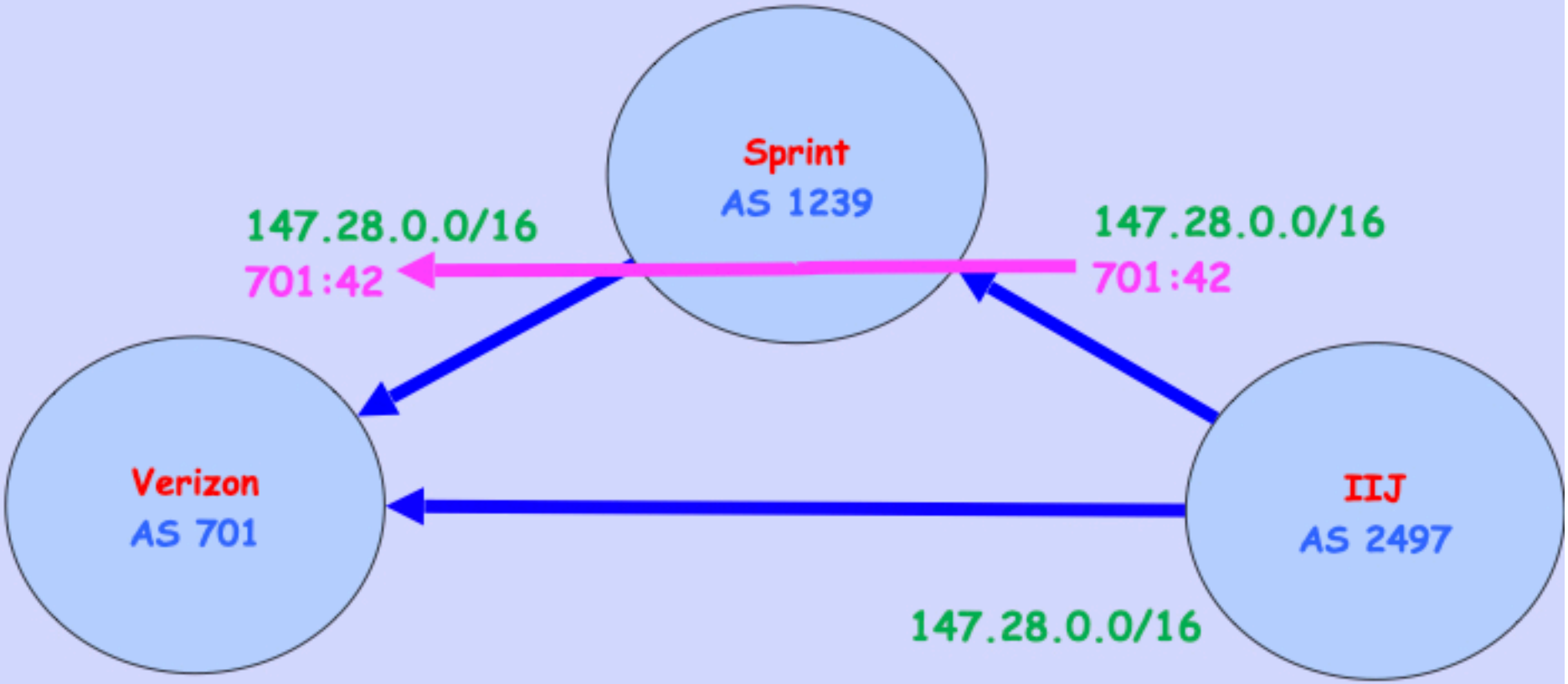
Flavors, We Think

- Active
  - Path prepending
  - Modify local preference
  - Remote triggered blackholing
  - Selective announcements
- Passive
  - Location Tagging
  - RTT Tagging

And then anything a thousand kiddies have invented



Propagation



Propagation

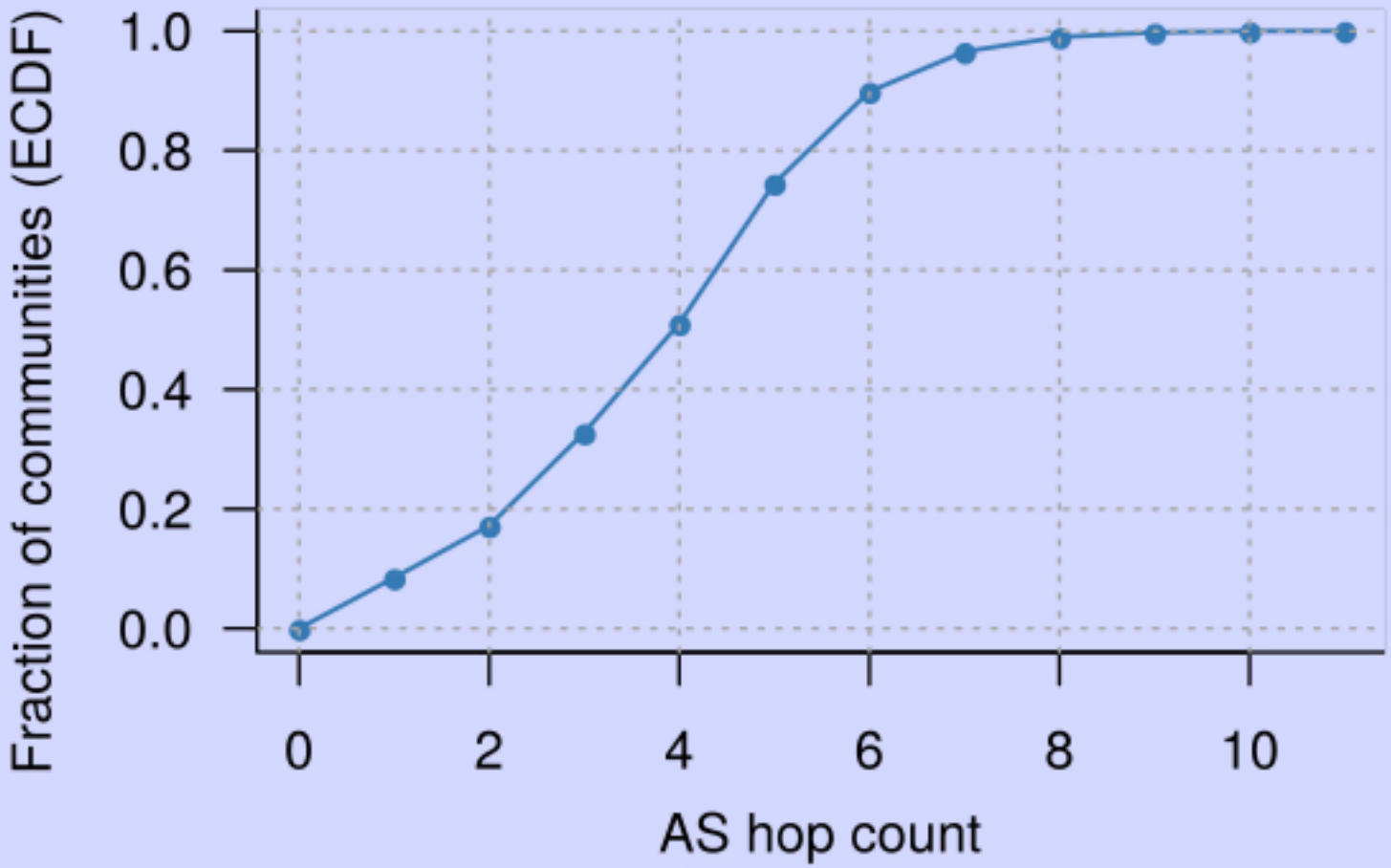
- RFC 1997: Communities are a transitive optional attribute
- RFC 7454: Scrub own, forward foreign communities
- So many people do not expect them to propagate that widely
- I, for one, did not

Only 14% of Transit ASs propagate communities

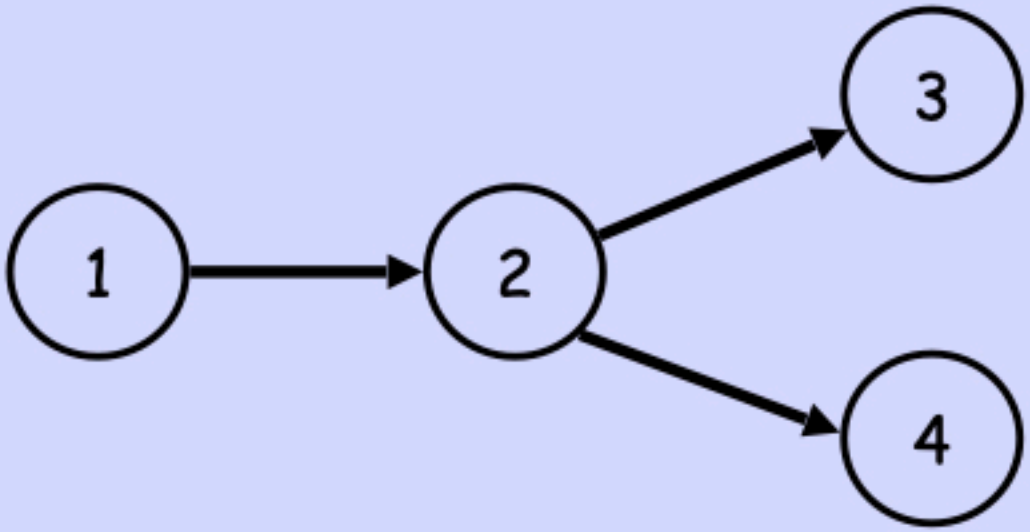
(2.2k of 15.5k)

Surprise!

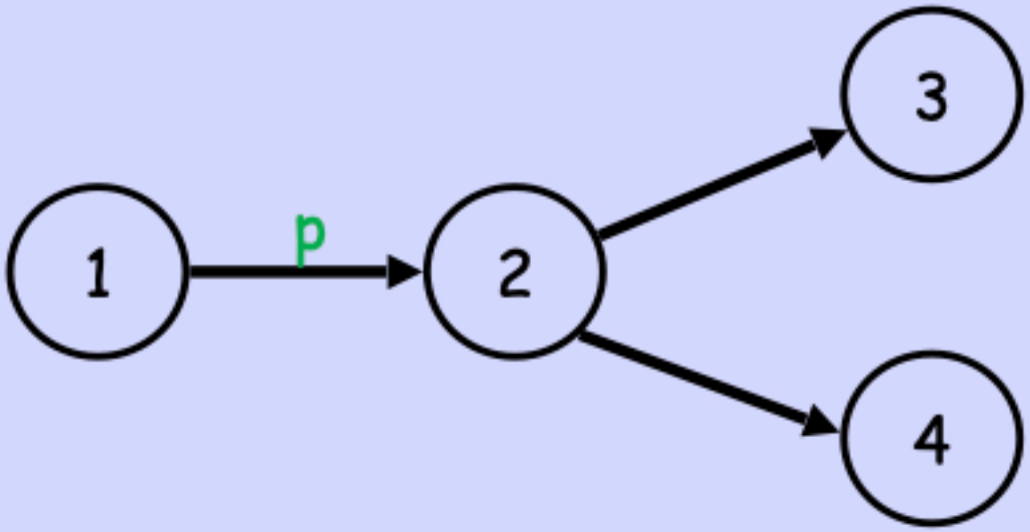
- 14% seems small, but the AS graph is highly connected
- More than 50% of communities traverse more than four ASes
- 10% of communities have a hop count of more than six ASes
- Longest community propagation observed: through 11 ASes



On/Off Path



On/Off Path



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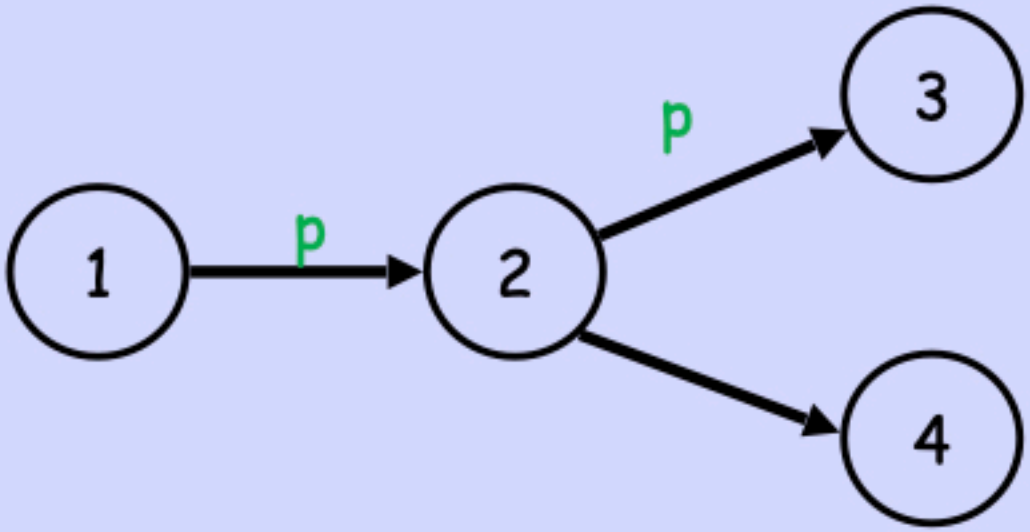

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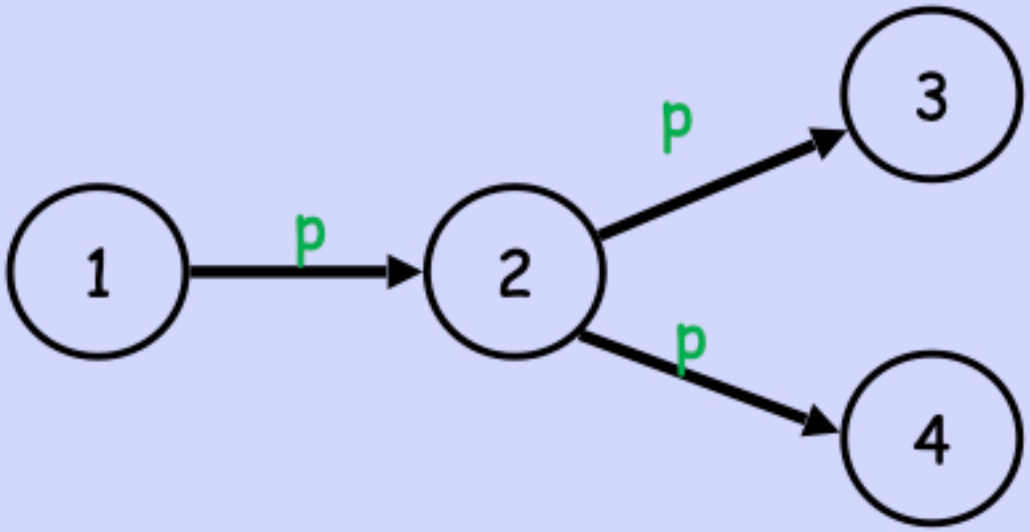

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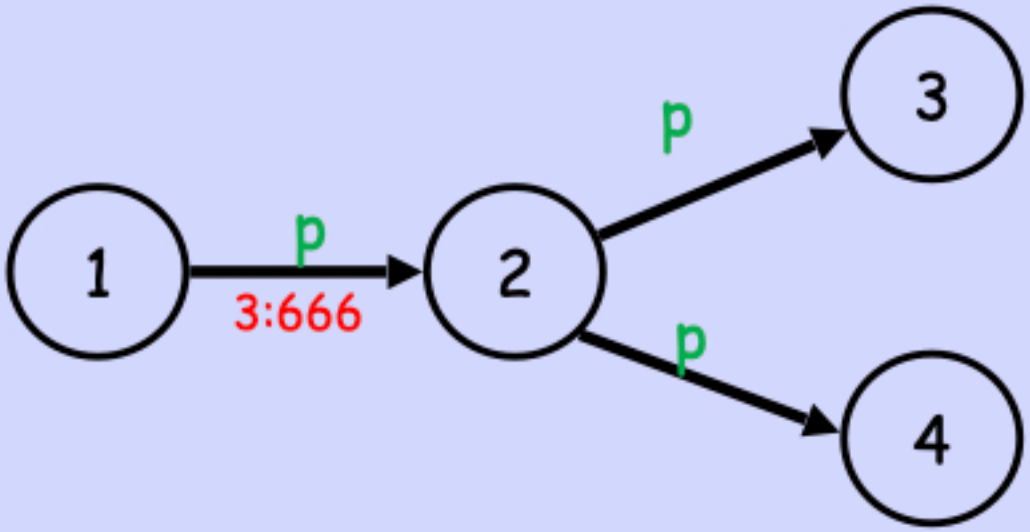

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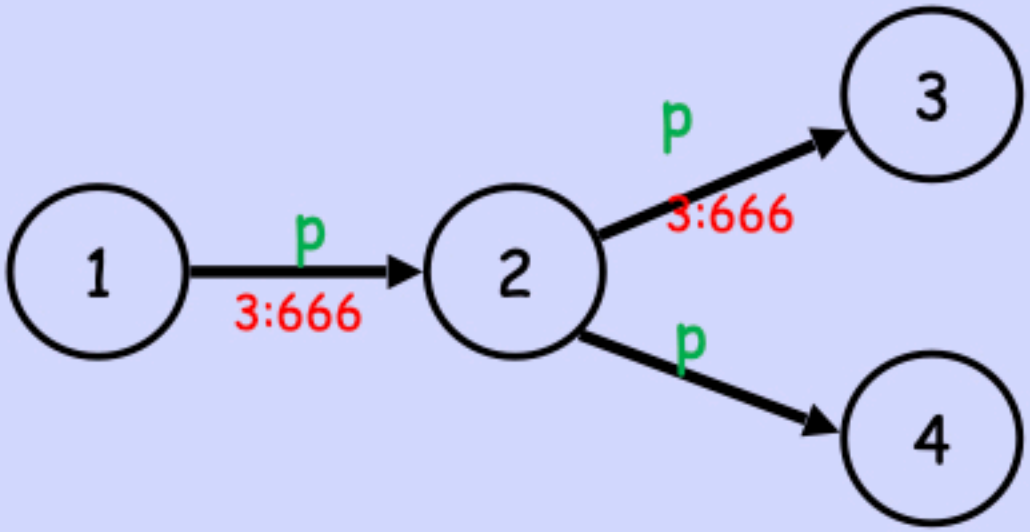

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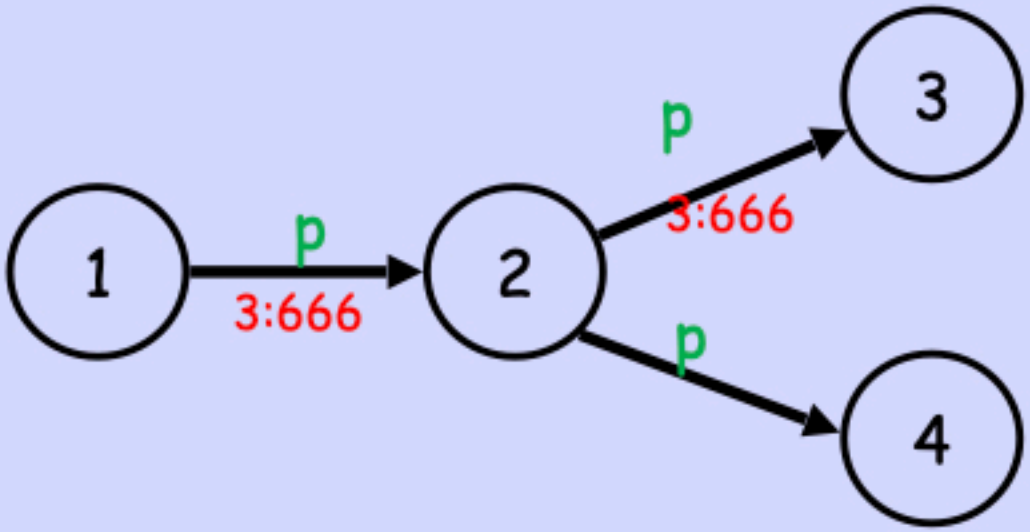
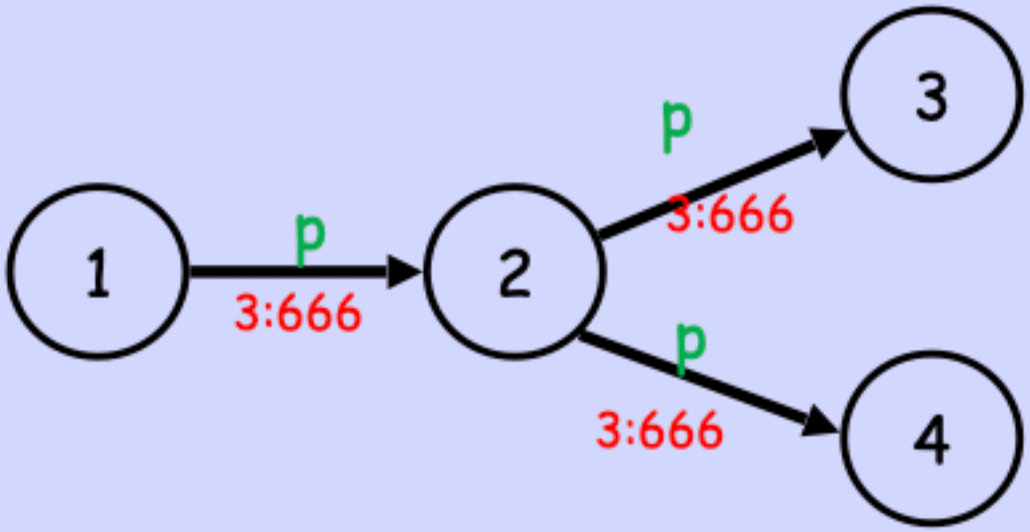


2 and 3 are On Path

On/Off Path



2 and 3 are On Path

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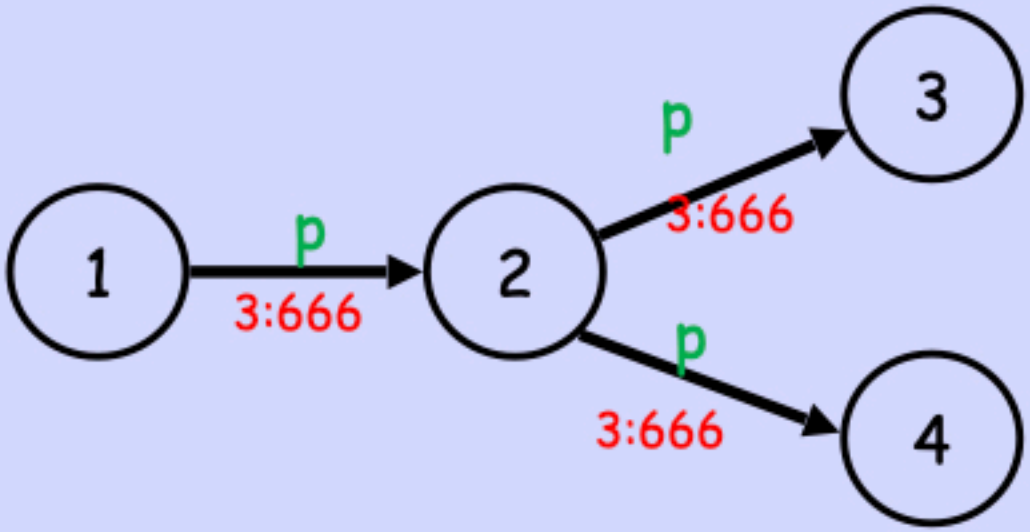
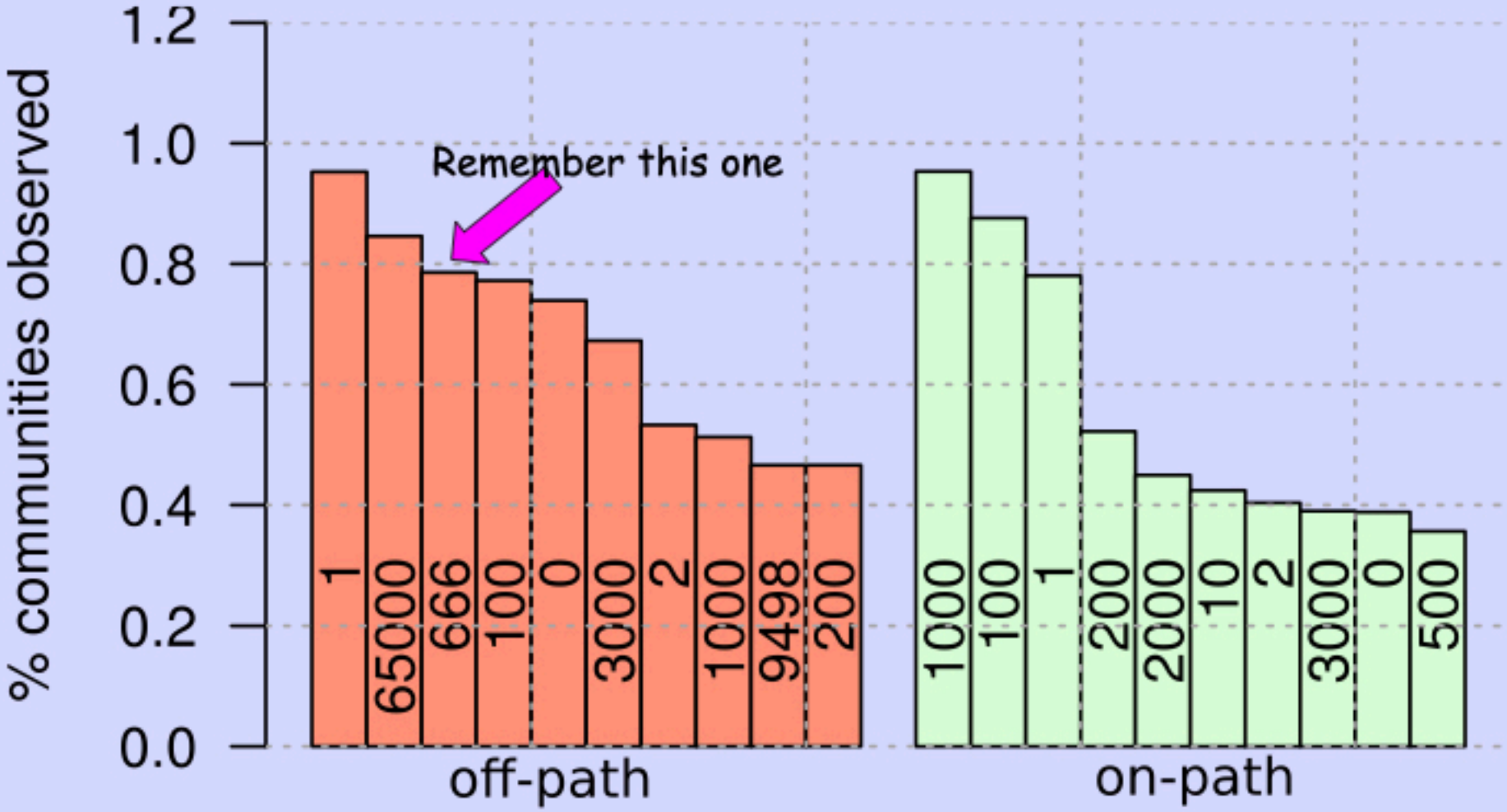


2 and 3 are On Path

4 is Off Path

Observed Communities



And We Have No Idea What Almost All of Them Mean

The Internet is an Experimental Hack

So Let's Break Things!

Method to our Madness

- All experiments first tested in Lab
- Impacts were estimated
- Validated on the Internet, with operators' consent, e.g. for hijacks

RTBH

One of the Very Few Defined Communities

RTBH

Remotely Triggered Black Hole Community

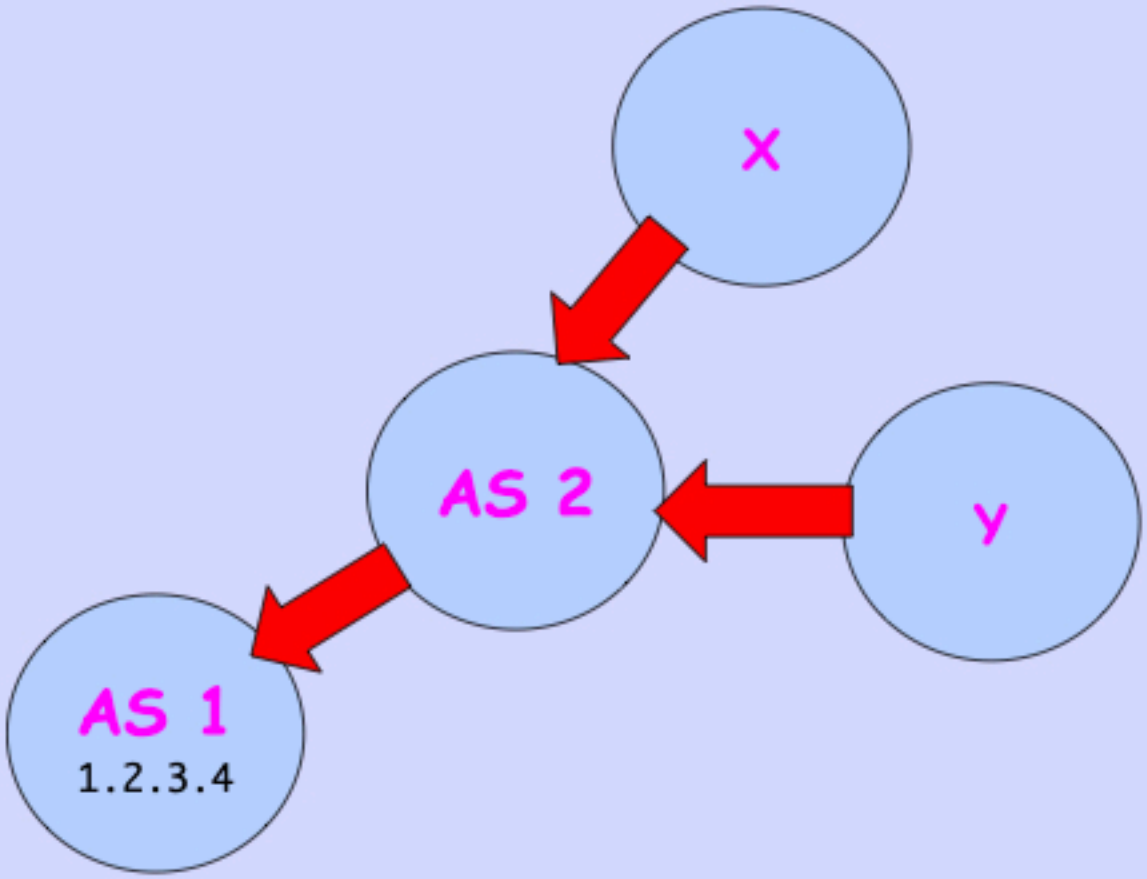
"TargetAS:666"

Attached to a Prefix

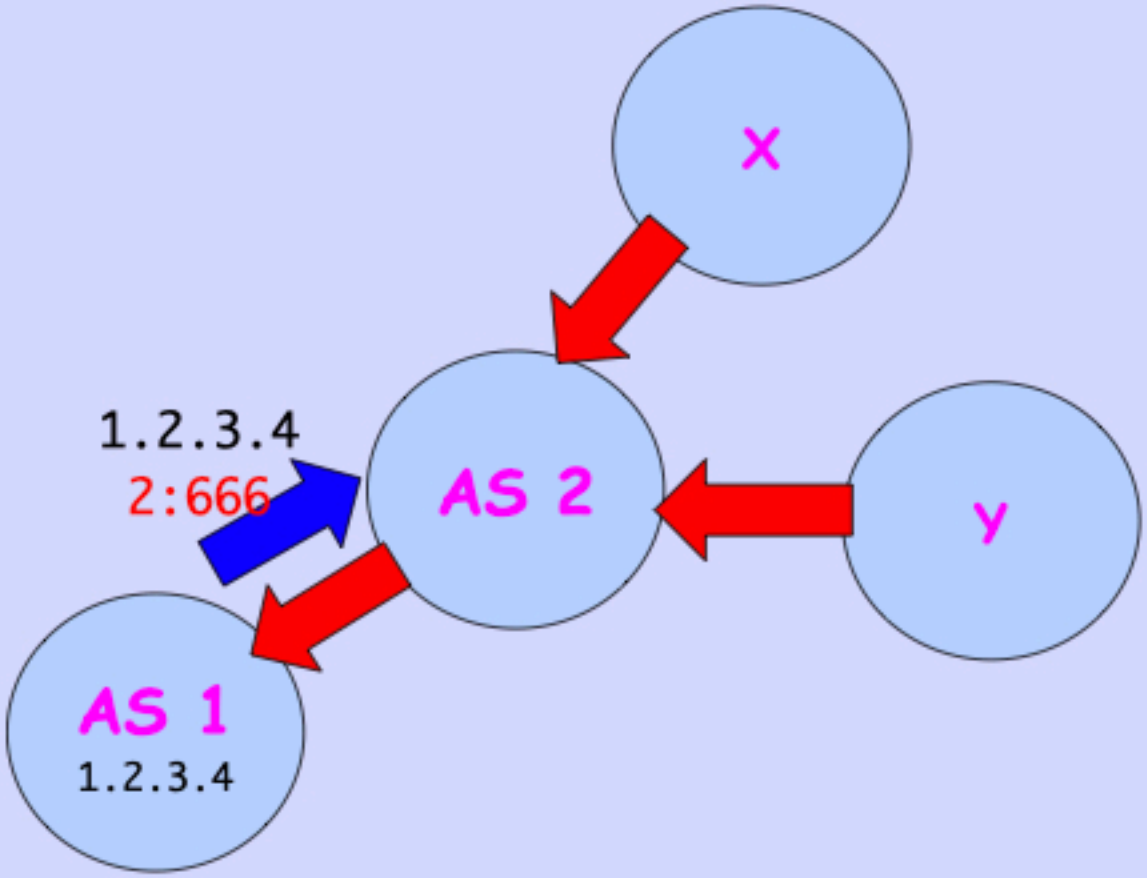
A DoS Defense

Signaling that Traffic to a Prefix be Dropped

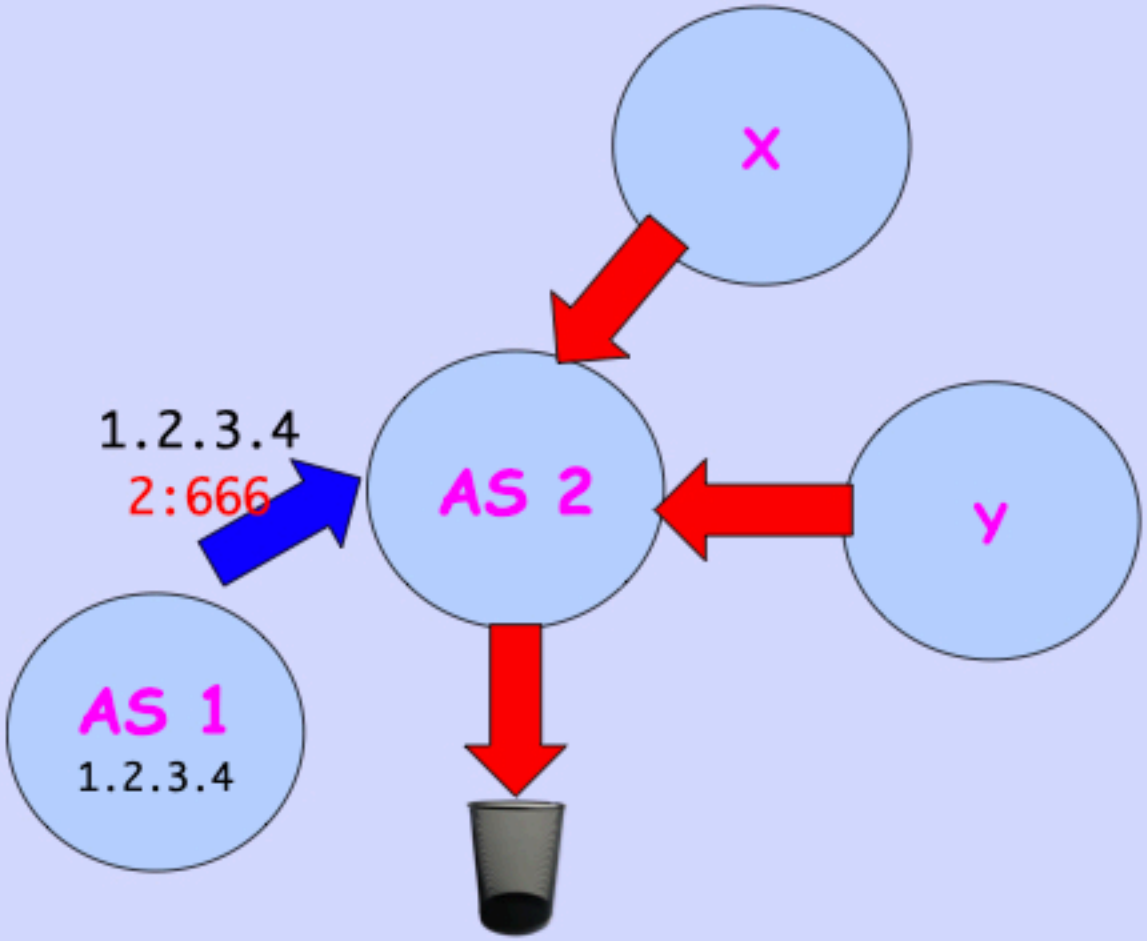
DDoS Attack



Ask AS 2 to Black Hole



Traffic Dropped



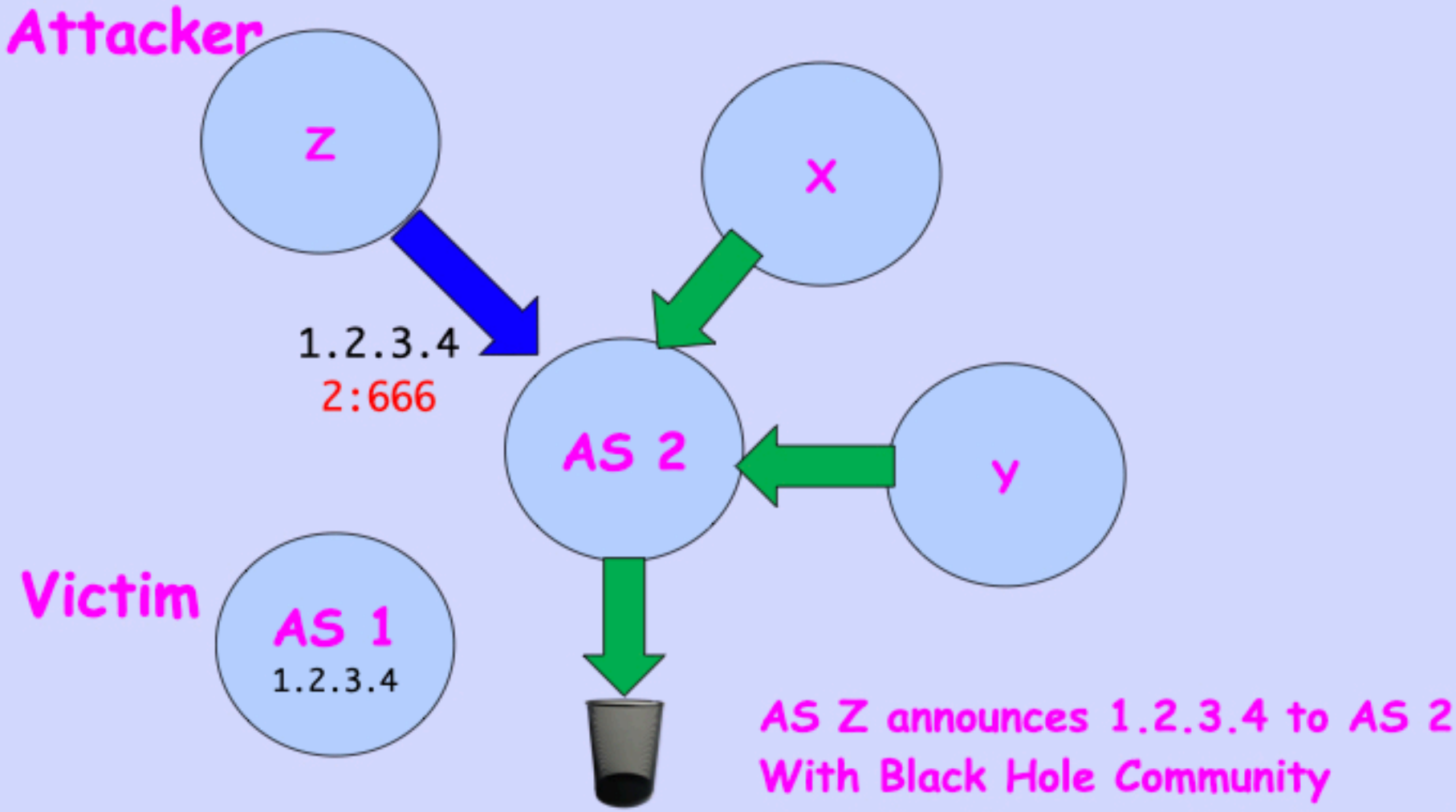
Safeguards, in Theory

- Provider should check customer prefix before accepting RTBH
- Customer may only blackhole own prefixes
- Different policies for Customers/Peers
- On receiving RTBH, do not propagate

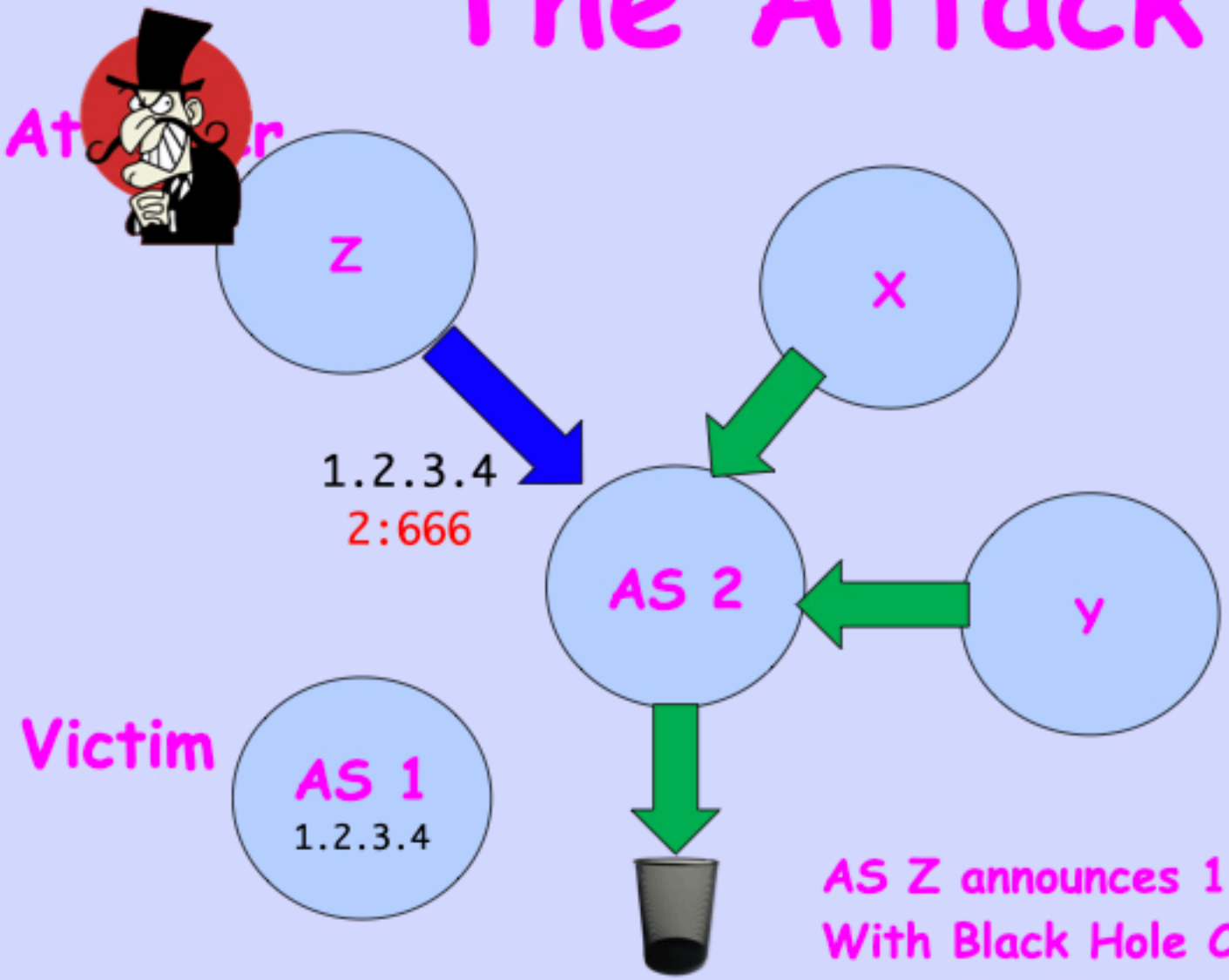
Which Looks Very Cool

Except it is an Attack Vector

The Attack



The Attack

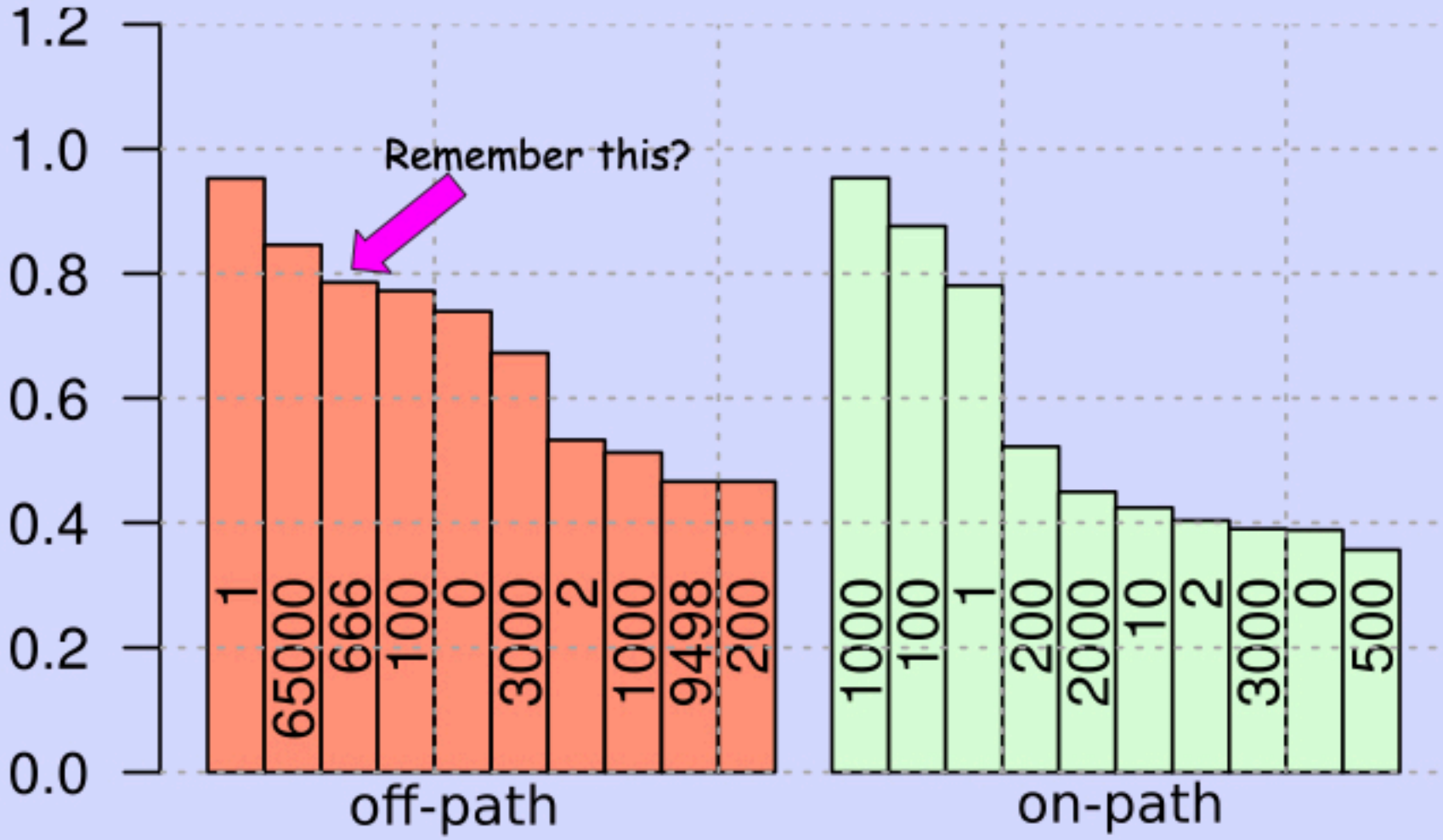


AS Z announces 1.2.3.4 to AS 2
With Black Hole Community
Good Traffic to AS 1 is Dropped

The Attack Works Well

- Works from a distance and is hard to spot
- Triggering RTBH is possible for attackers because, e.g.,:
  - BH prefix is more specific, thus accepted via exception
  - Providers check BH community before prefix filters (bug in NANOG recipe)
  - No validation for origin of community is possible

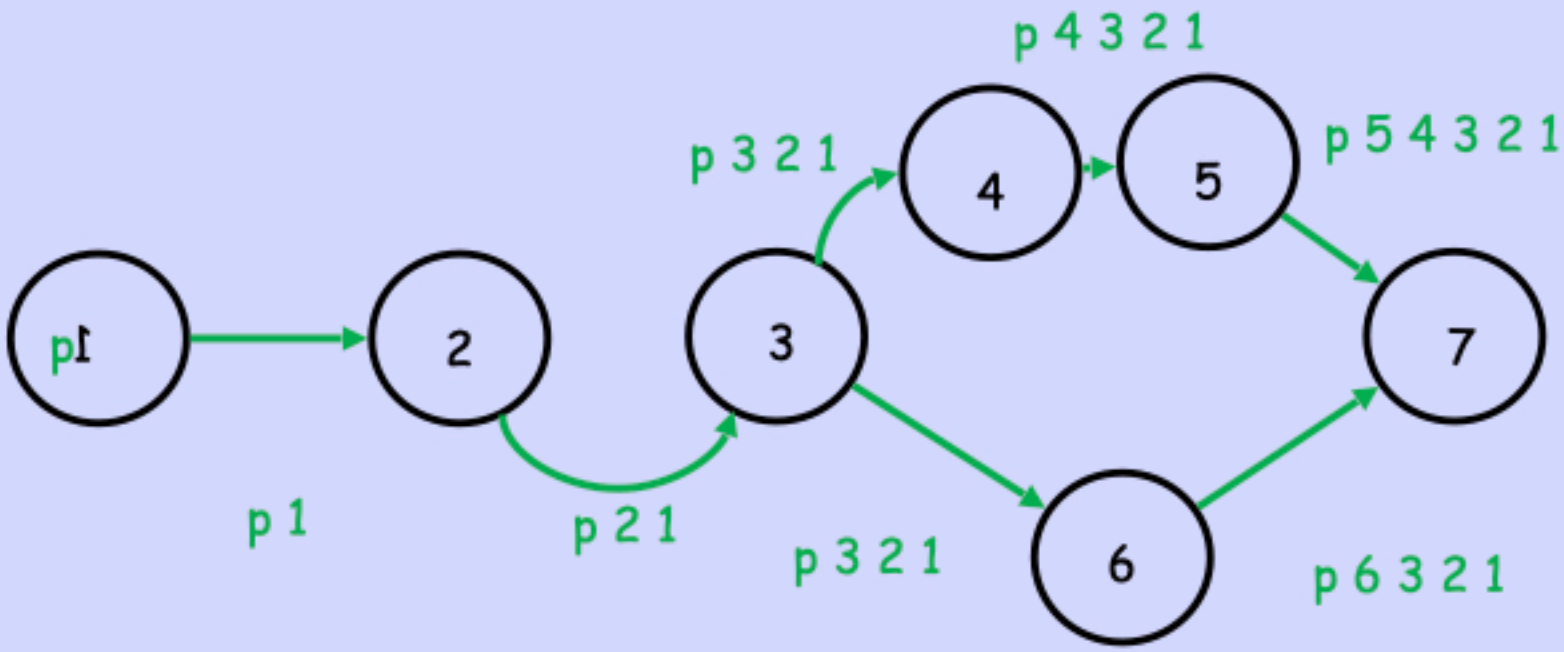
Off-Path Attacks



Traffic Steering

p 4 3 2 1

Traffic Steering



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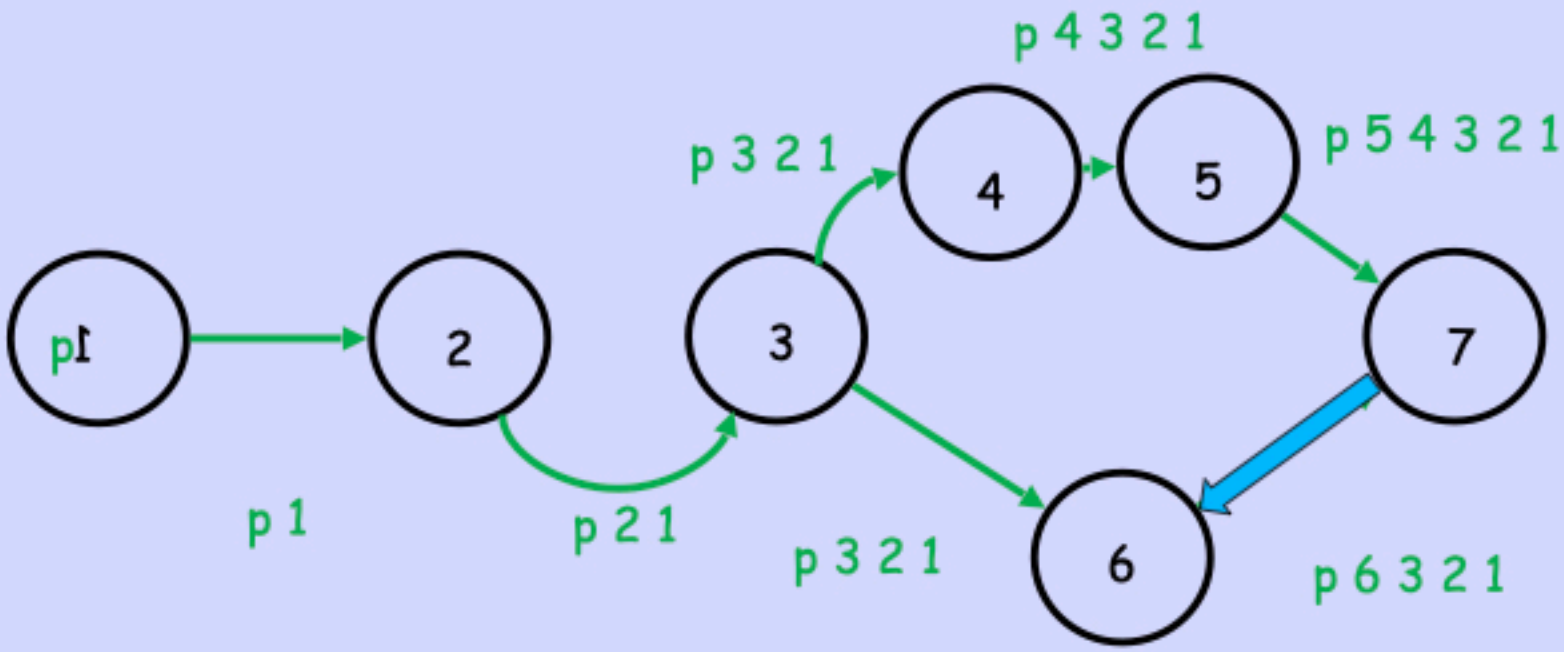

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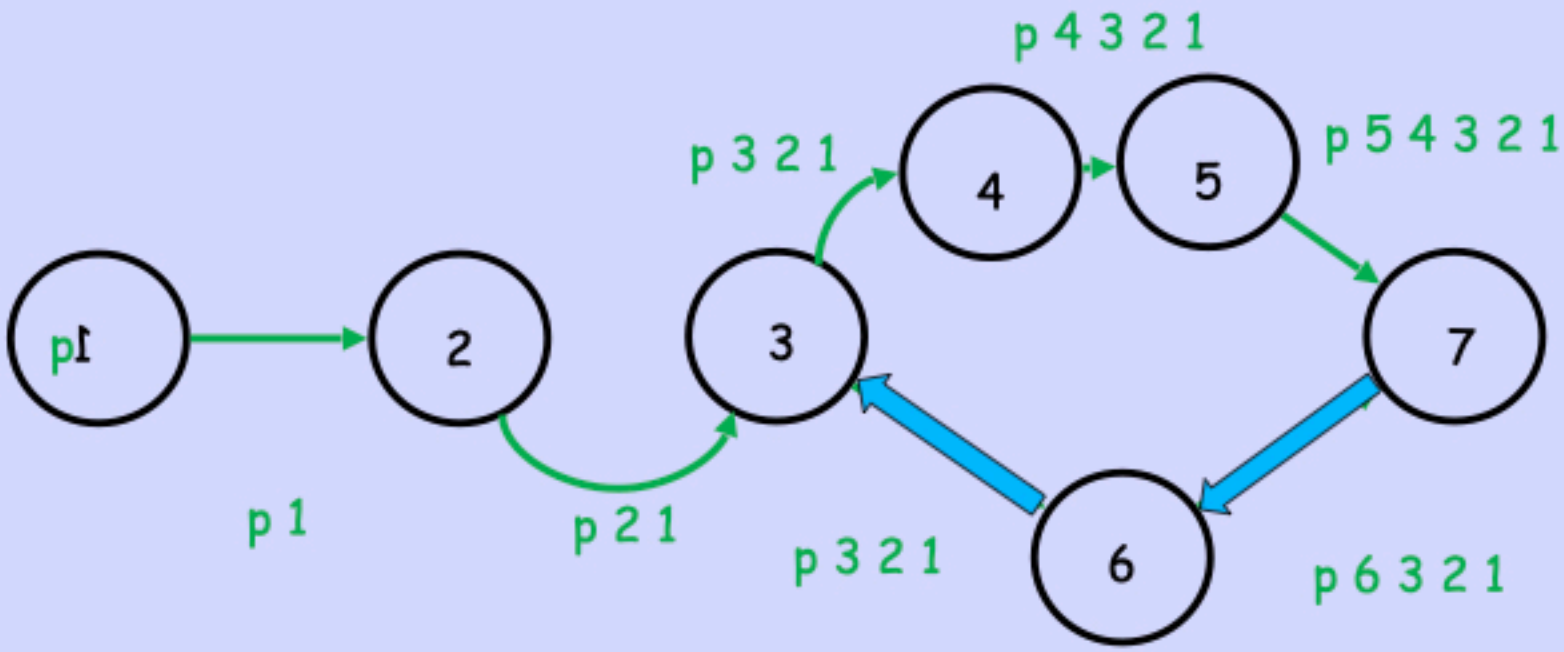

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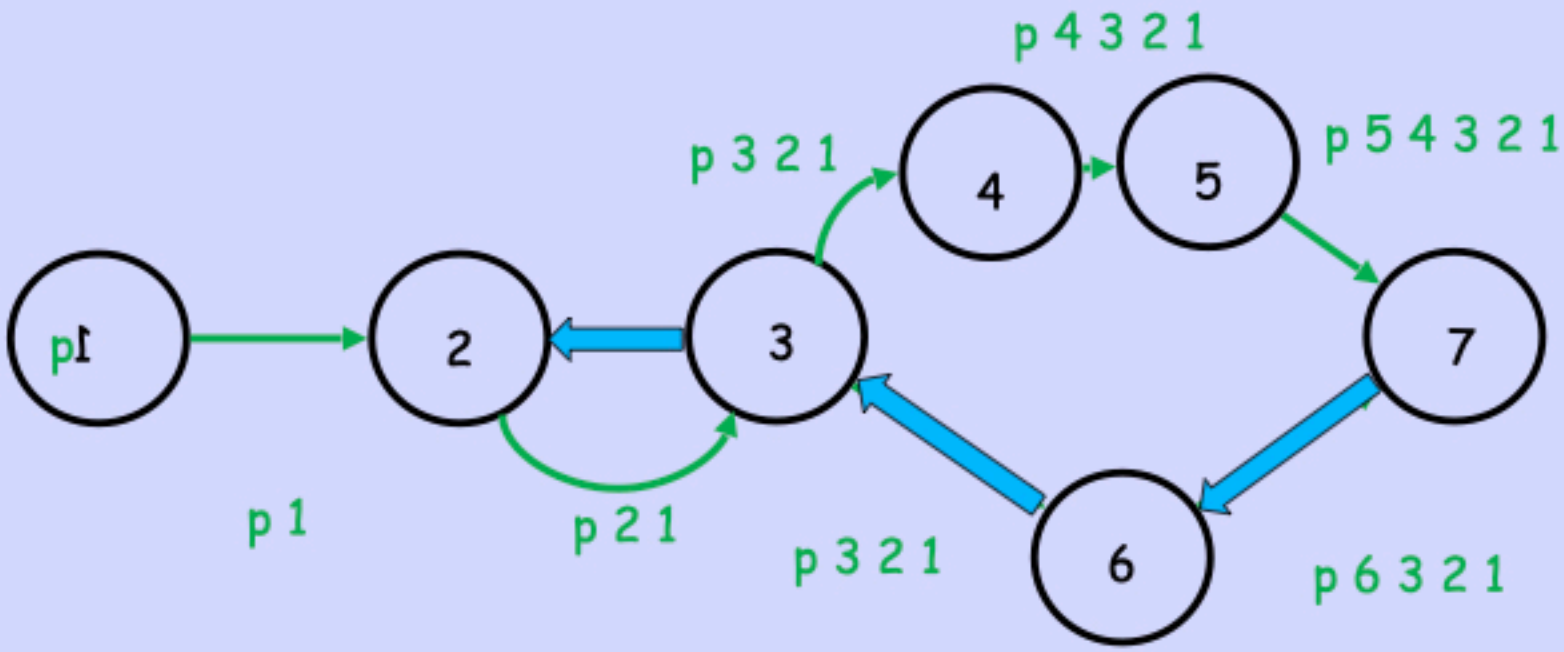

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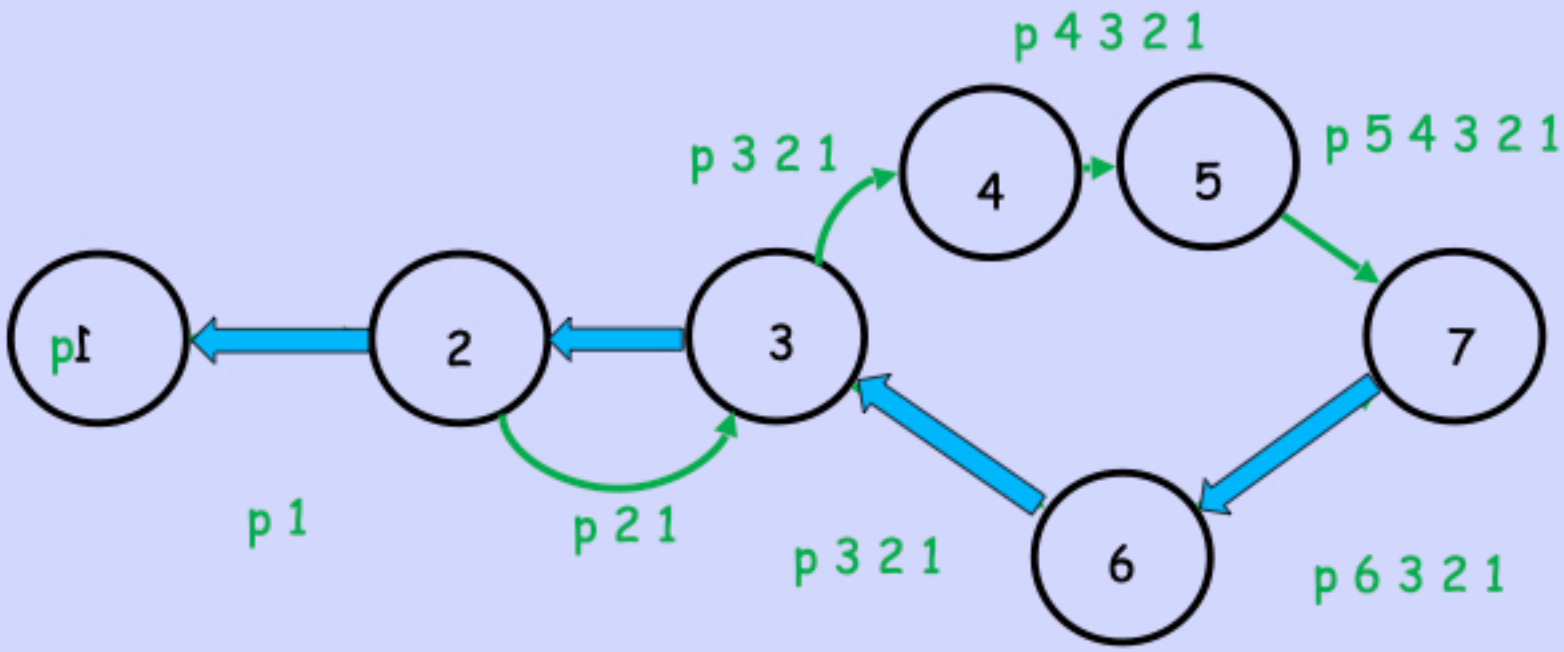

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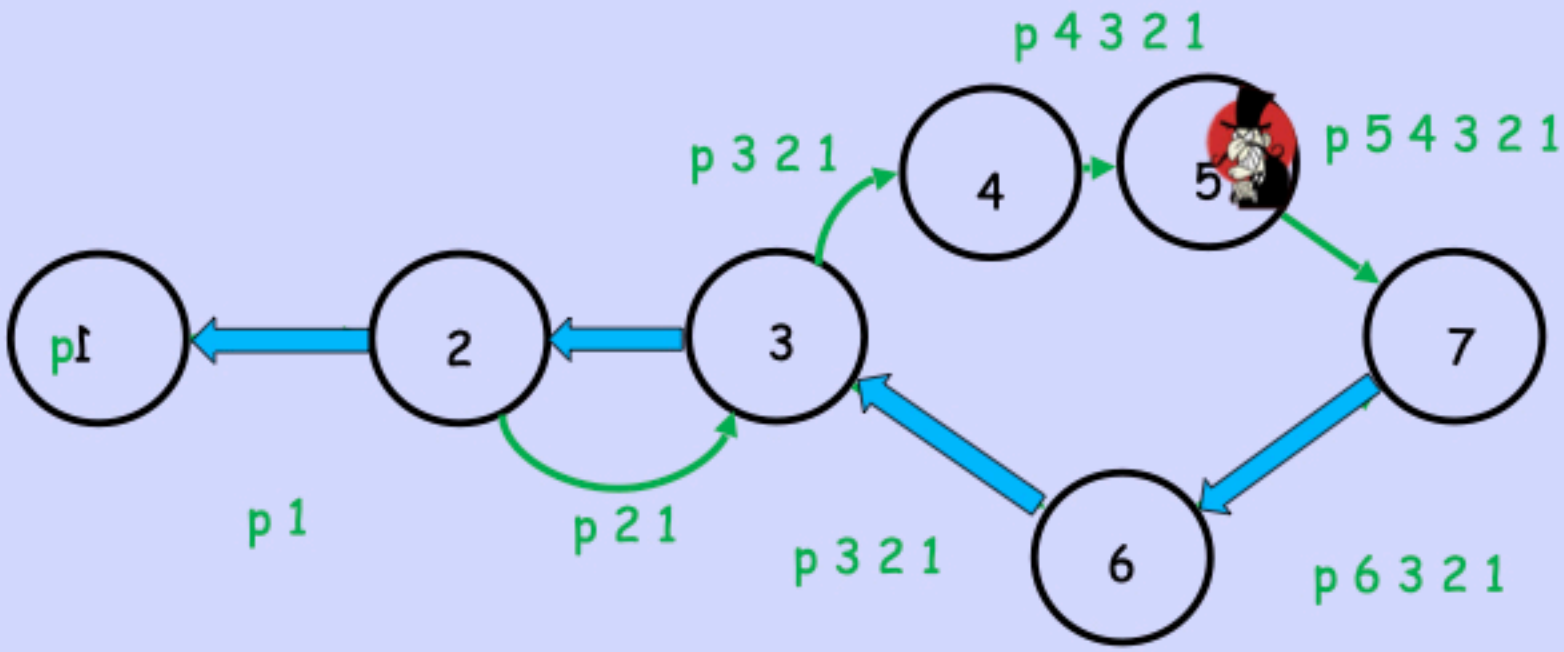

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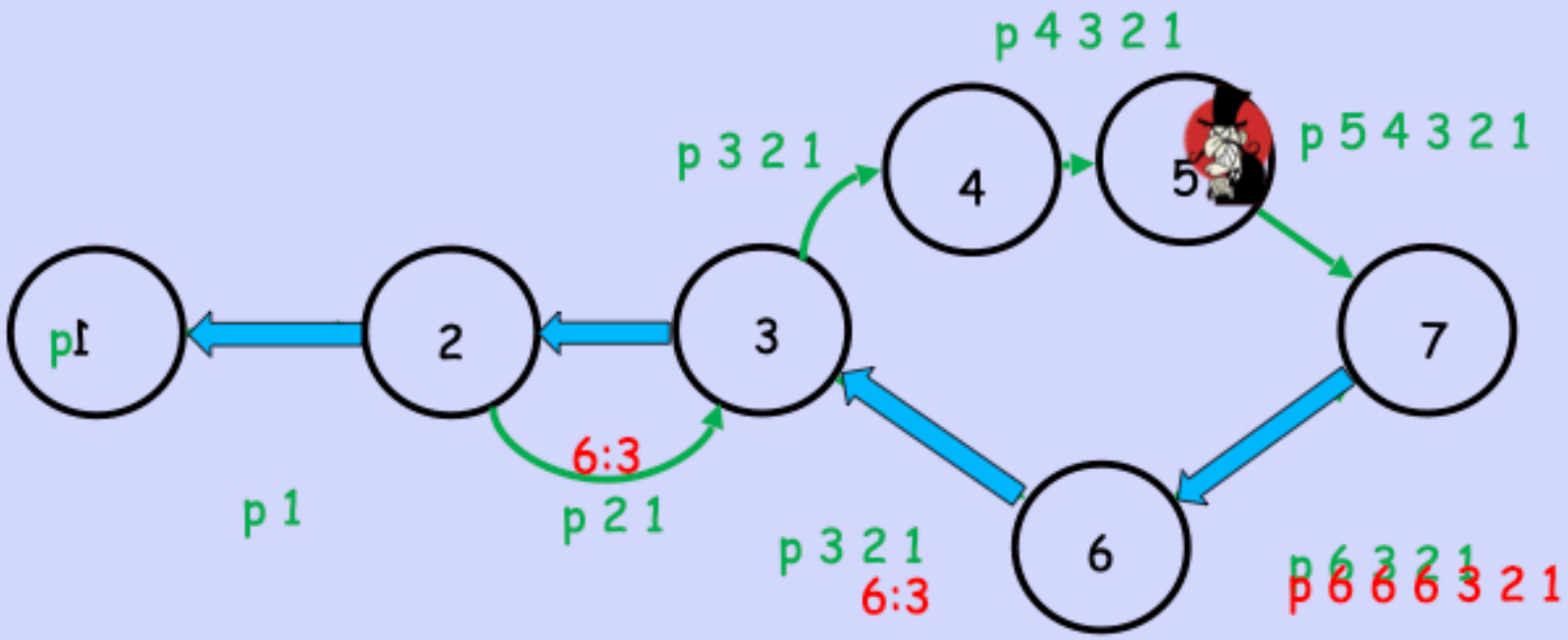

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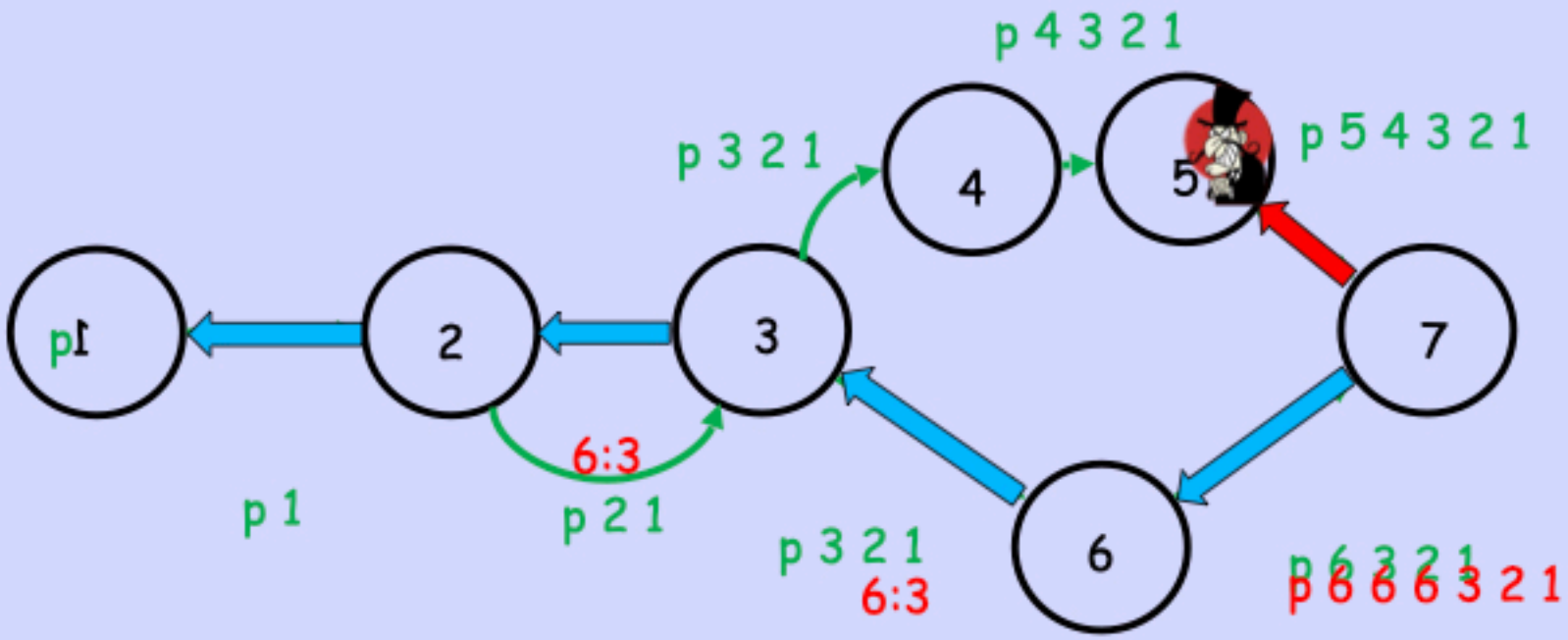

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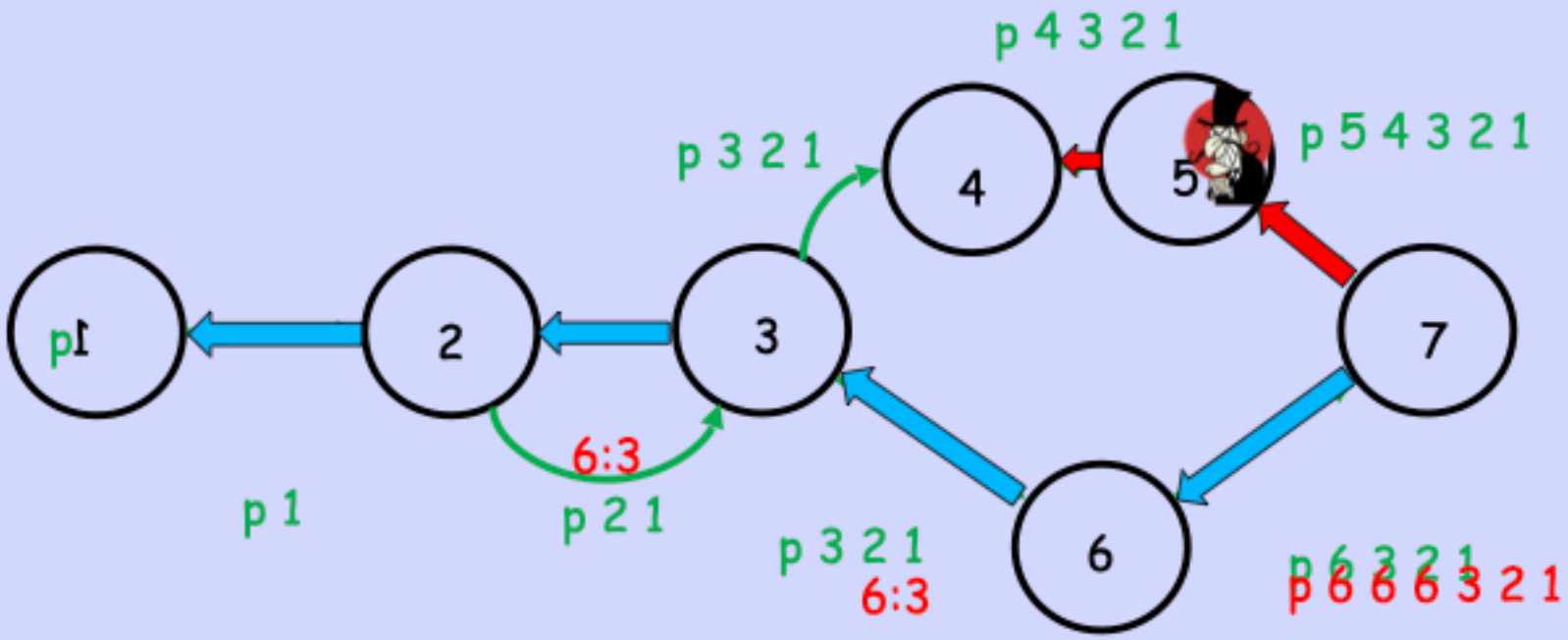

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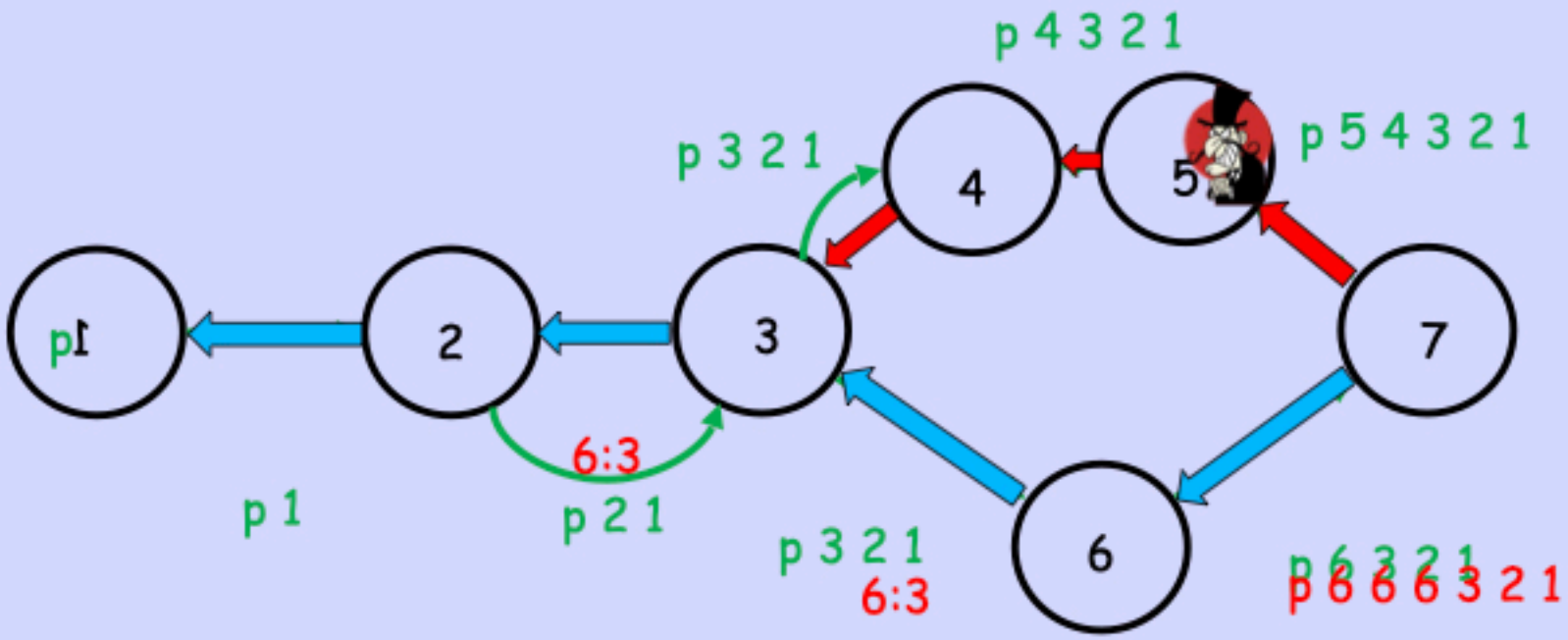

But Is That Realistic?

Yes, In The Wild!

https://dyn.com/blog/bgp-dns-hijacks-target-payment-systems/

"BGP hijacks made use of BGP communities to shape route propagation. Although they also changed origins, which was the giveaway."

It's the Cloud, Man

- ASN value ambiguous: who is "sender", "recipient"
- No defined semantics, values can mean anything
- Used both for signaling and triggering of actions
- No cryptographic protection
- Attribution is impossible
- It is hard to apply filters or understand what is going on

I Read it on the Internet

- Communities can be modified, added, removed by every AS
- No attribution is possible
- No cryptographic protection
- Yet operators bet on their 'correctness'
- Large communities partially improve the situation

Don't Propagate Without Thinking Very Deeply

- On Input – Drop anything not addressed to you, unless special agreement
- On Output – Drop everything except signals from you to the direct peer
- And Beware Cisco 'mis-feature' re well known communities
- RFC 8642 - Policy Behavior for Well-Known BGP Communities

Design on a Napkin
Die by Napkin