The Next Generation of BGP Data Collection Platforms

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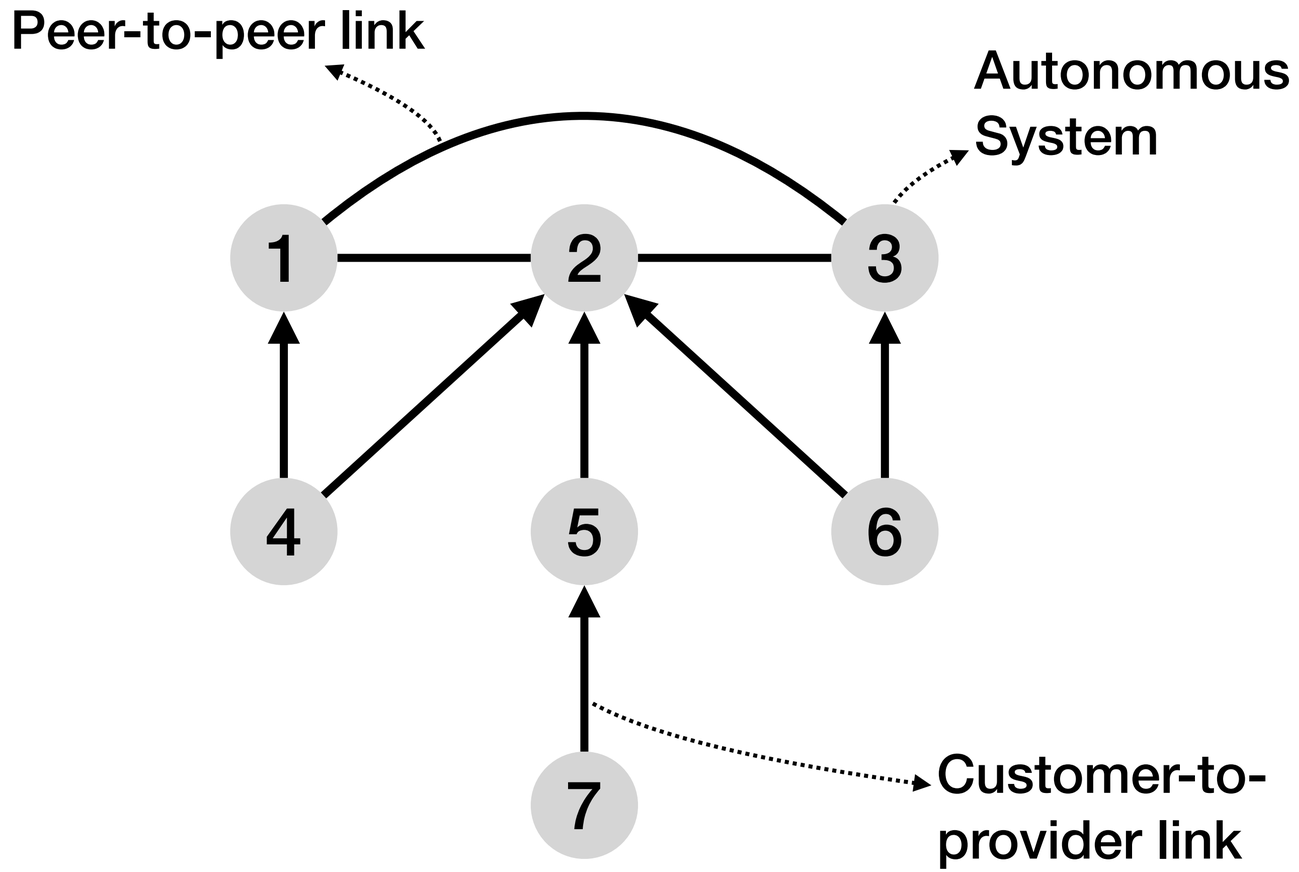
University of Strasbourg

AIMS GMI Workshop
25 June 2024

Joint work with:

Thomas Holterbach
Thomas Krenc
KC Claffy
Cristel Pelsser

Public BGP routes are collected by RIPE RIS and RouteViews



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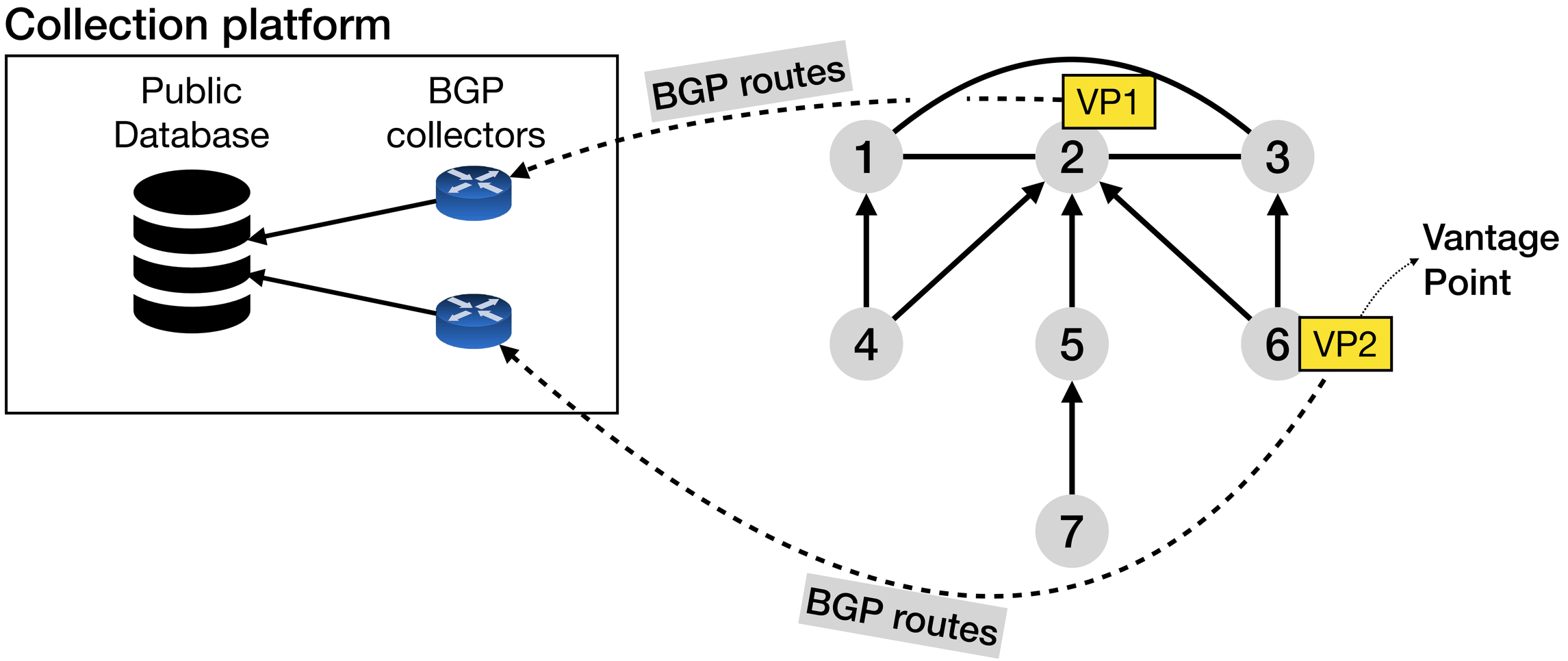

Three observations motivate reevaluating how we collect BGP routes

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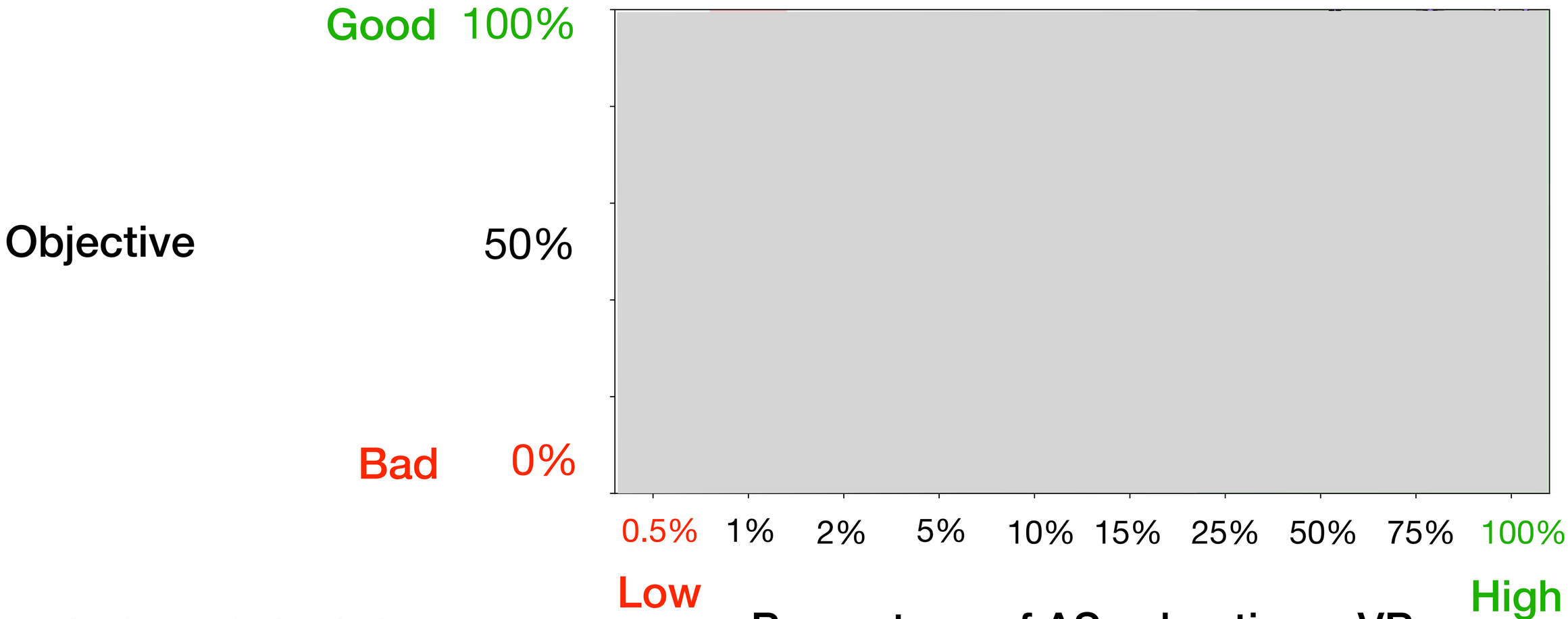
Observation #1: RIPE RIS and RouteViews lack coverage

RIS and RouteViews' low coverage negatively impacts many studies



Results from 10 simulations
on "mini" Internets with 6k ASes

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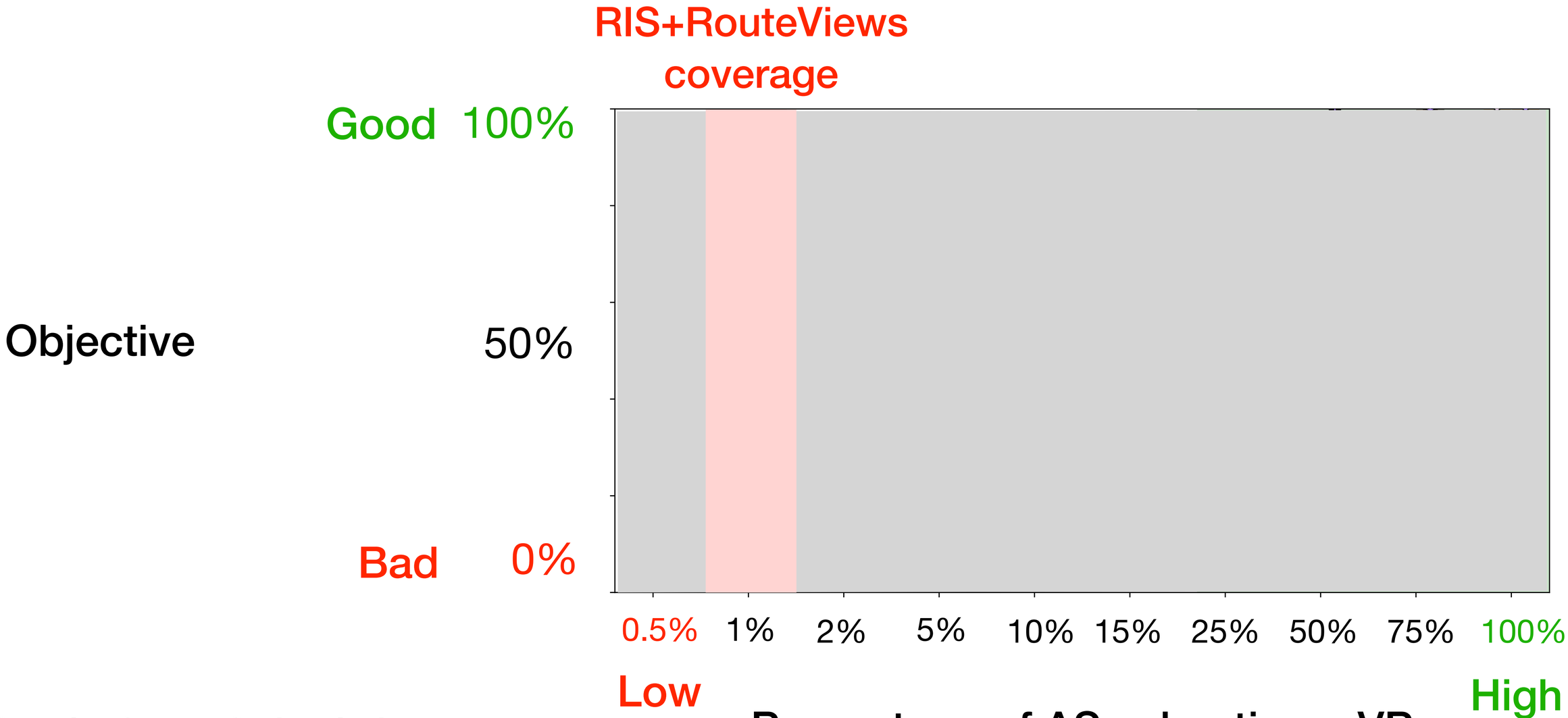

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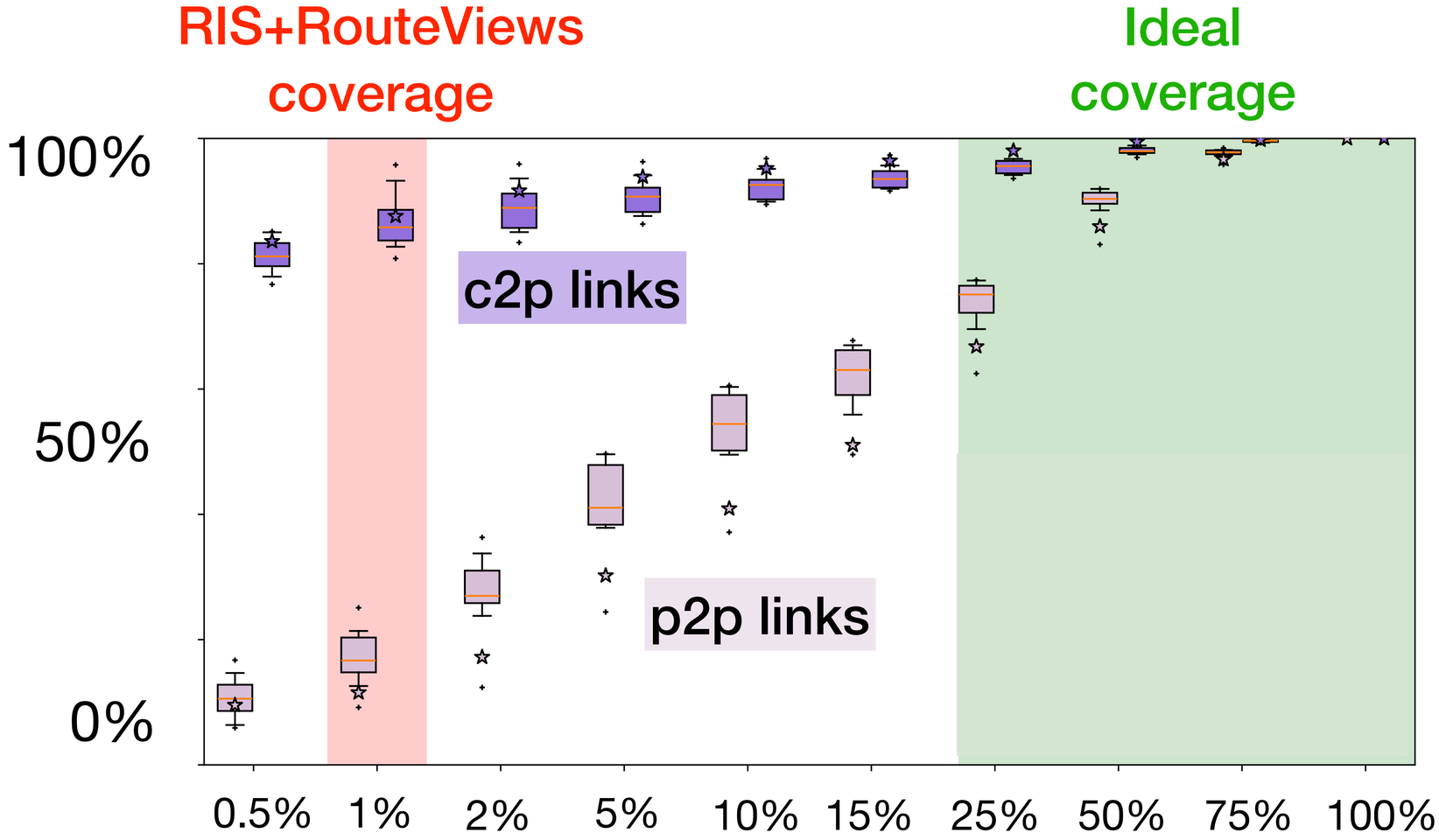

Percentage of AS links observed

Percentage of ASes hosting a VP (custom scale)

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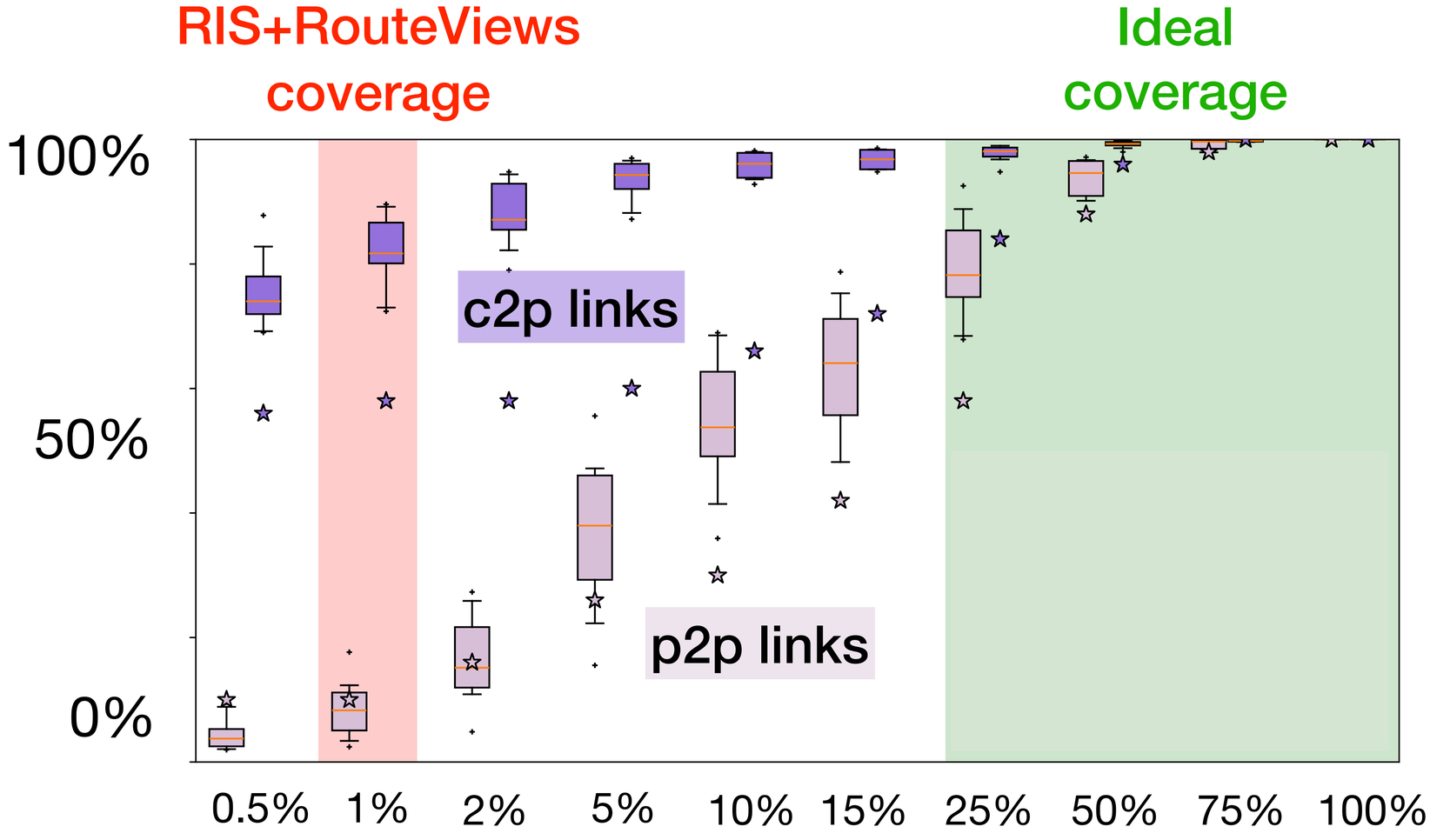


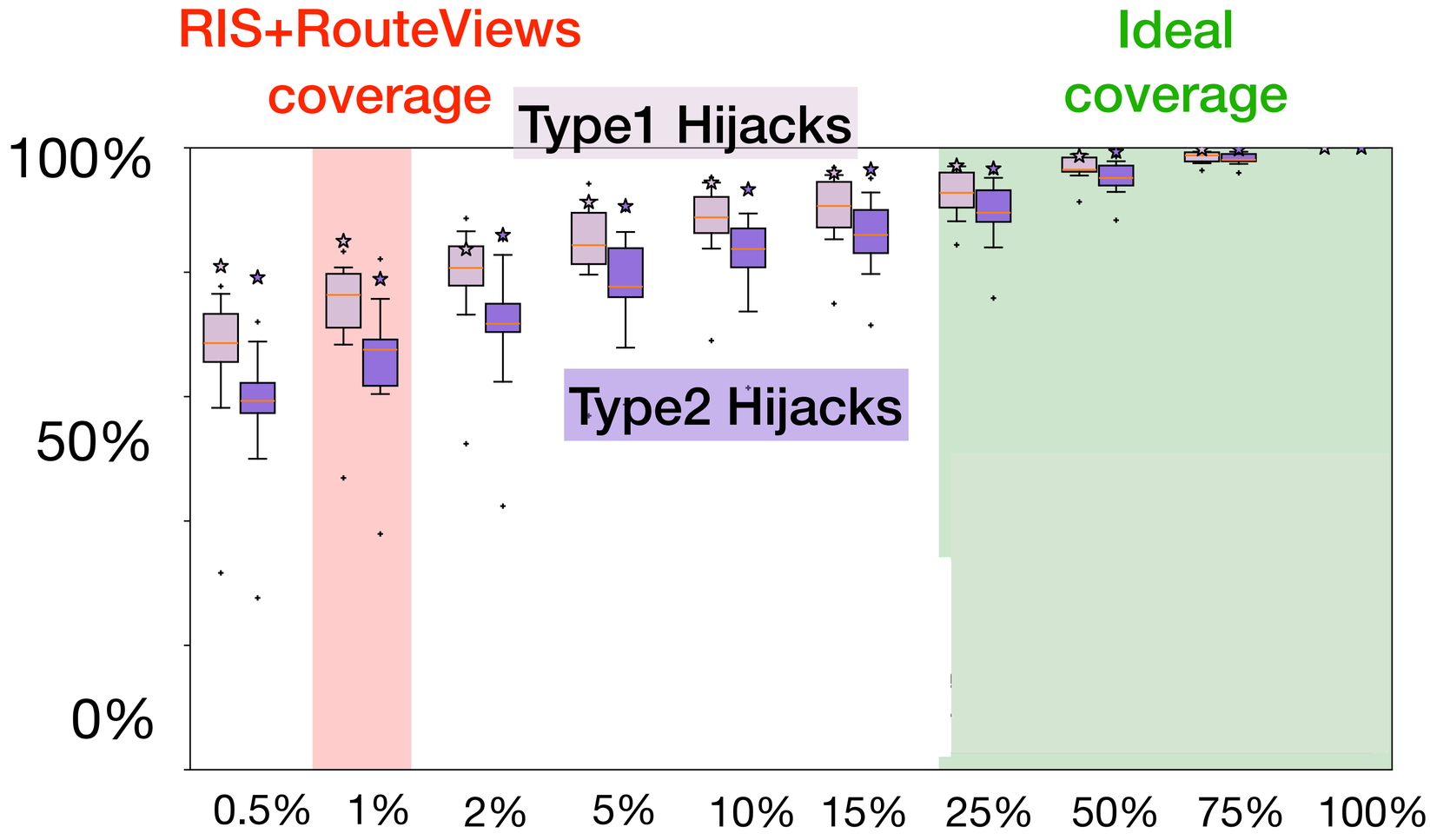
Percentage of localized* failures

Percentage of ASes hosting a VP (custom scale)

*We use Feldmann et al.'s algorithm (SIGCOMM'04)

Results from 10 simulations on "mini" Internets with 1k ASes

RIS and RouteViews' low coverage negatively impacts many studies



Percentage of forged-origin hijacks detected

Percentage of ASes hosting a VP (custom scale)

Results from 10 simulations on "mini" Internets with 6k ASes

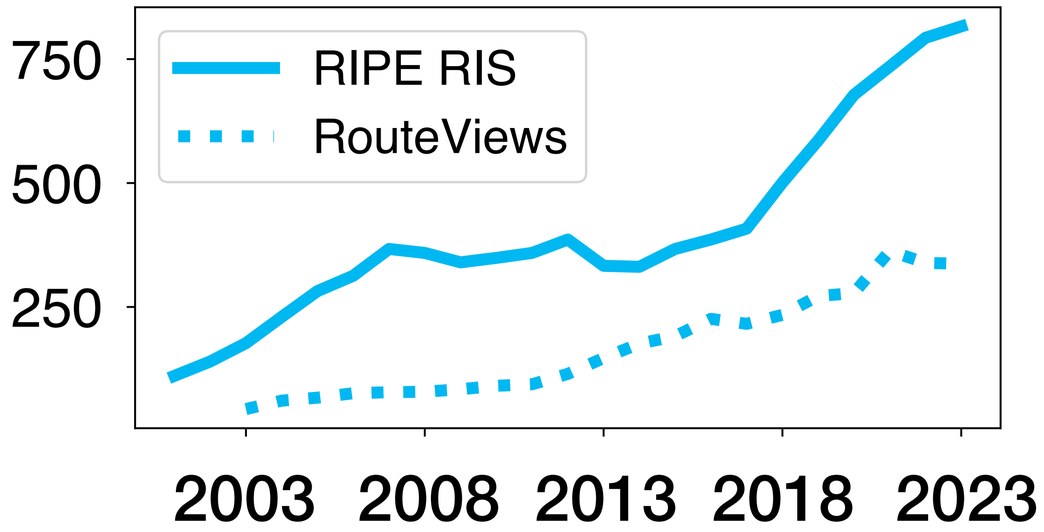
Three observations motivate reevaluating how we collect BGP routes

Observation #1: RIPE RIS and RouteViews lack coverage

Observation #2: RIPE RIS and RouteViews coverage is flat over time

Despite deploying new VPs, RIS and RouteViews' coverage is flat due the growing size of the Internet

Number of ASes hosting a VP



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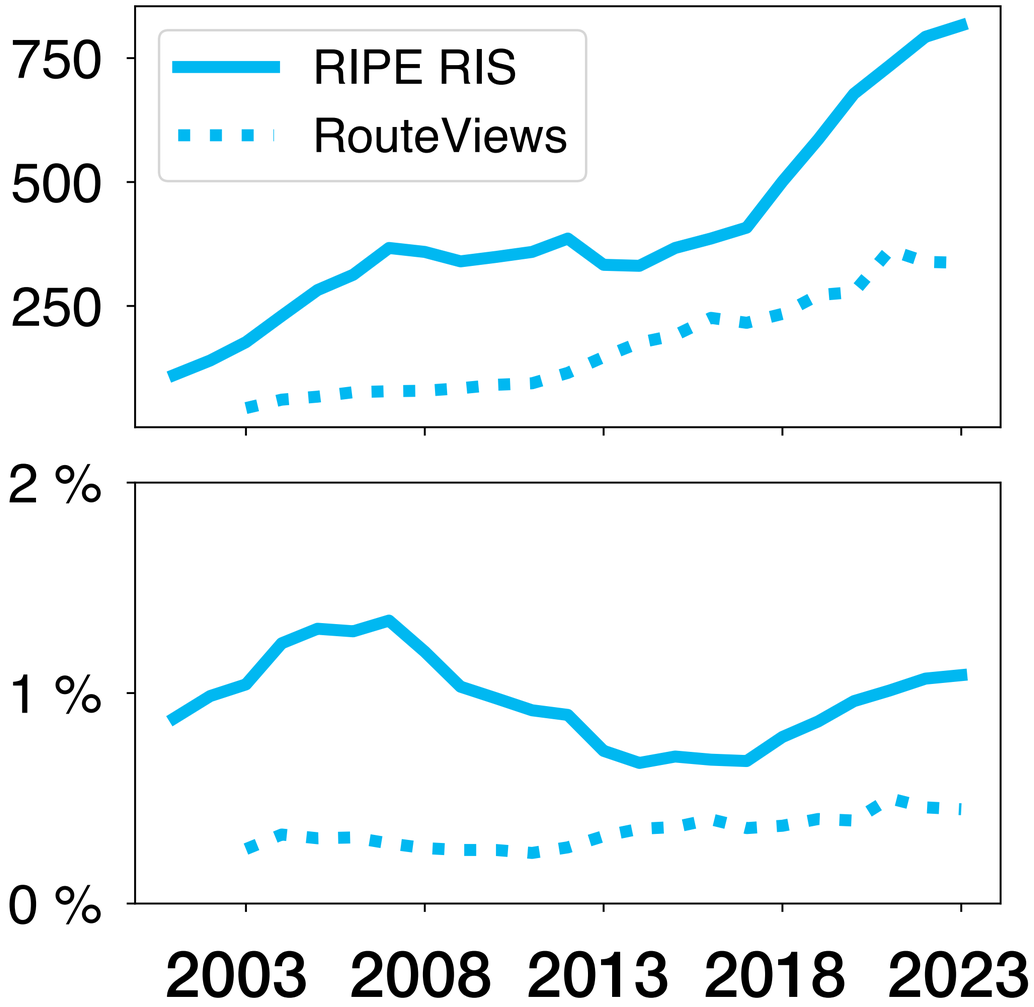

Three observations motivate reevaluating how we collect BGP routes

Observation #1: RIPE RIS and RouteViews lack coverage

Observation #2: RIPE RIS and RouteViews coverage is flat over time

Observation #3: Deploying new VPs leads to a unmanageable number of routes to process

The number of routes collected increases quadratically

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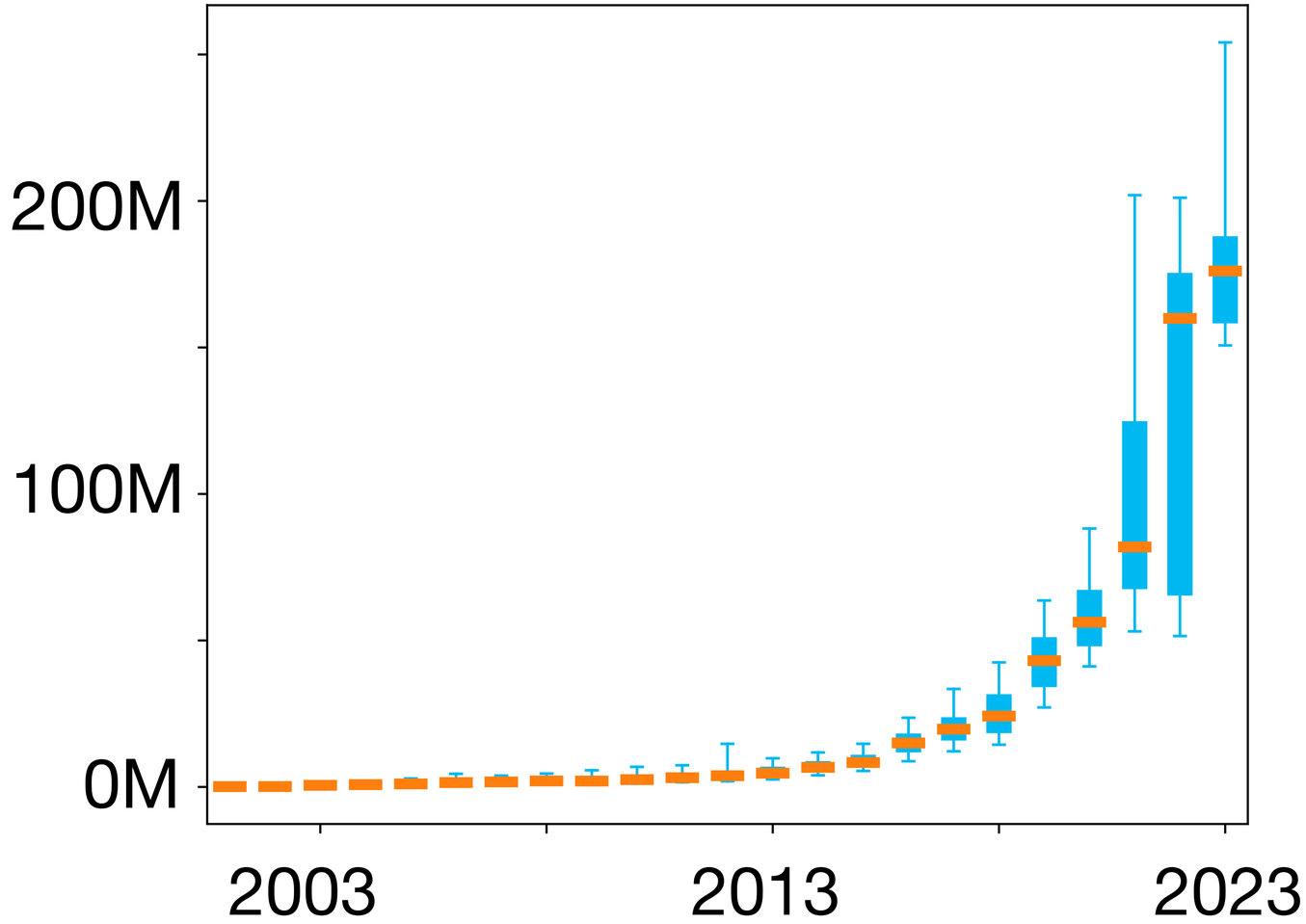
# of BGP routes collected per hour
(RIS + RouteViews)



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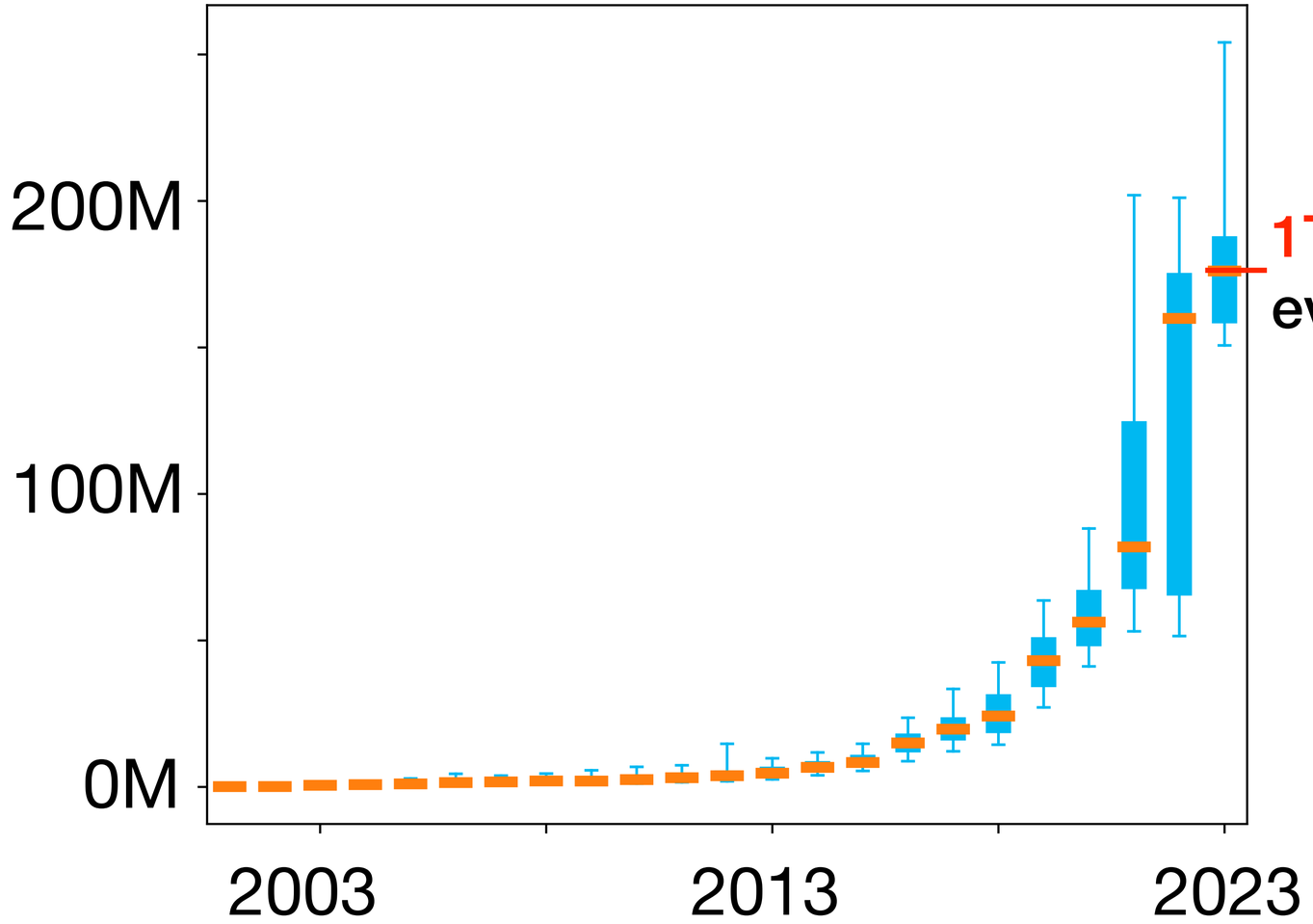

1TB to process every day!

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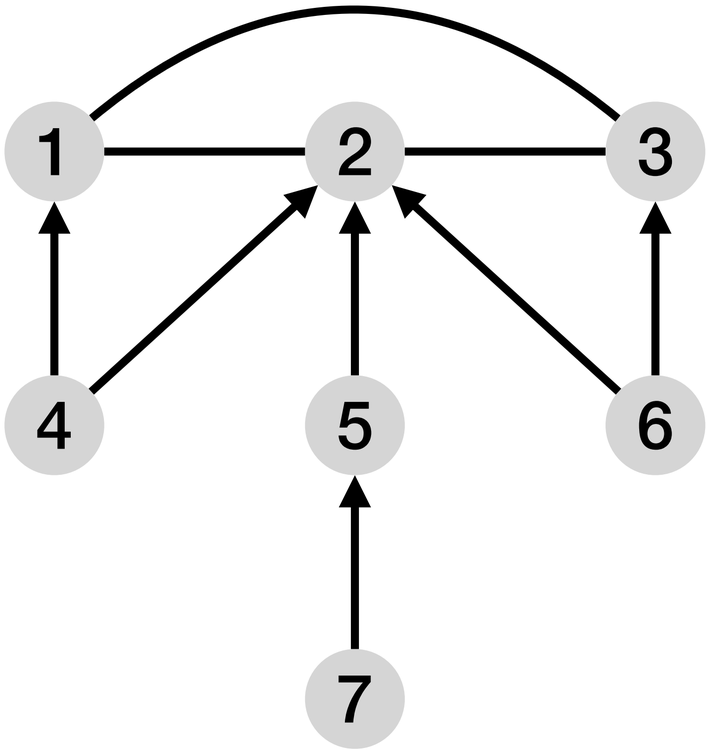
Outline

1. We observe that BGP routes are often redundant

BGP routes can be redundant



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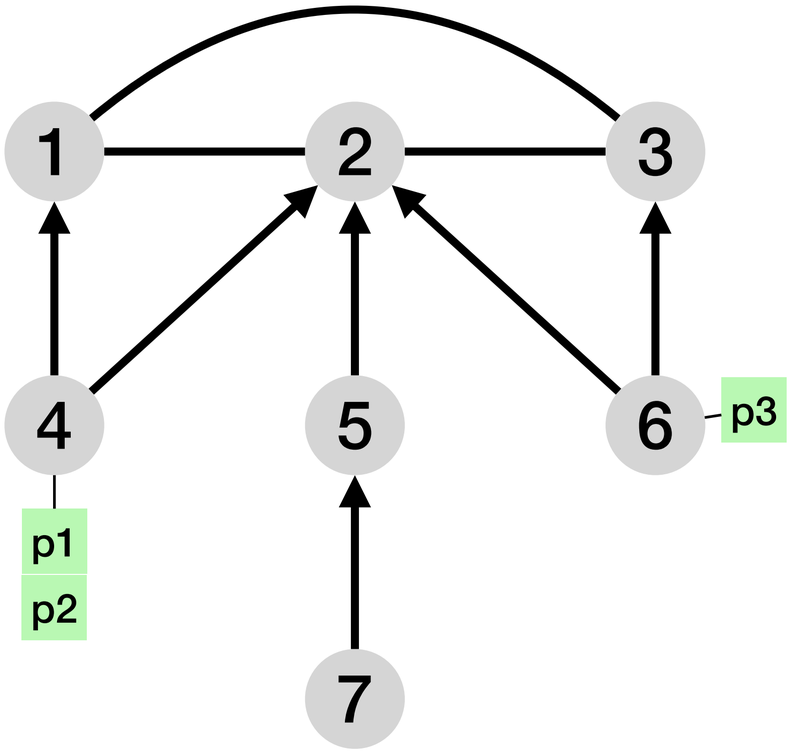

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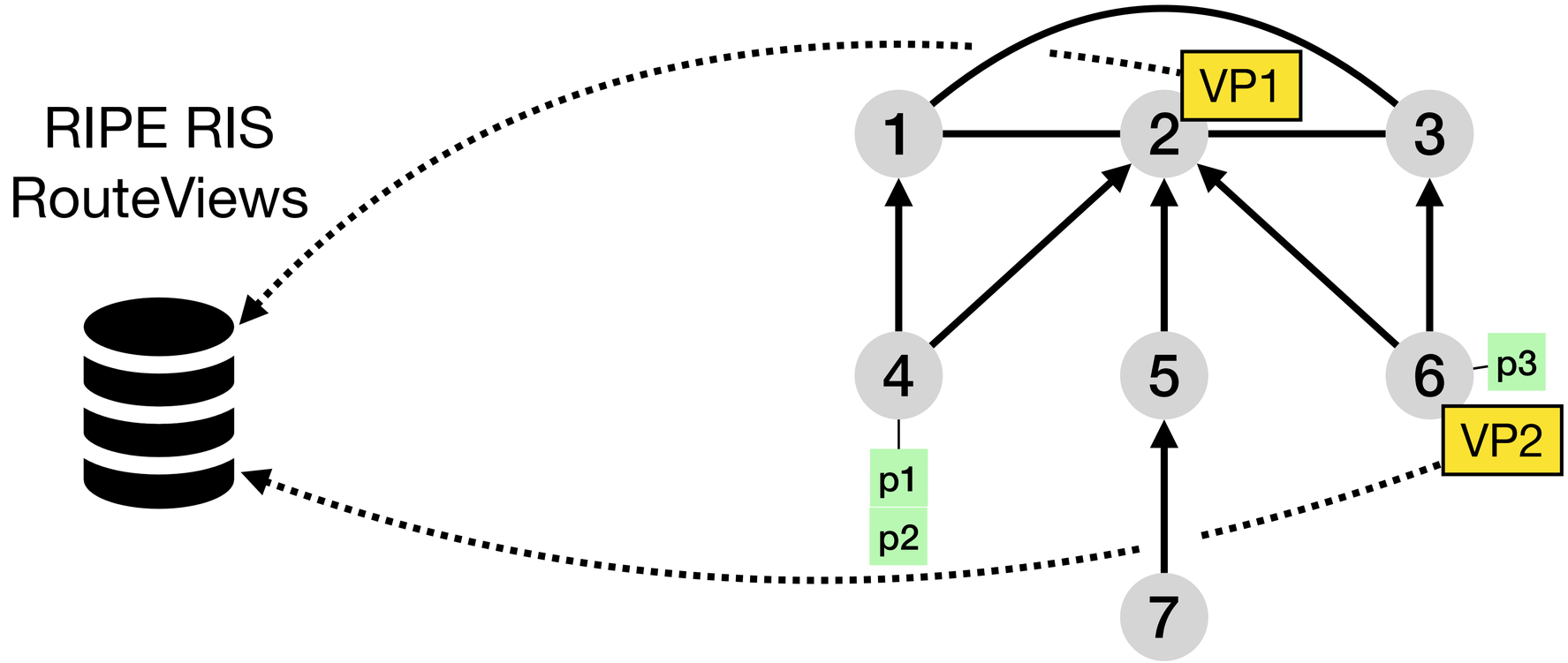

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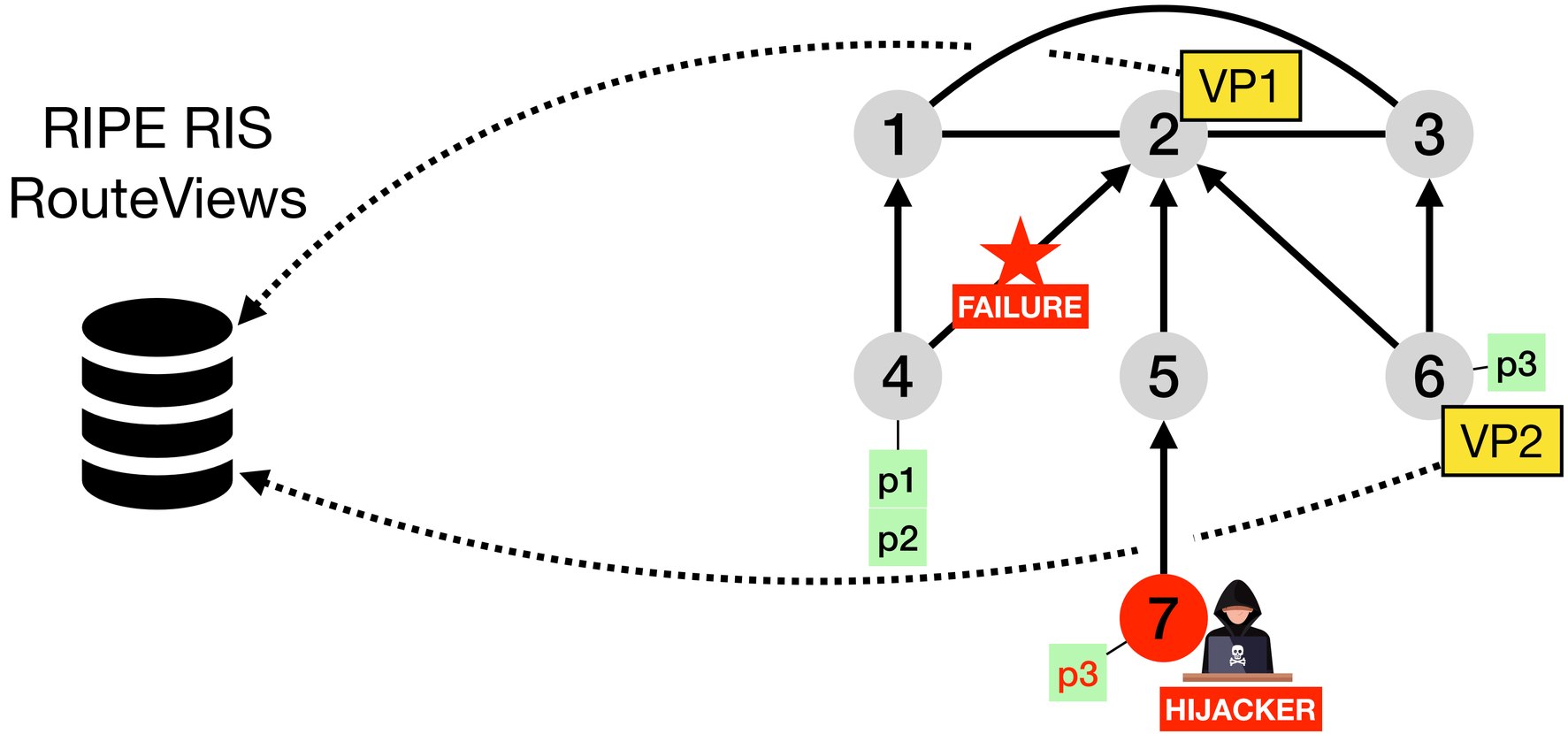
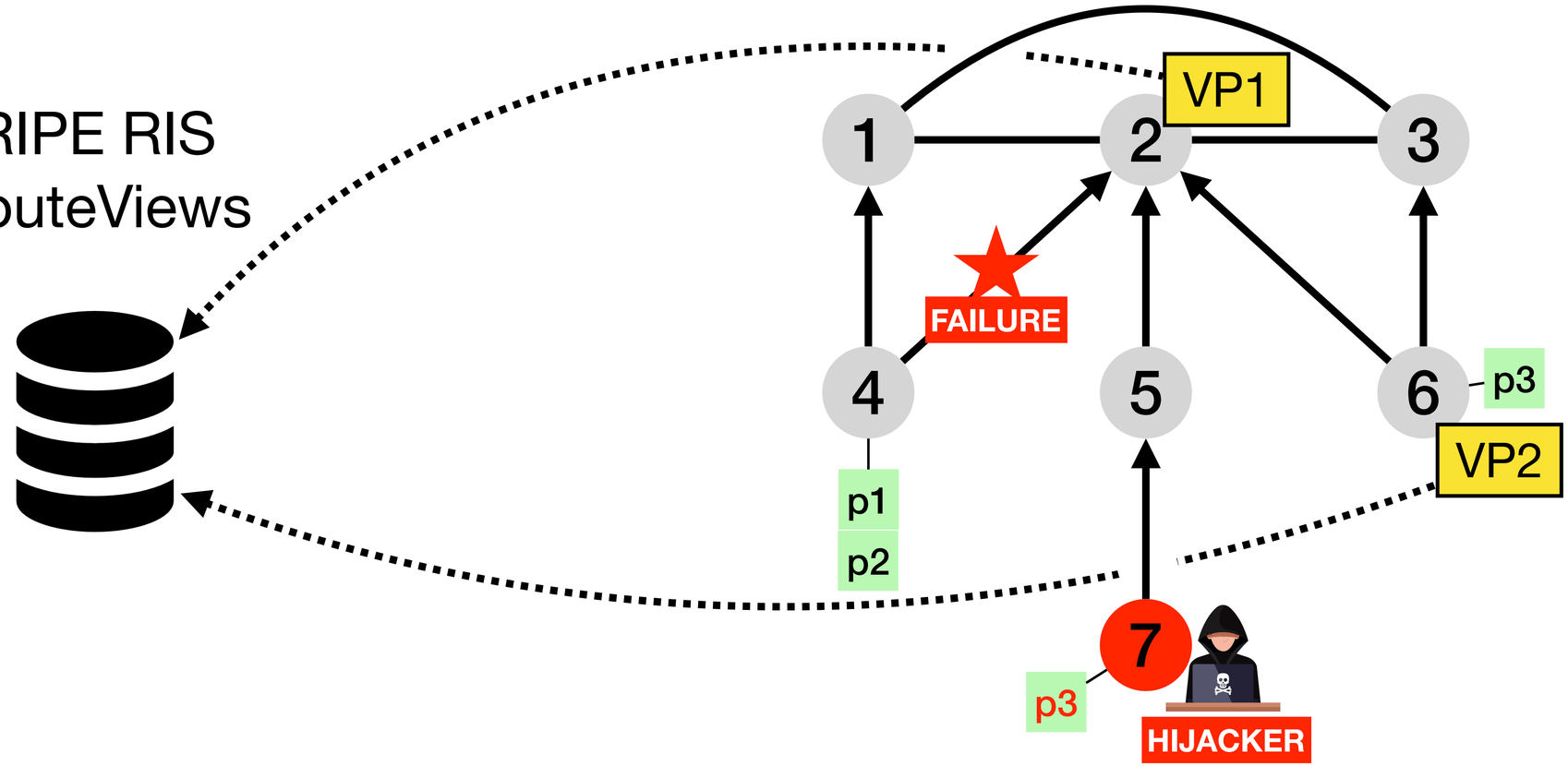


BGP routes can be redundant

Collected routes

VP	prefix	AS path

RIPE RIS
RouteViews



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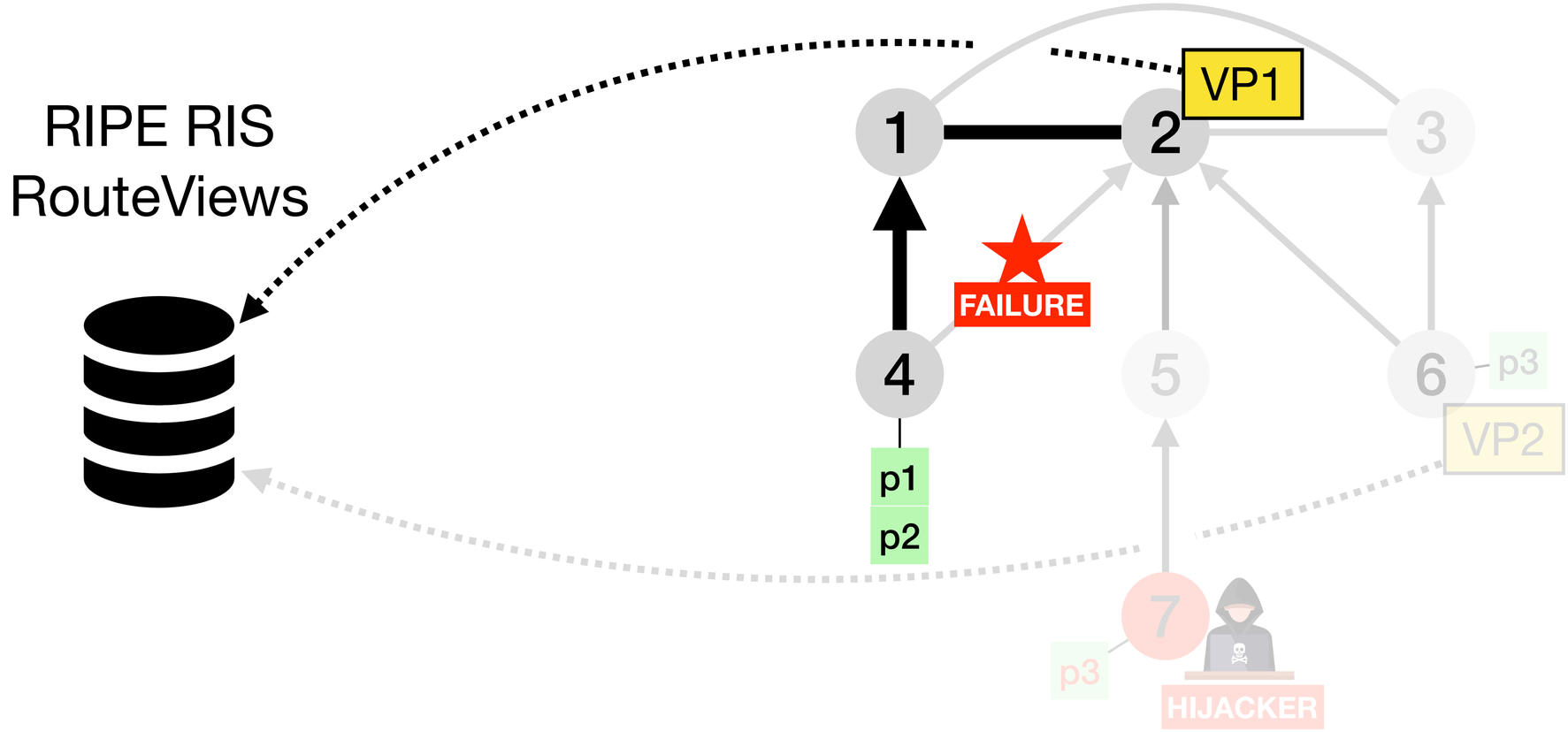

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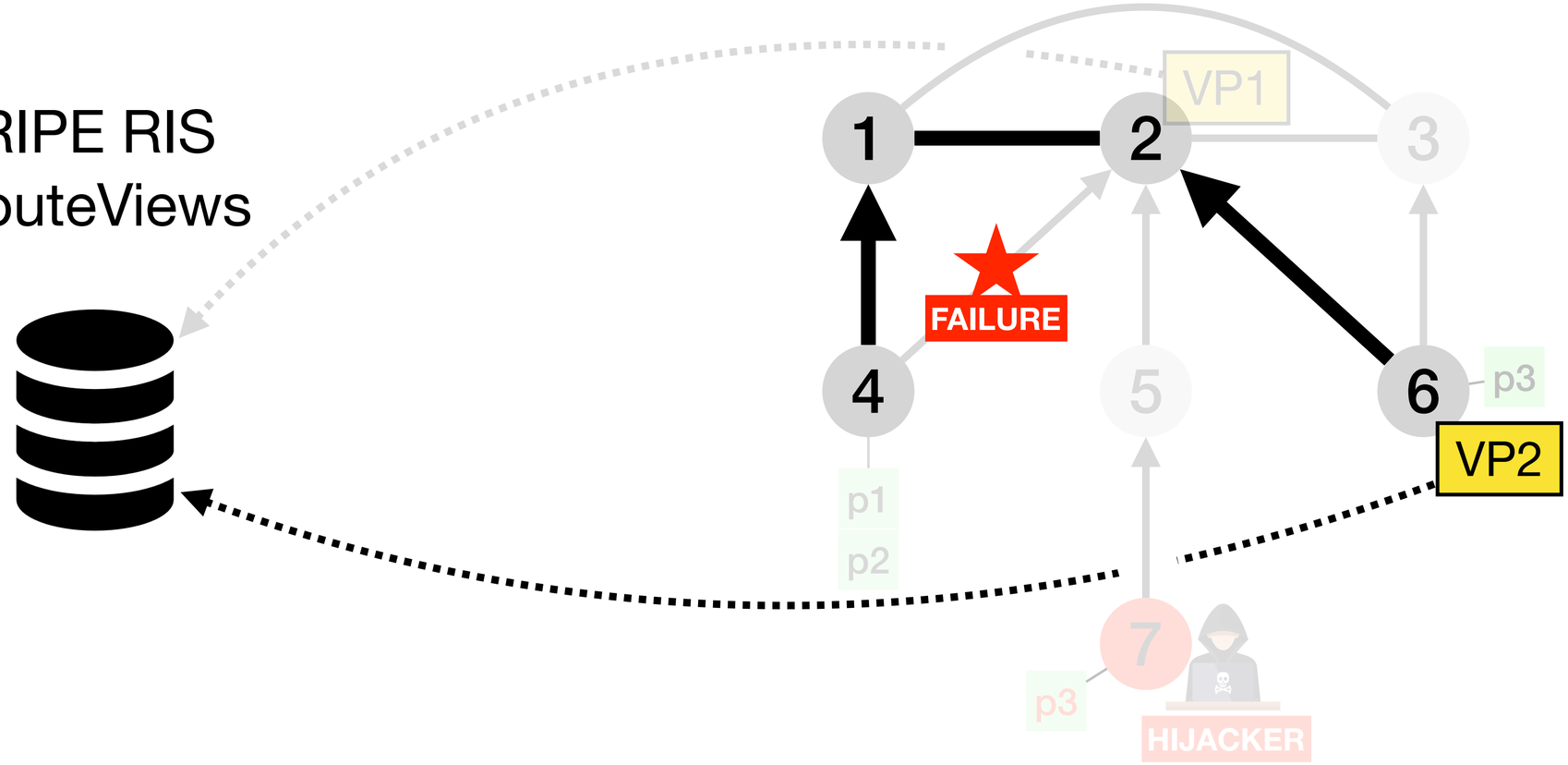

BGP routes can be redundant

Redundant routes

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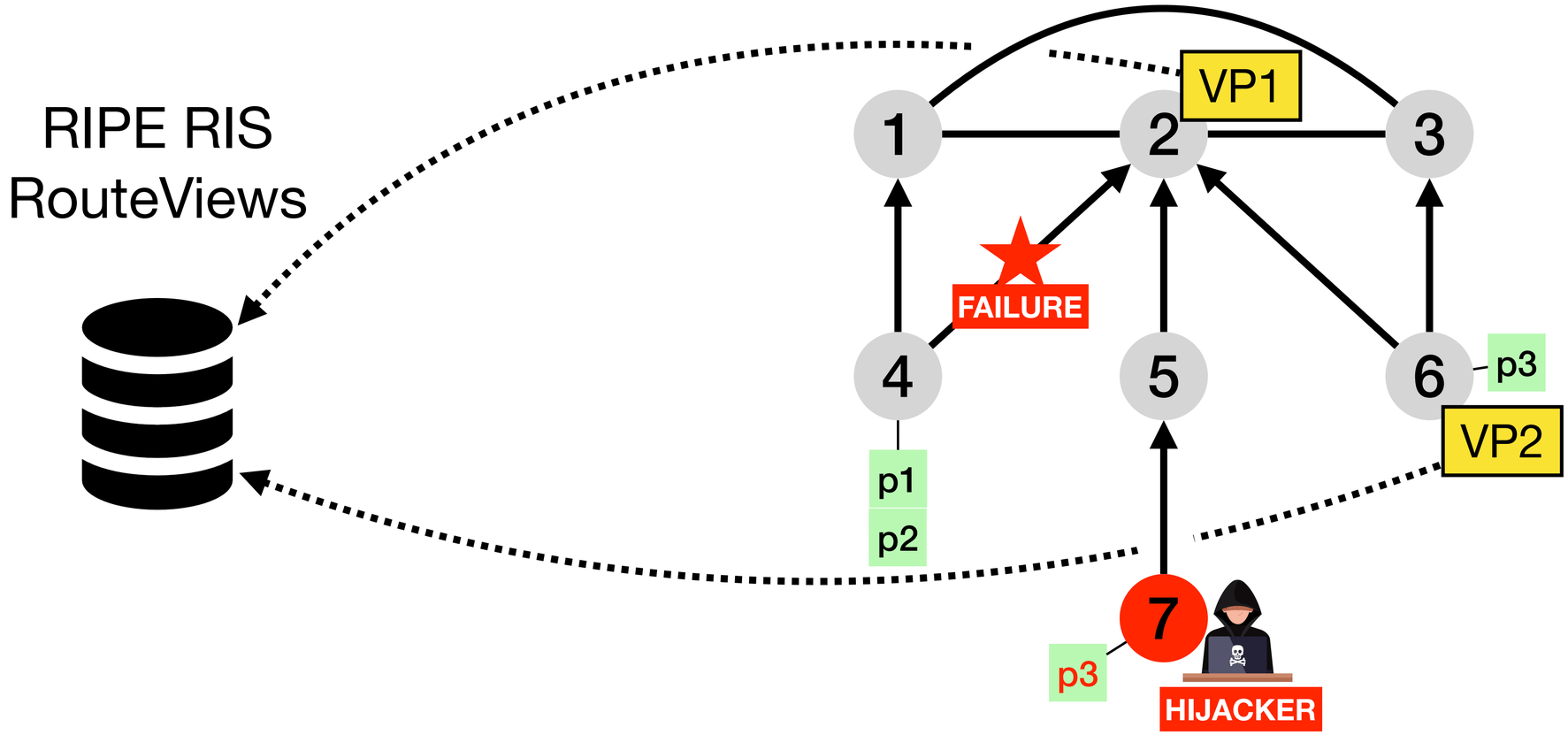
Redundant routes



Redundant BGP routes are not so useful

Redundant routes

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Redundant routes

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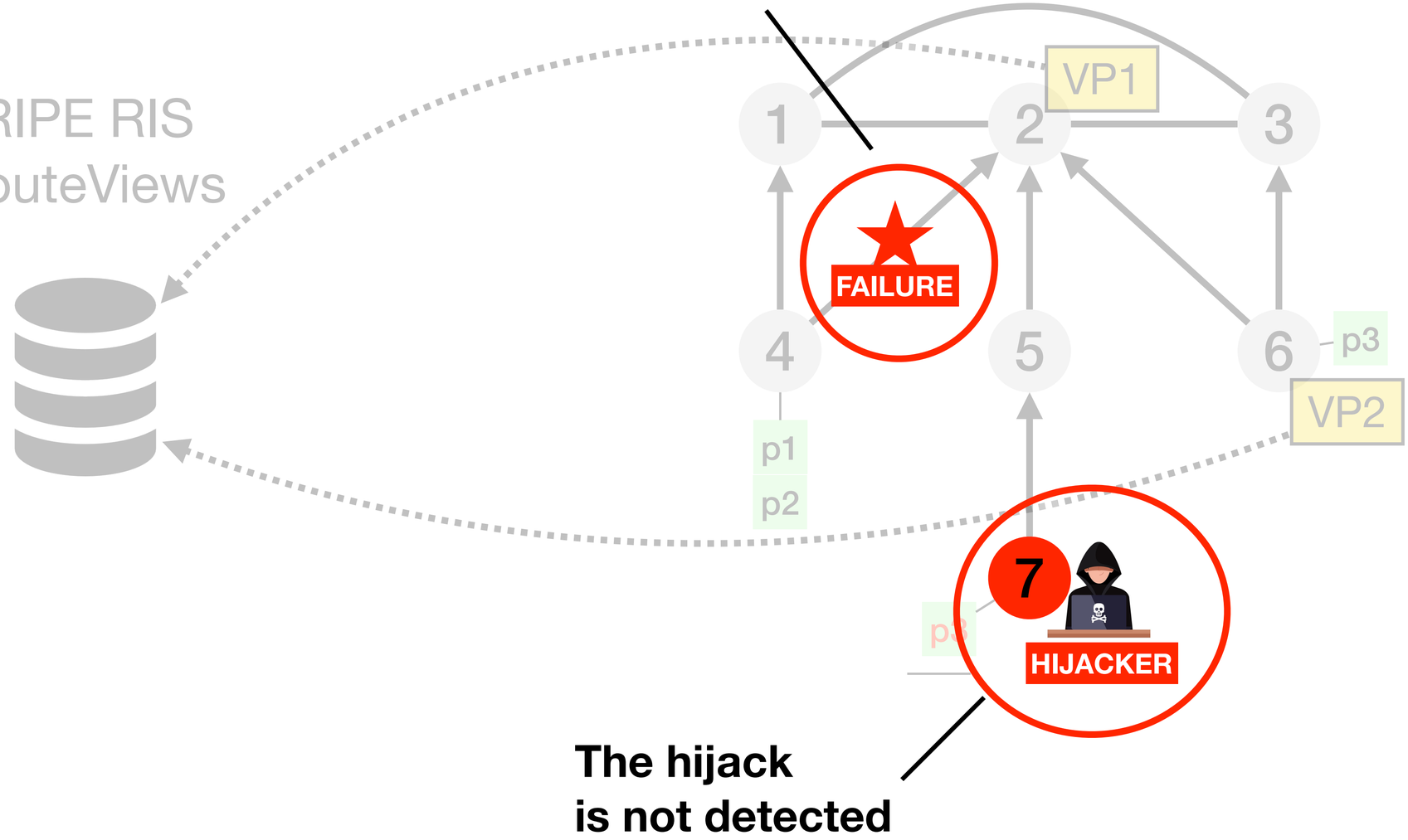

Outline

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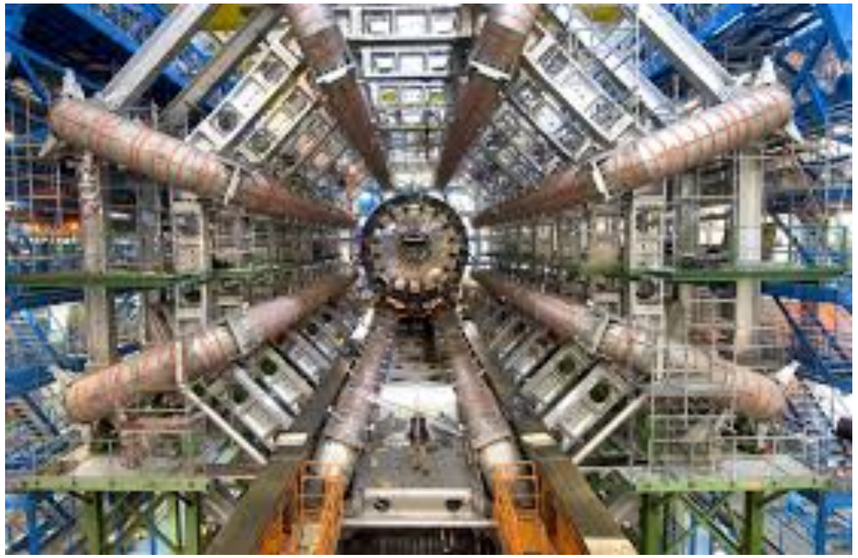
are often redundant

2. Redundant BGP routes enable
an overshoot-and-discard collection scheme

Large Hadron Collider (LHC) generates billions of collisions



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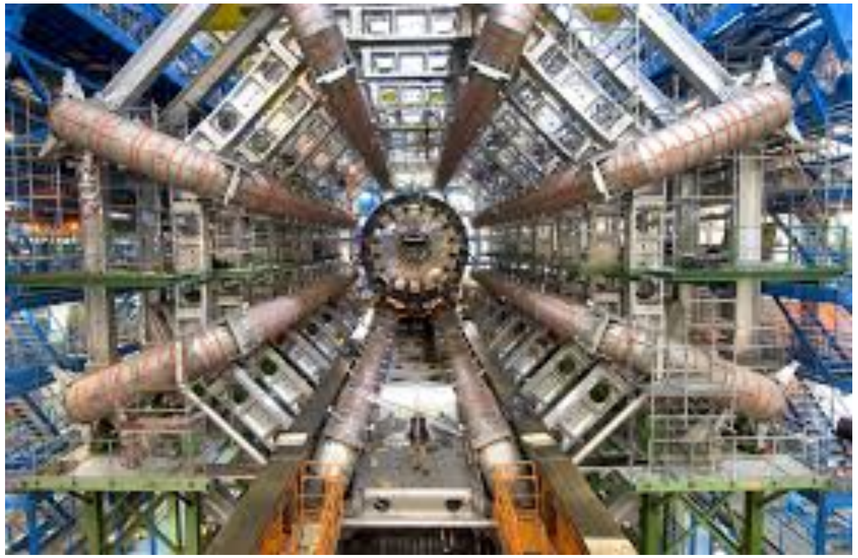

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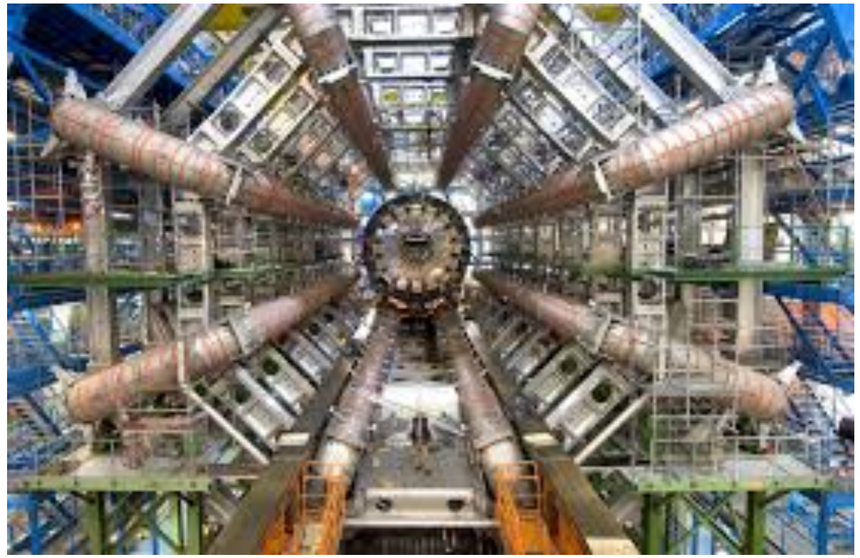

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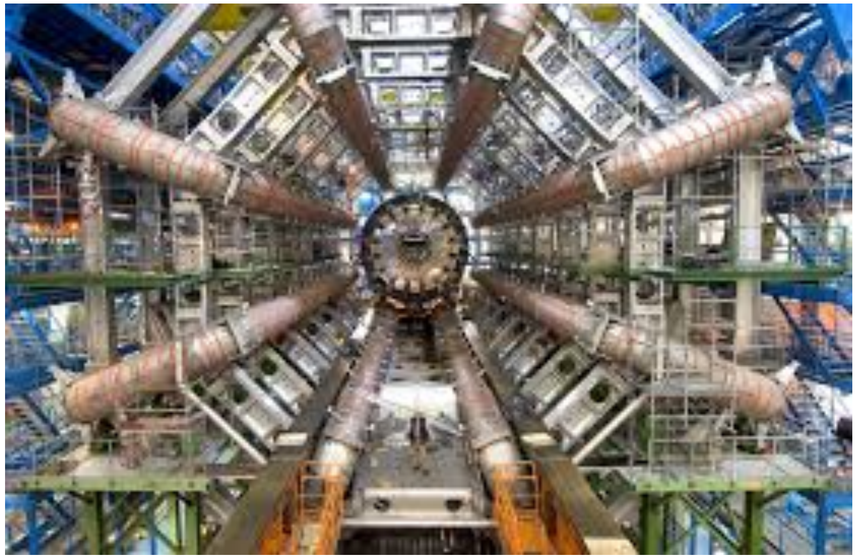

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They are using an "overshoot-and-discard" collection strategy

The “overshoot-and-discard” data collection paradigm can be adapted to BGP data collection

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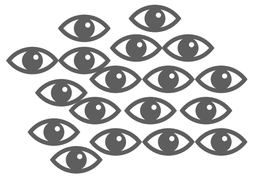
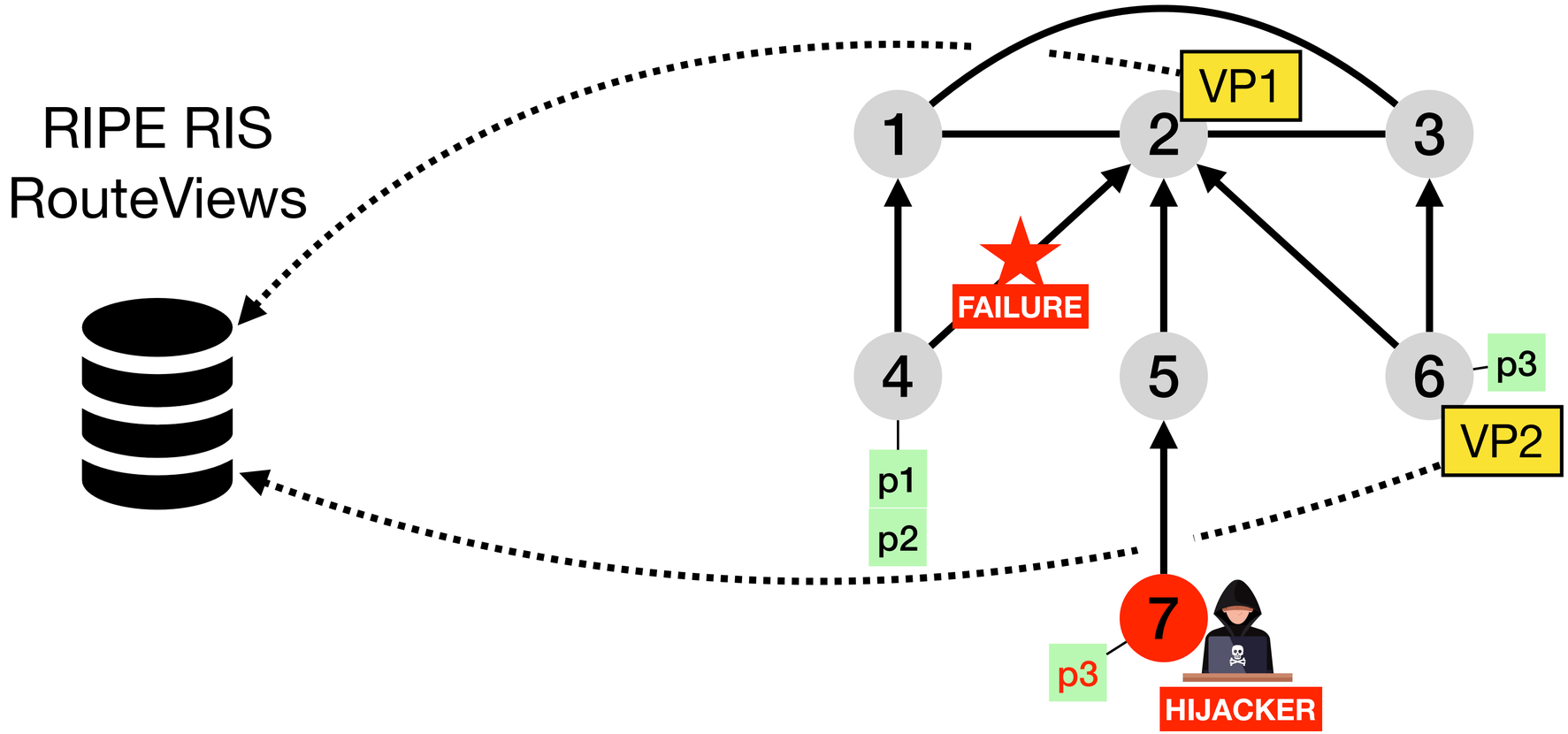


Overshoot: We collect data from as many VPs as possible

To prevent missing important information

Overshoot: deploying as many VPs as possible



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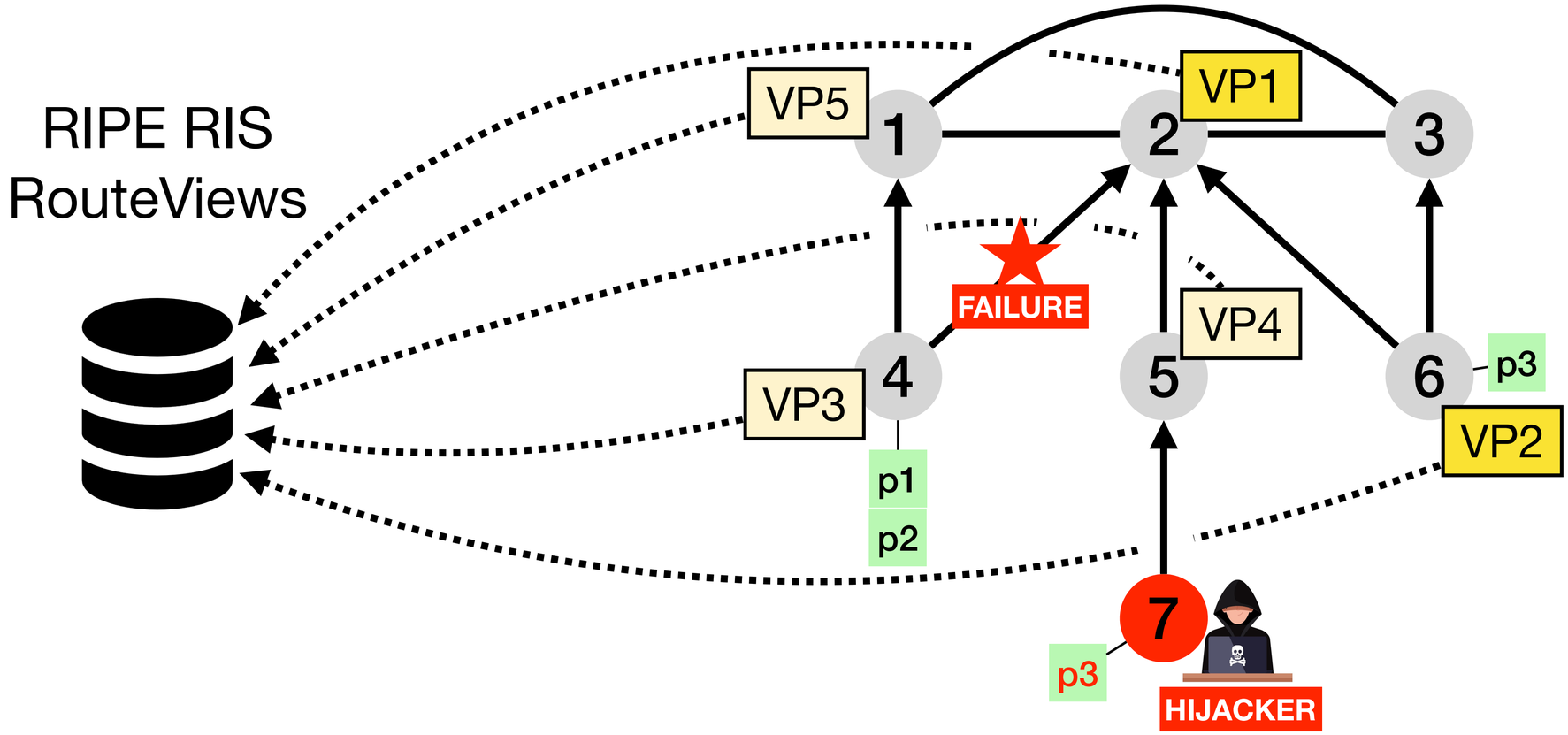

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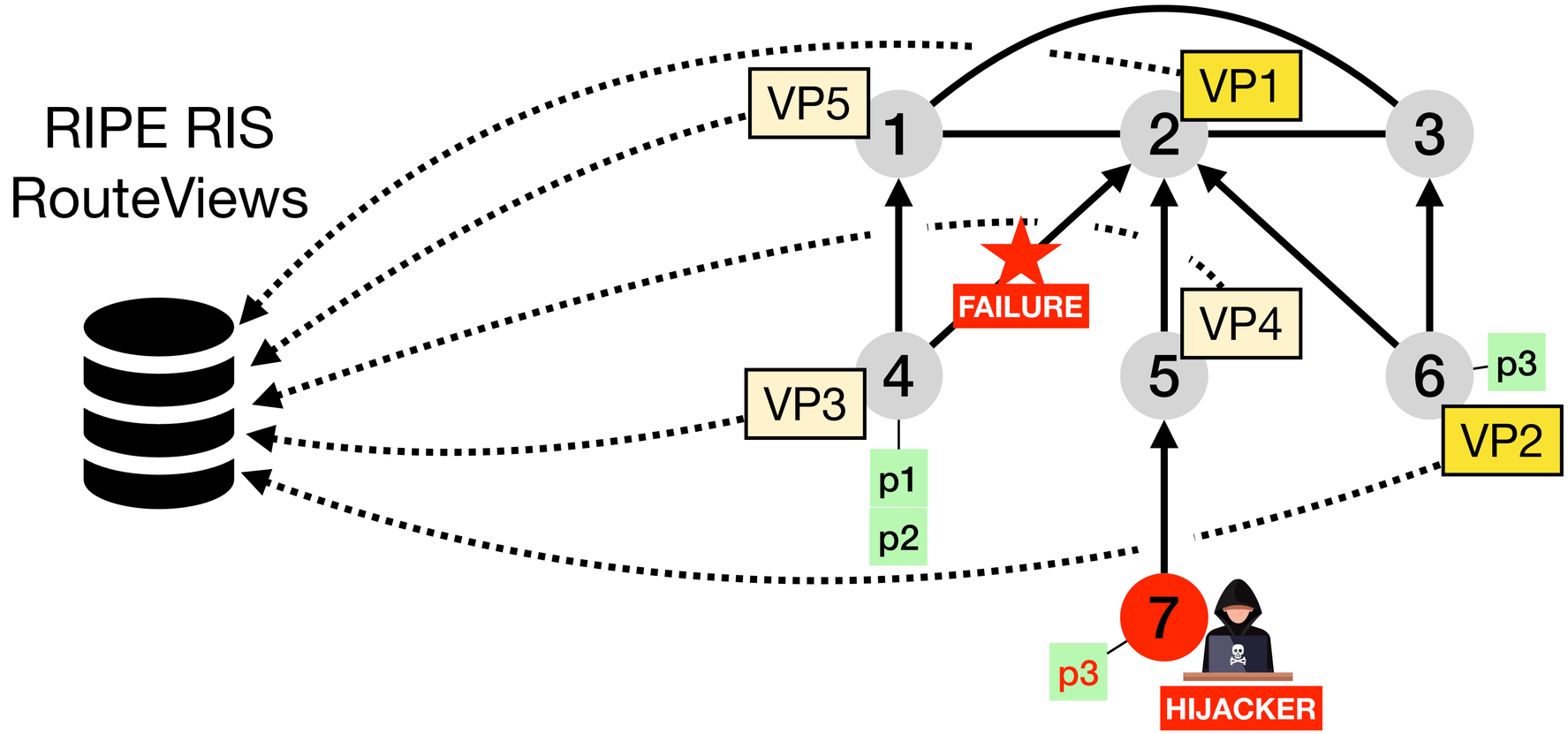
VP3	p3	4 1 2 6
VP4	p3	5 7



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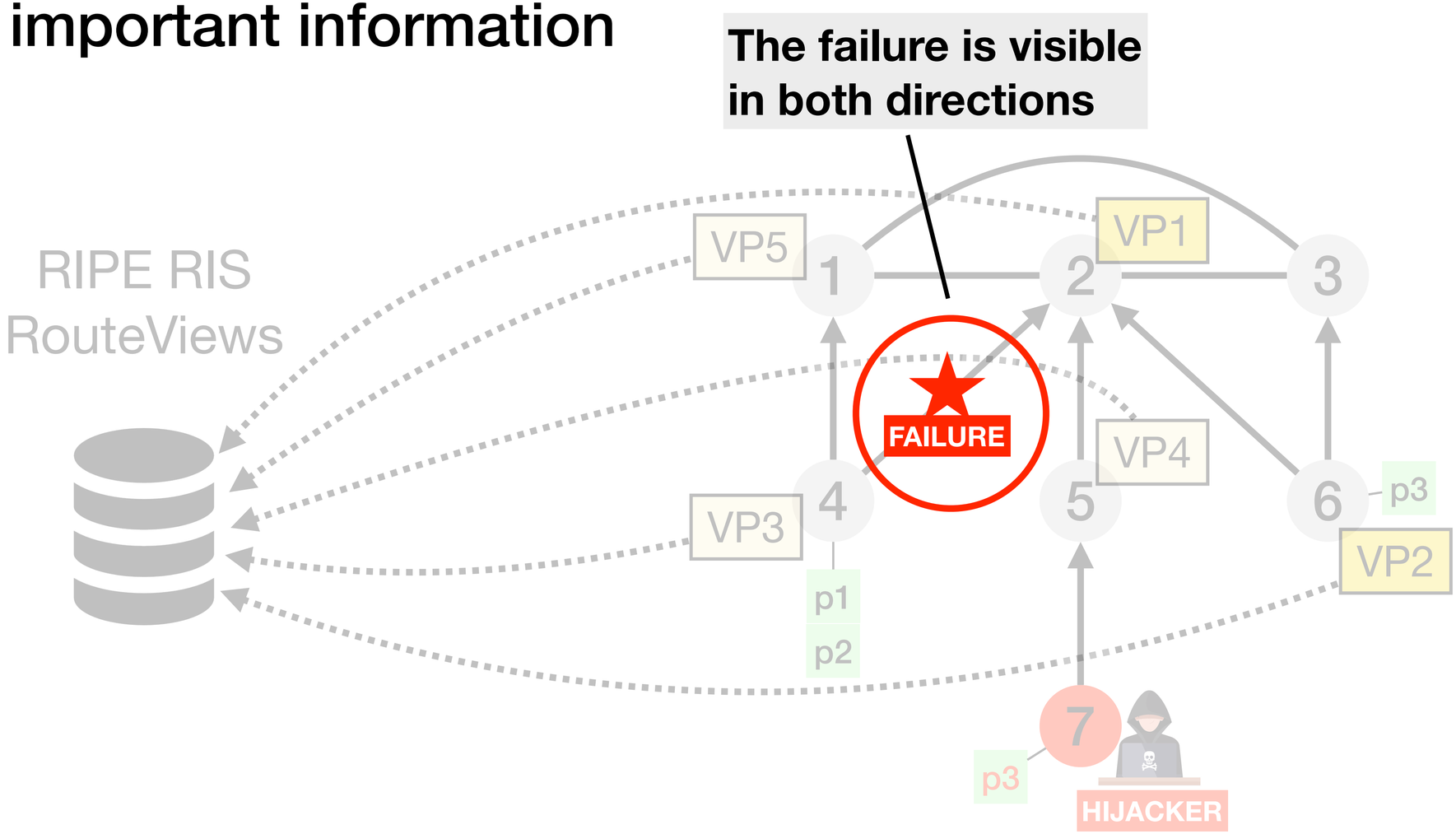

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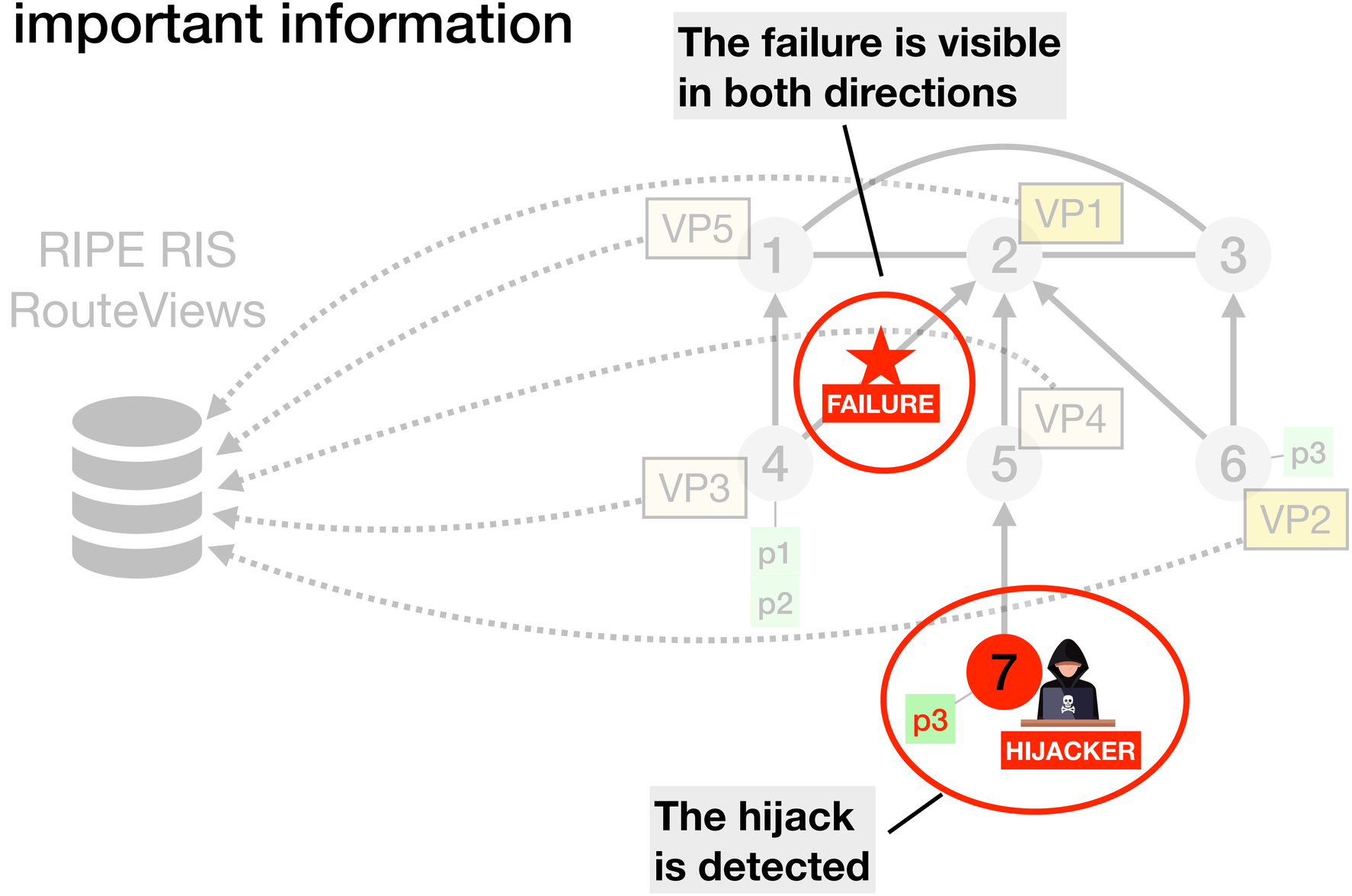

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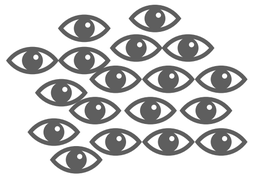

Overshoot: We collect data from as many VPs as possible

To prevent missing important information

Discard: We filter out the redundant BGP routes

To reduce the volume of data collected

Discard: redundant BGP routes are discarded using filters

Collected routes

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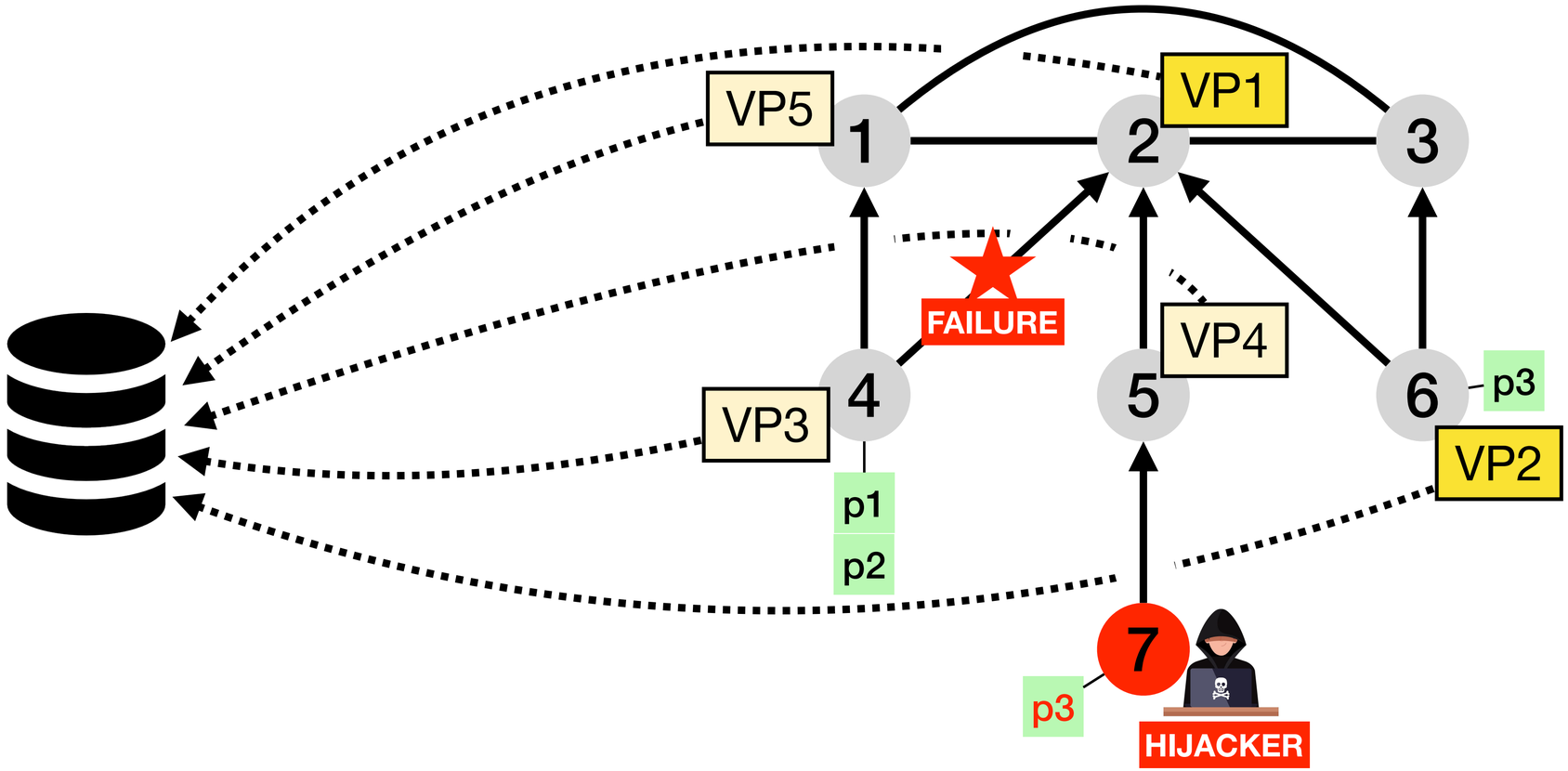

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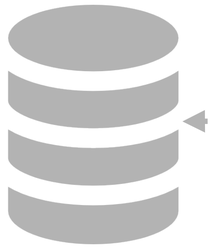
RIPE RIS
RouteViews



From VP1 drop p1 p2
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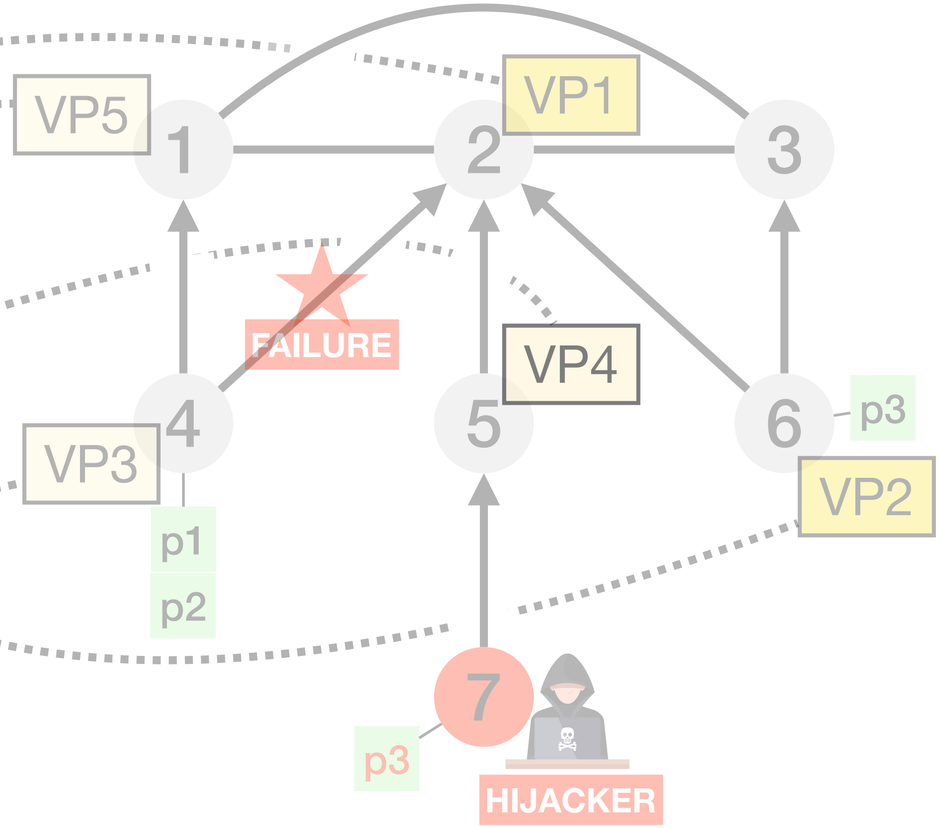

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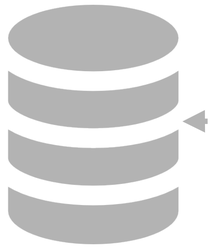

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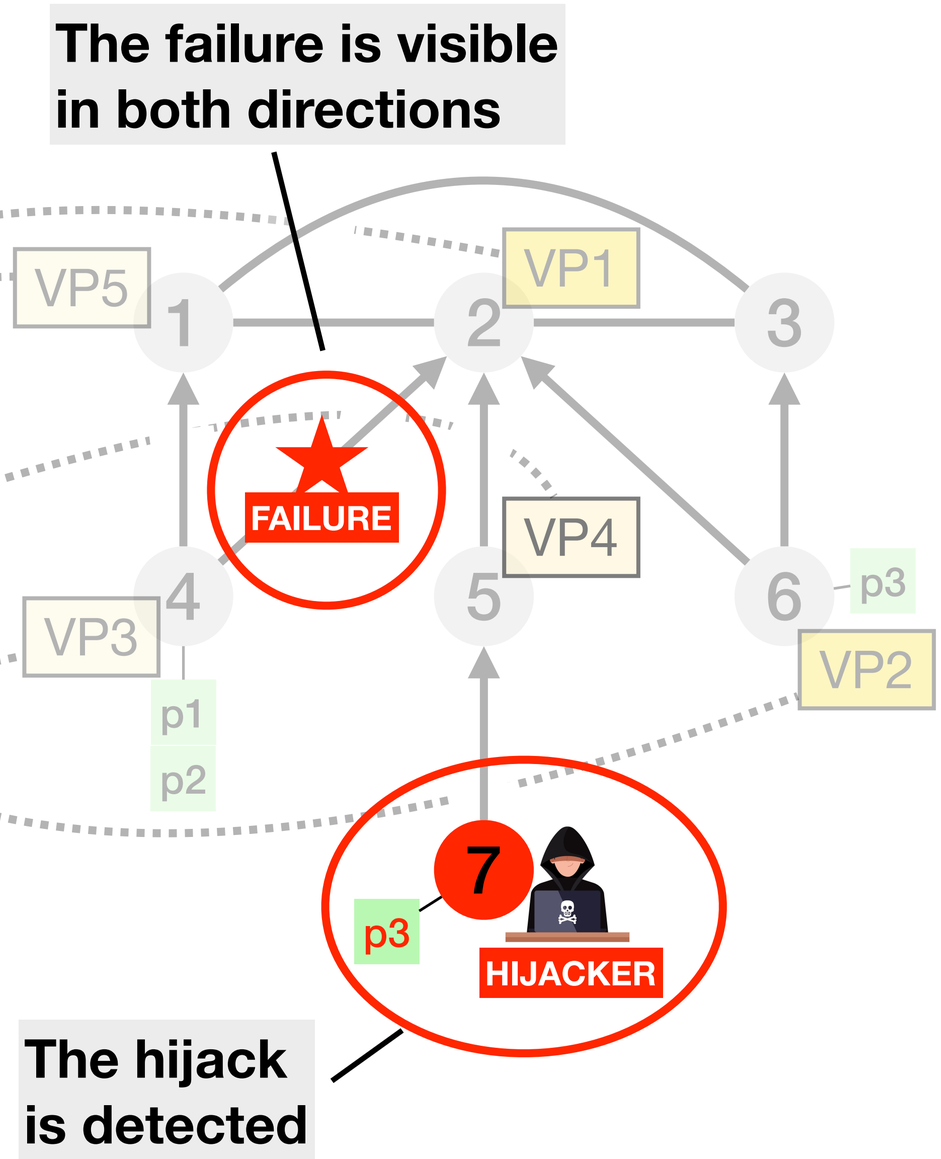

Outline

1. We observe that BGP routes
are often redundant

2. Redundant BGP routes enable
an overshoot-and-discard collection scheme

3. *GILL*: a system that measures redundancy between BGP routes and generates filters that discard redundant routes

GILL **selects the updates to retain**
using a new metric called the Reconstitution Power (RP)

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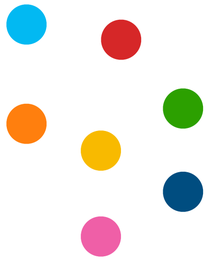
Original set of updates



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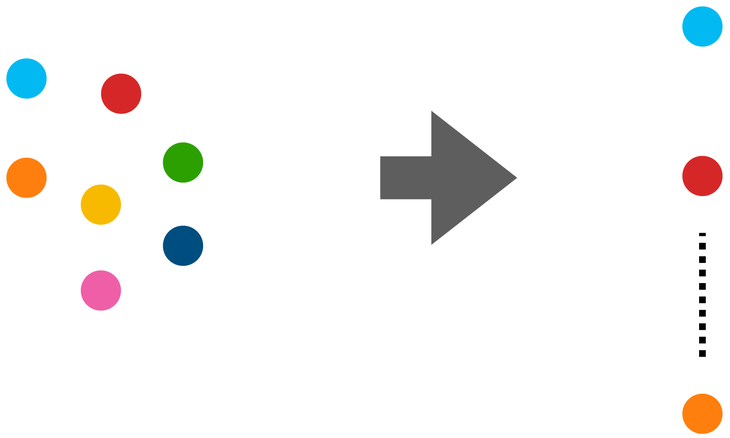
Original set of updates

Sampled update



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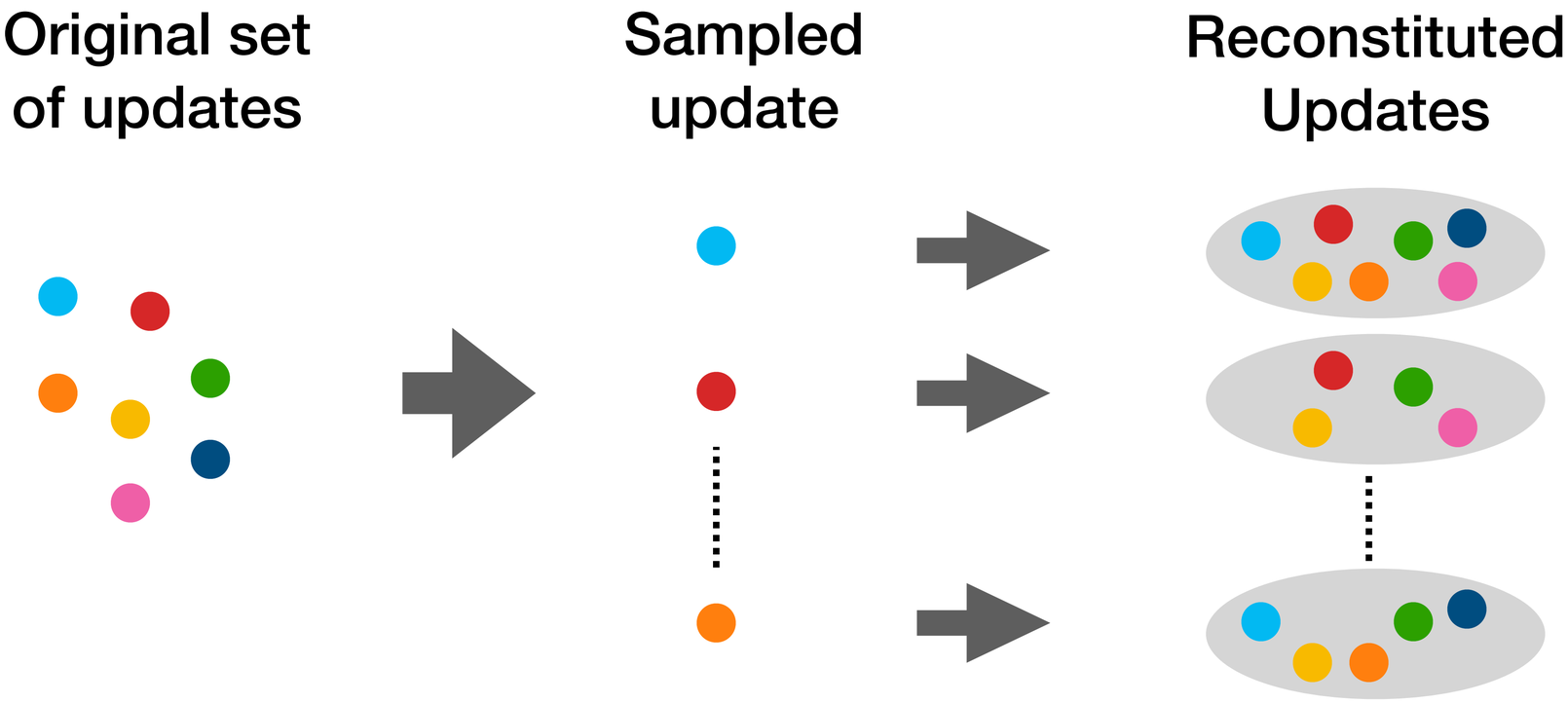

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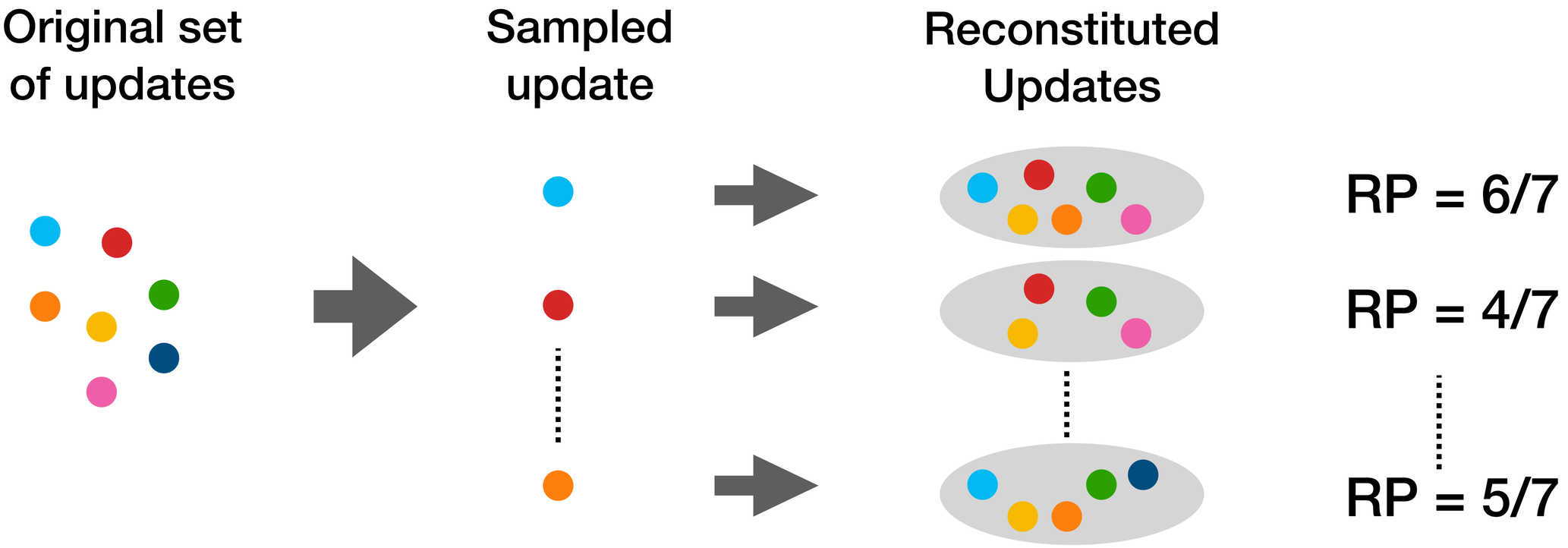

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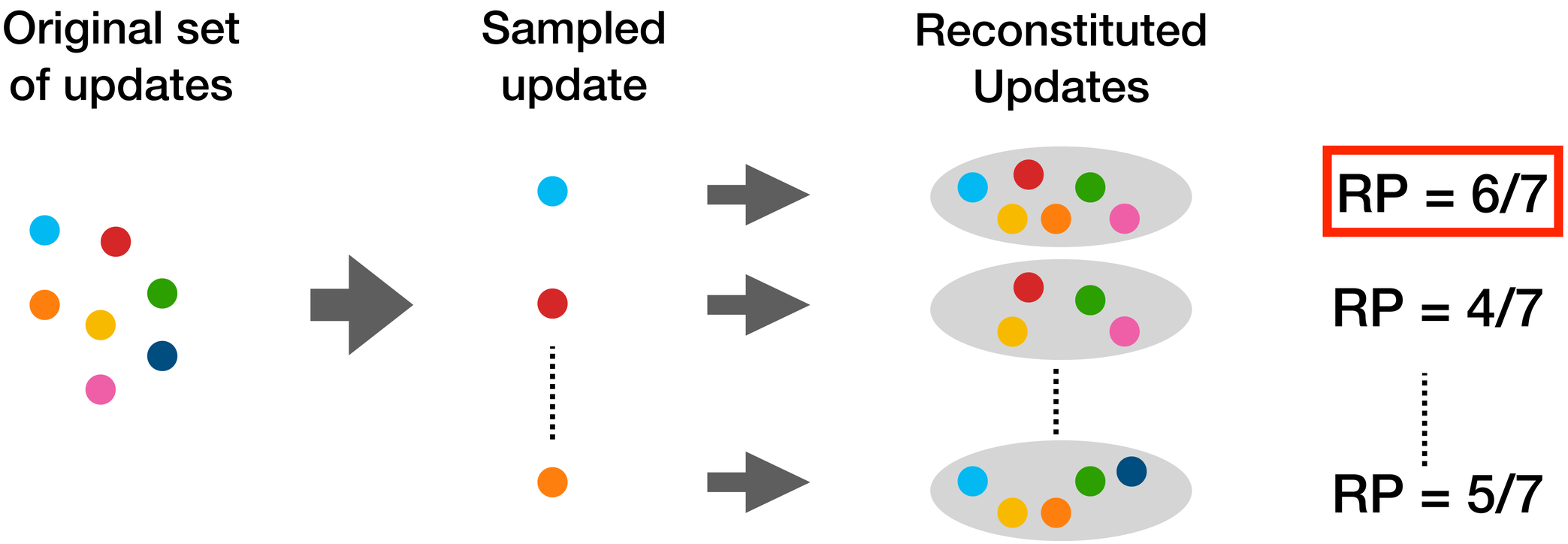

GILL **iteratively selects the updates with the higher Reconstitution Power**

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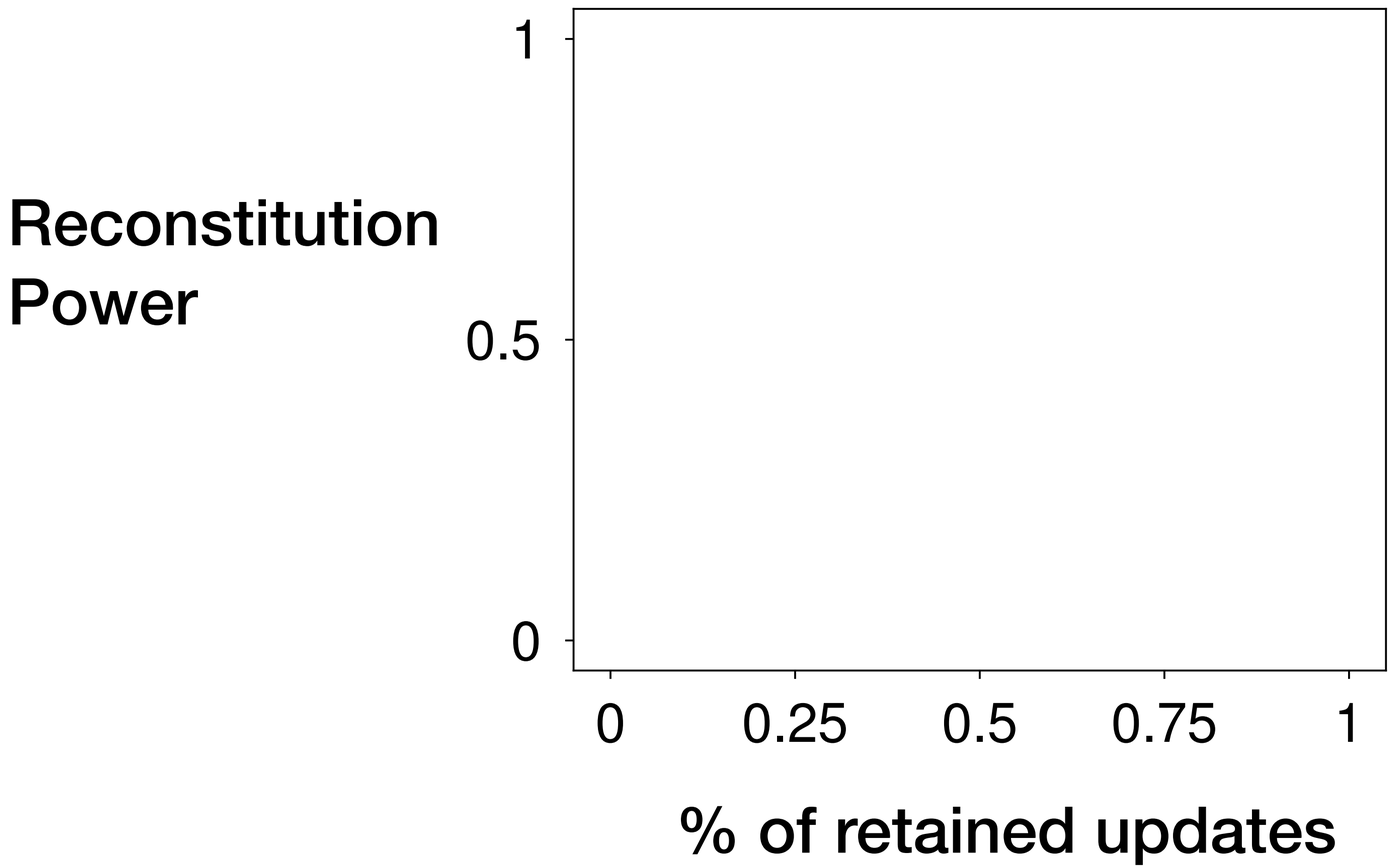

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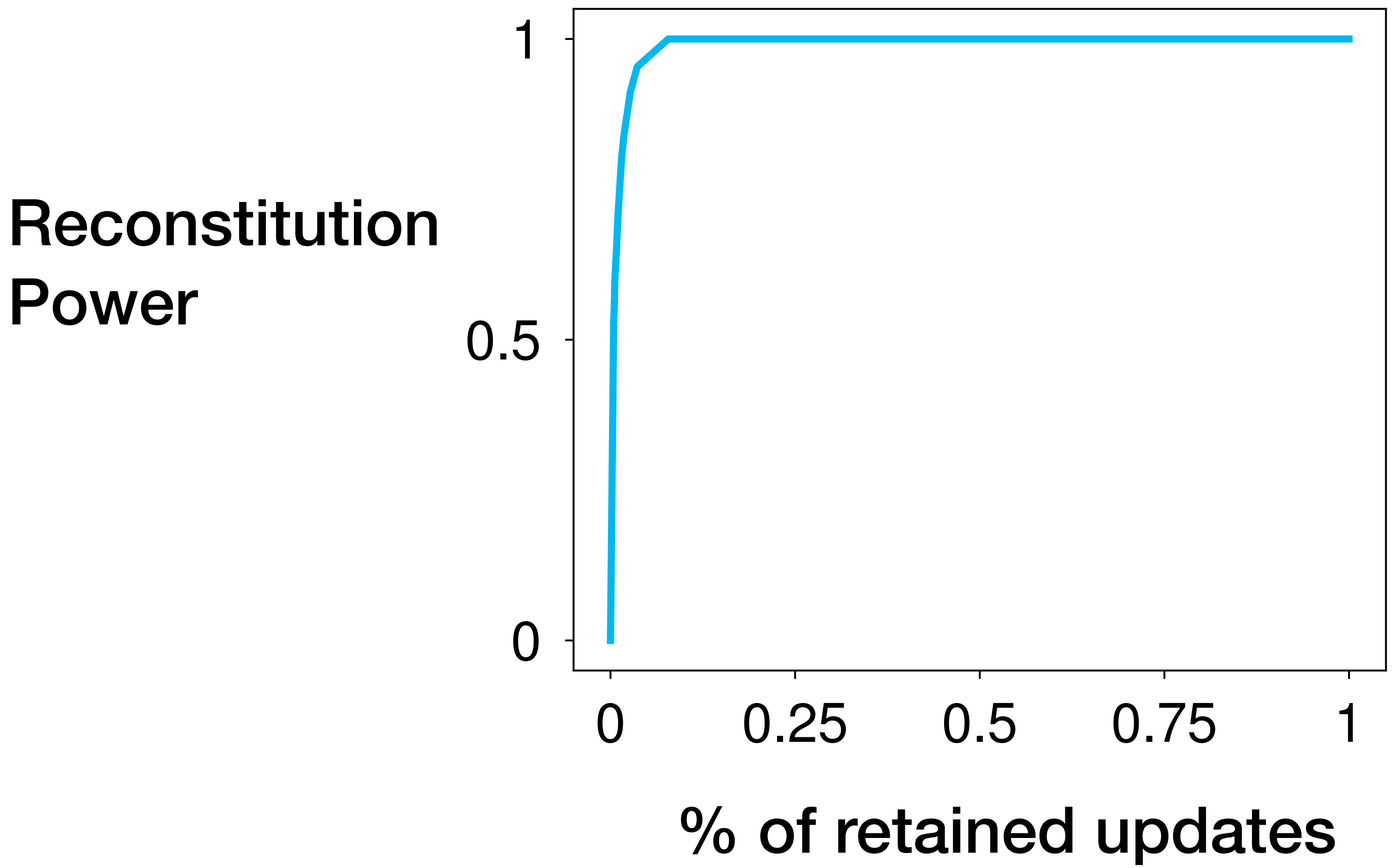

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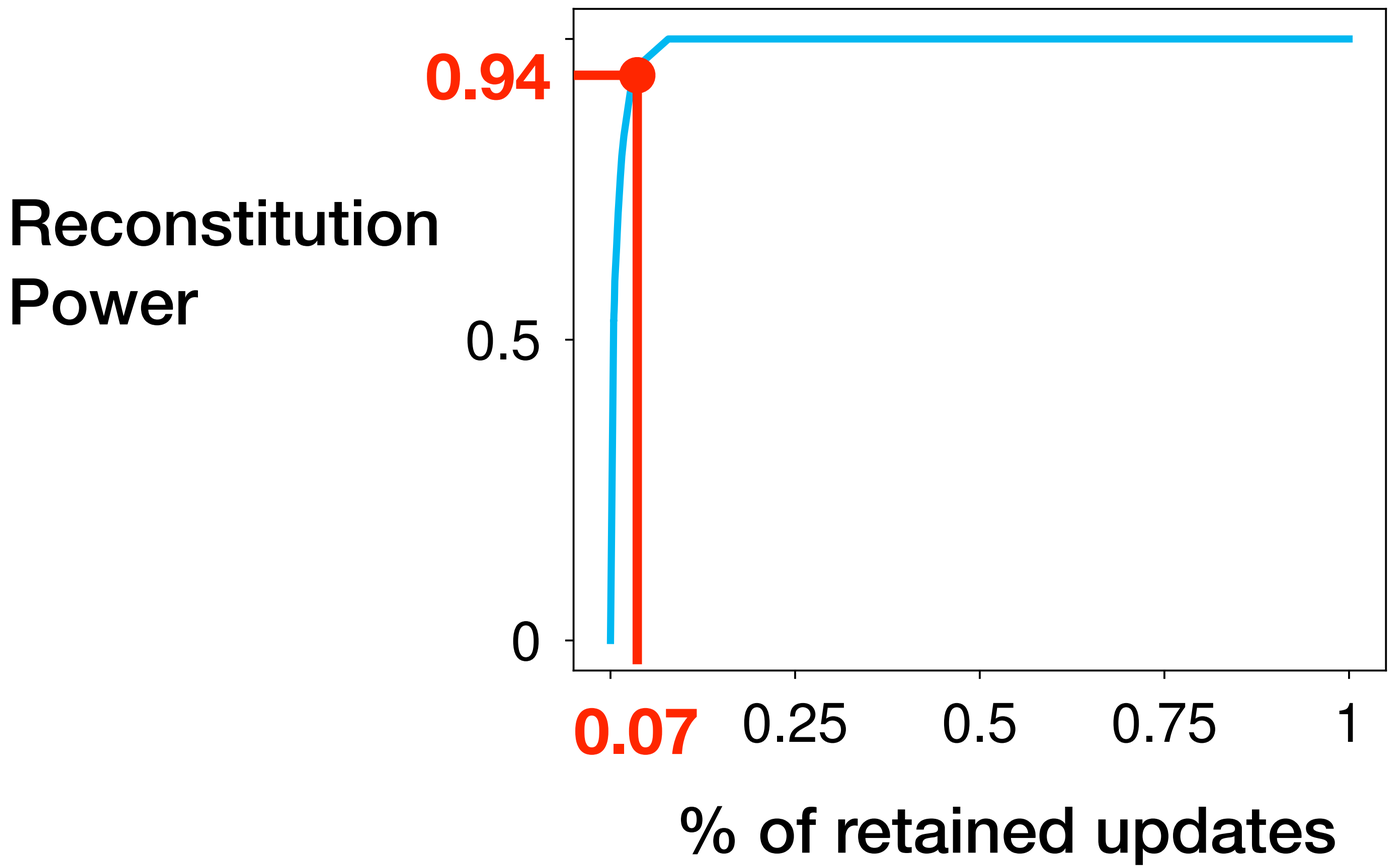

We can reconstitute 94% of the updates from 7% of them

GILL builds filters that discriminate retained updates from redundant updates

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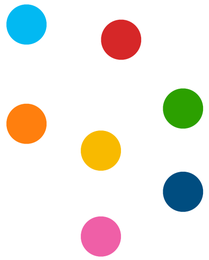
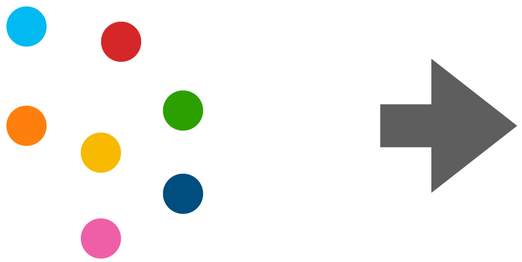
Original set
of updates

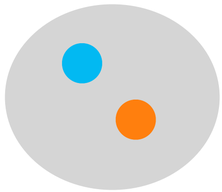


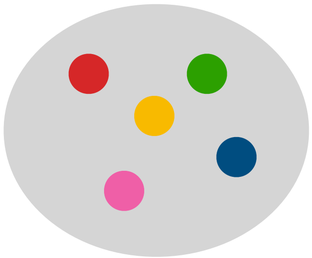
GILL builds filters that discriminate retained updates from redundant updates

Original set of updates



Retained updates

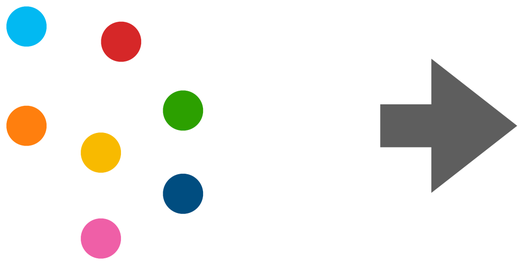




Redundant updates

GILL builds filters that discriminate retained updates from redundant updates

Original set of updates



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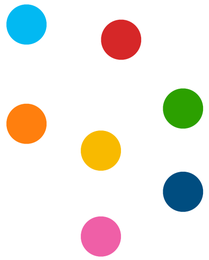
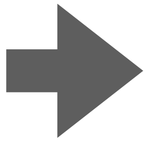
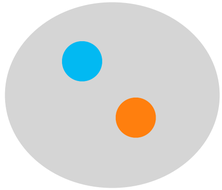
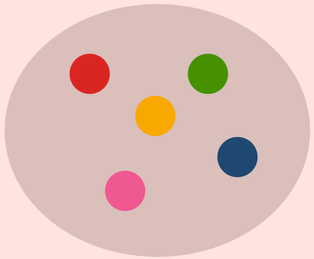




Retained updates



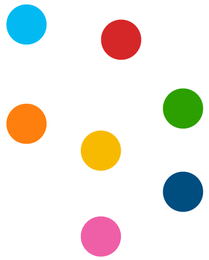


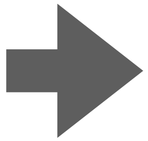
Redundant updates

How much information do we lose?

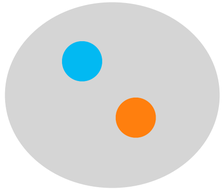
GILL builds filters that discriminate retained updates from redundant updates

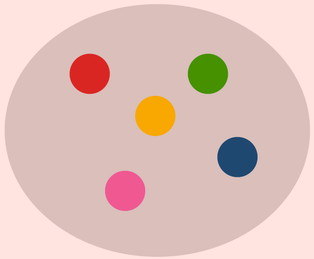
Original set of updates





Retained updates





Redundant updates

How much information do we lose?

Not much!

Outline

1. We observe that BGP routes
are often redundant

2. Redundant BGP routes enable
an overshoot-and-discard collection scheme

3. ***GILL***: a system that measures redundancy between BGP routes
and generates filters that discard redundant routes

**4. *GILL's* long-term impact is significant
for various objectives**

GILL's long-term impact

	Platform's settings		
	coverage	% of discarded BGP updates	# of stored BGP updates
Current approach	2%	0%	X
GILL			

Results from simulations
on "mini" Internets with 6k ASes

GILL's long-term impact

	Platform's settings			Use cases		
	coverage	% of discarded BGP updates	# of stored BGP updates	Topology mapping (p2p links)	Failure localisation (p2p links)	Hijacks detected (Type-1)
Current approach	2%	0%	X	20%	37%	73%
GILL						

Results from simulations
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Current approach	2%	0%	X	20%	37%	73%
GILL	50%	96%	X			

Same number of updates

Results from simulations
on "mini" Internets with 6k ASes

GILL's long-term impact

	Platform's settings			Use cases		
	coverage	% of discarded BGP updates	# of stored BGP updates	Topology mapping (p2p links)	Failure localisation (p2p links)	Hijacks detected (Type-1)
Current approach	2%	0%	X ↑ Same number of updates ↓	20%	37%	73%
GILL	50%	96%	X	61%	80%	82%

Results from simulations
on "mini" Internets with 6k ASes

A prototype of ***GILL*** is already up and running!

https://bgproutes.io/

GILL

Expanding BGP Data Horizons

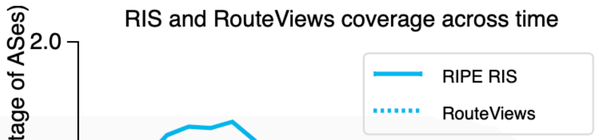
BGP routes collected from operational routers are extremely valuable to monitor and study Internet routing. However, BGP data collection platforms as currently architected face fundamental challenges that threaten their long-term sustainability: their data comes with enormous redundancy and yet dangerous visibility gaps.

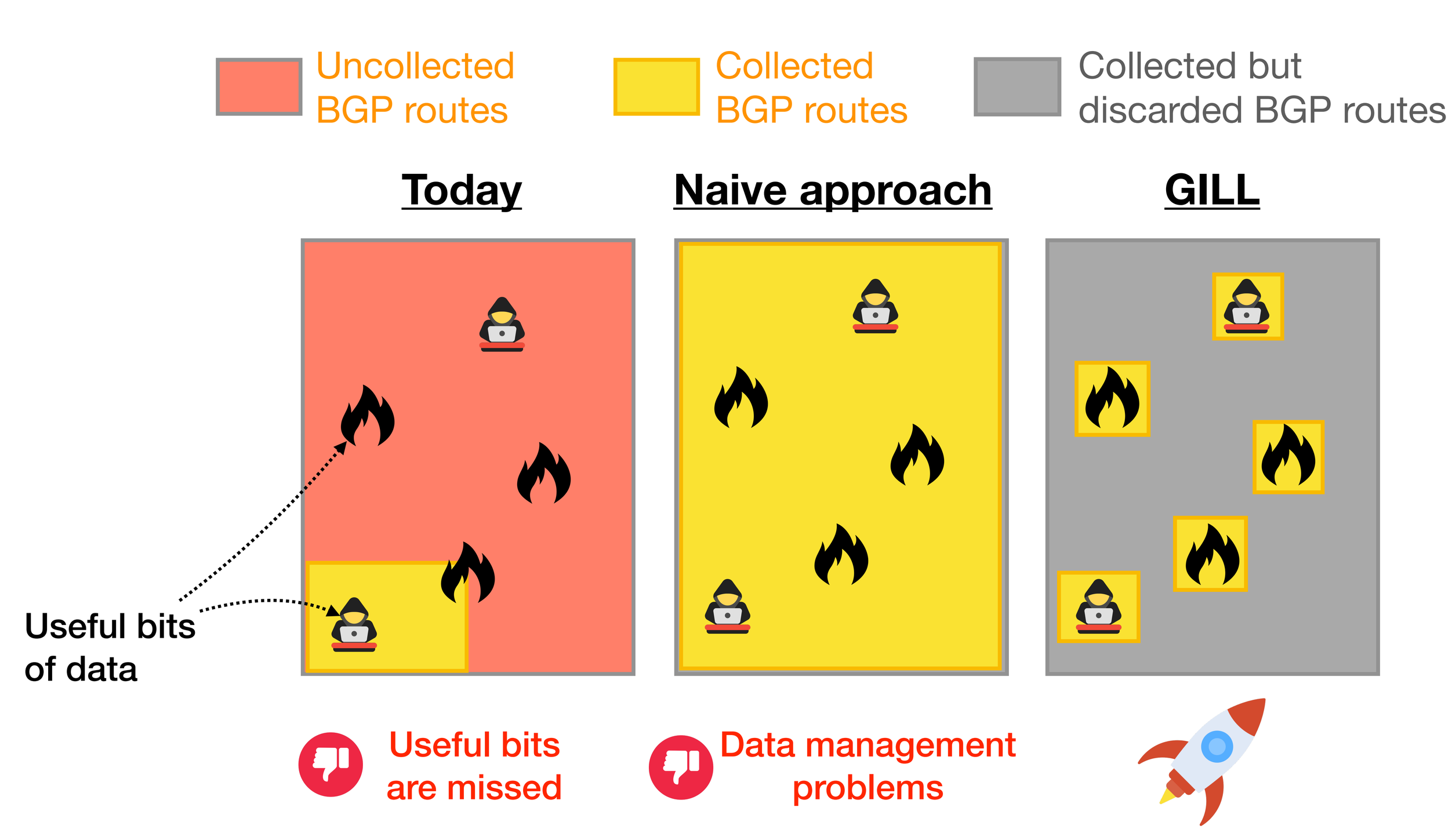
GILL is a new BGP routes collection platform that can collect routes from at least an order of magnitude more routers compared to existing platforms while limiting the increase in human effort and data volume.

GILL's key principle is an *overshoot-and-discard* collection scheme: Any AS can easily peer with GILL and export their routes. However, GILL only stores and makes available to users the nonredundant routes.

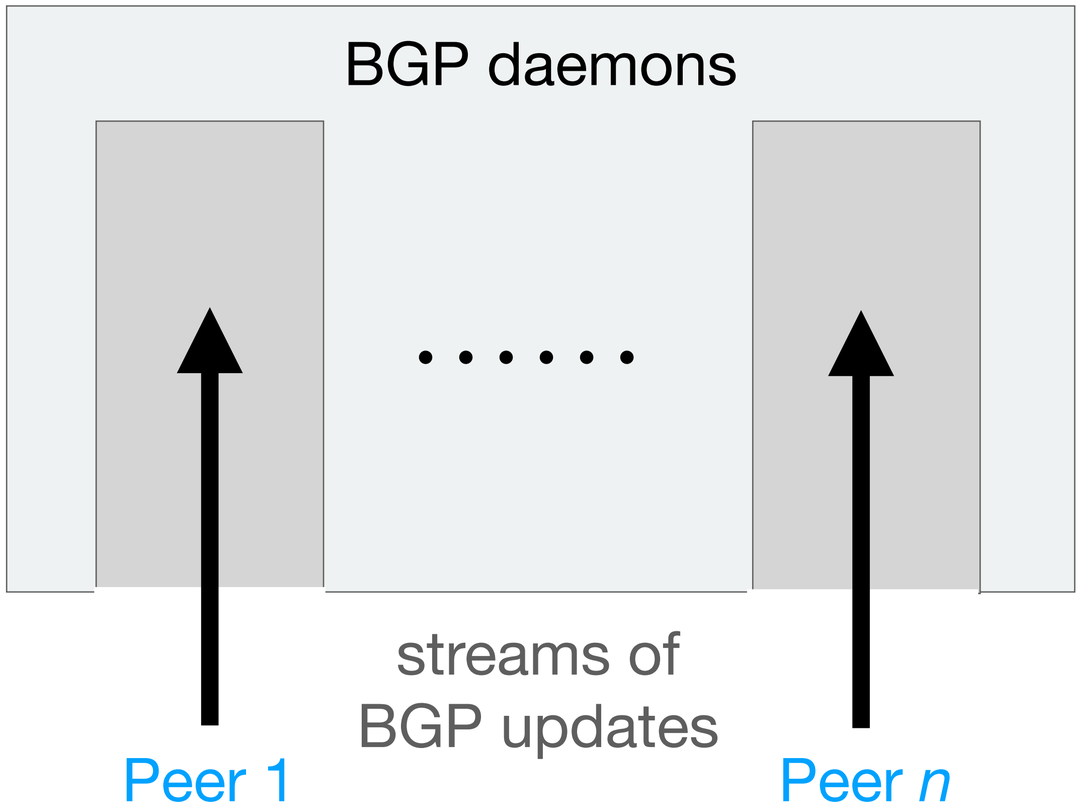
Coverage matters but is challenging

RIPE RIS and RouteViews, the two main BGP routes collection platforms, peer with routers from an increasing number of ASes (1500 in 2023).

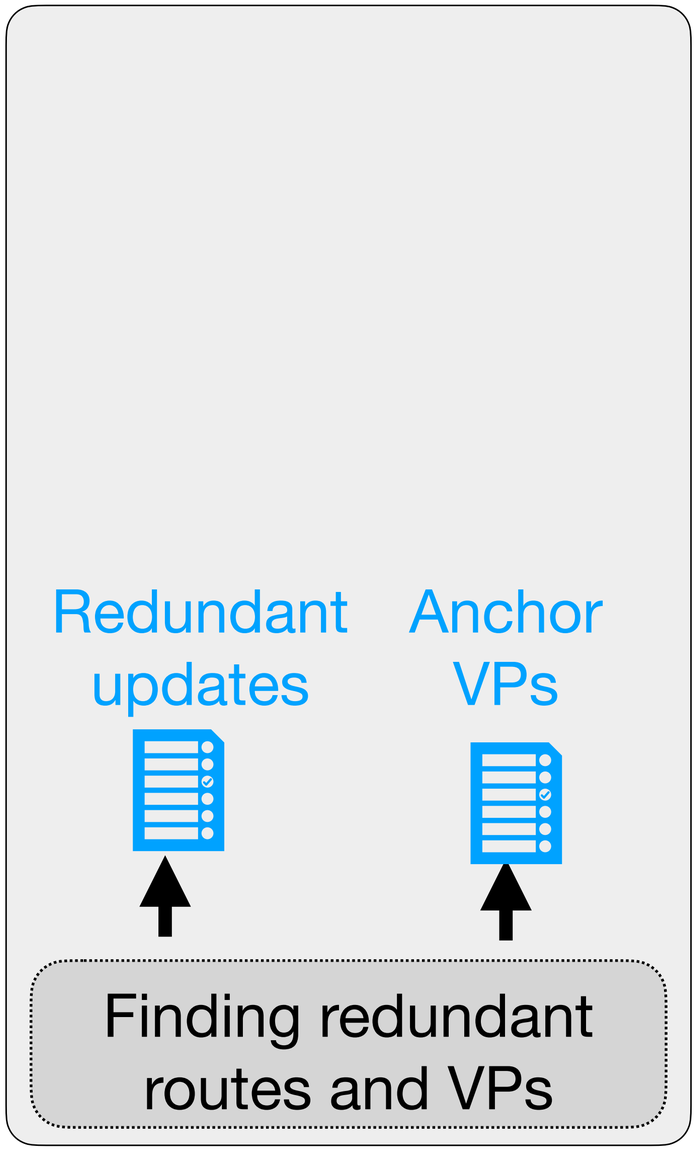


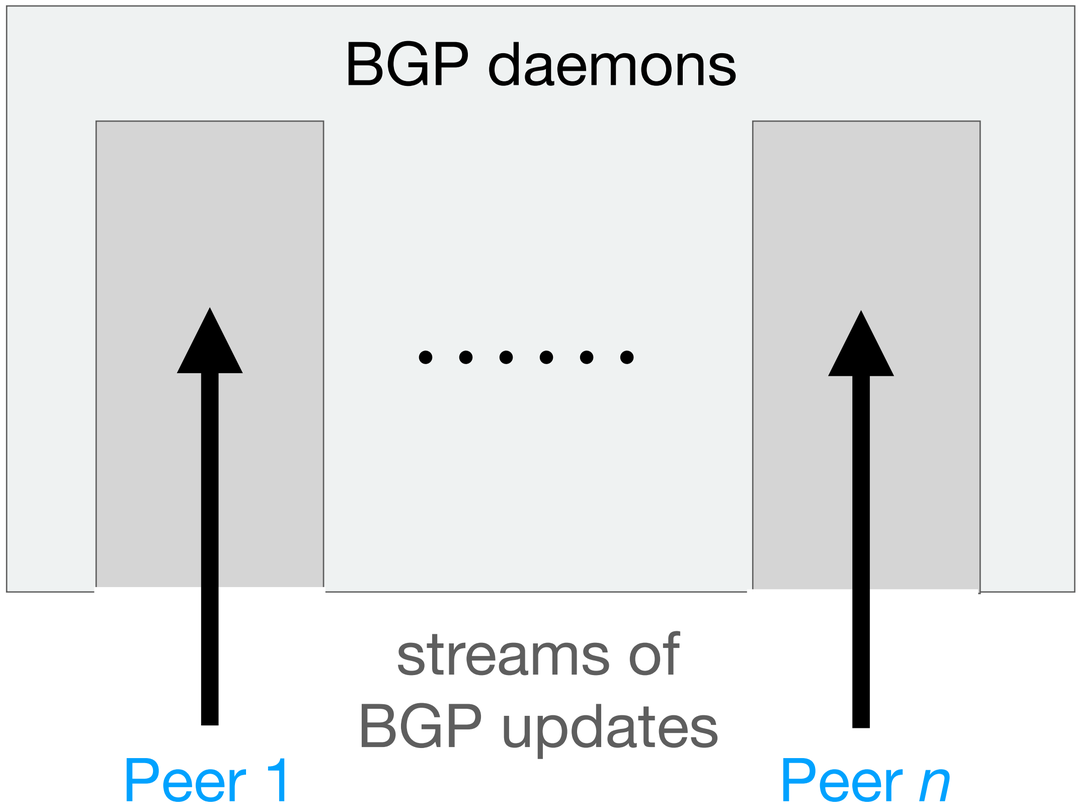

Uncollected BGP routes
Collected BGP routes
Collected but discarded BGP routes
Today
Naive approach
GILL
Useful bits of data
Useful bits are missed
Data management problems

GILL uses BGP daemons written in C and optimized to collect BGP routes



GILL finds redundant updates and anchors VP





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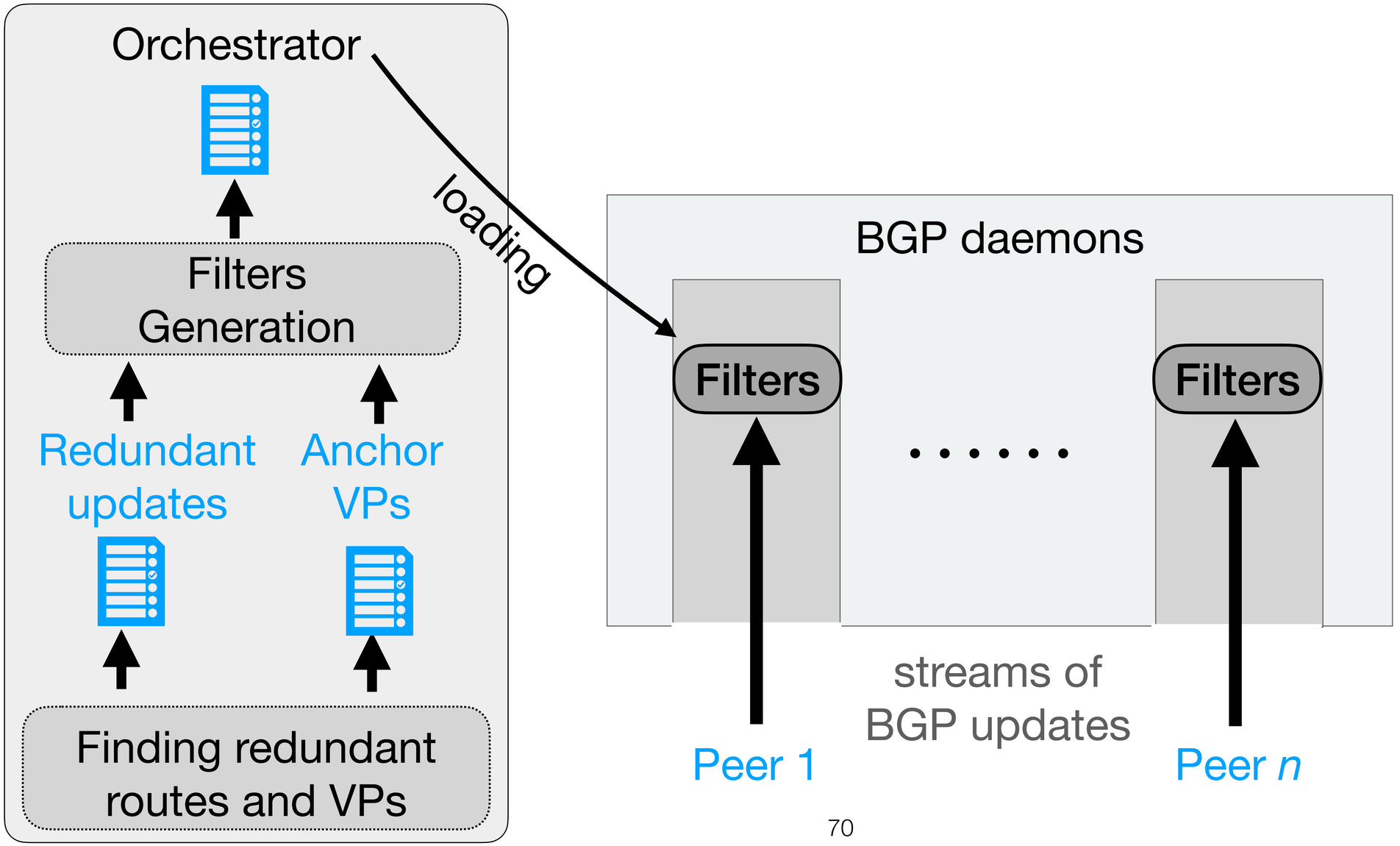
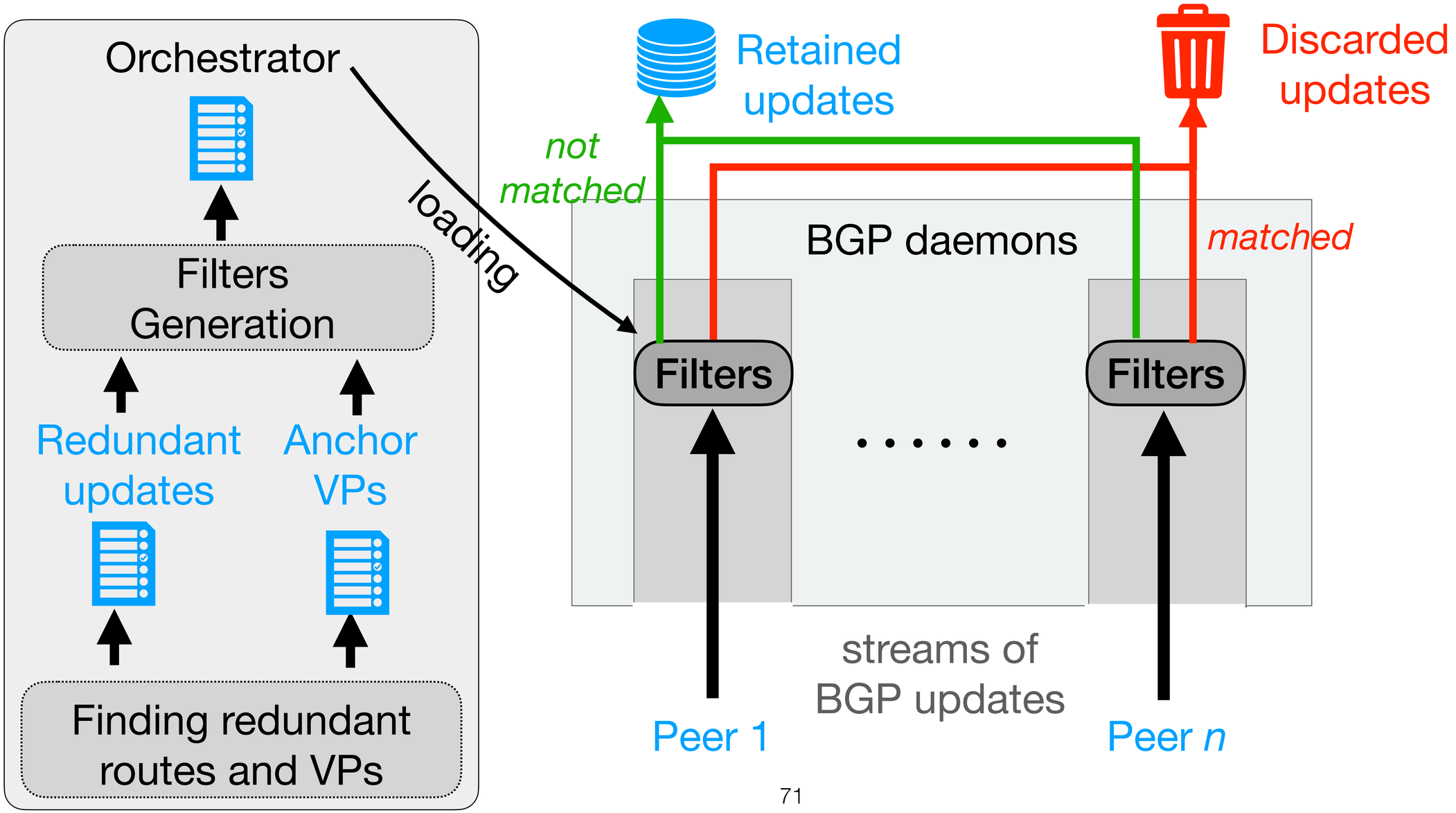
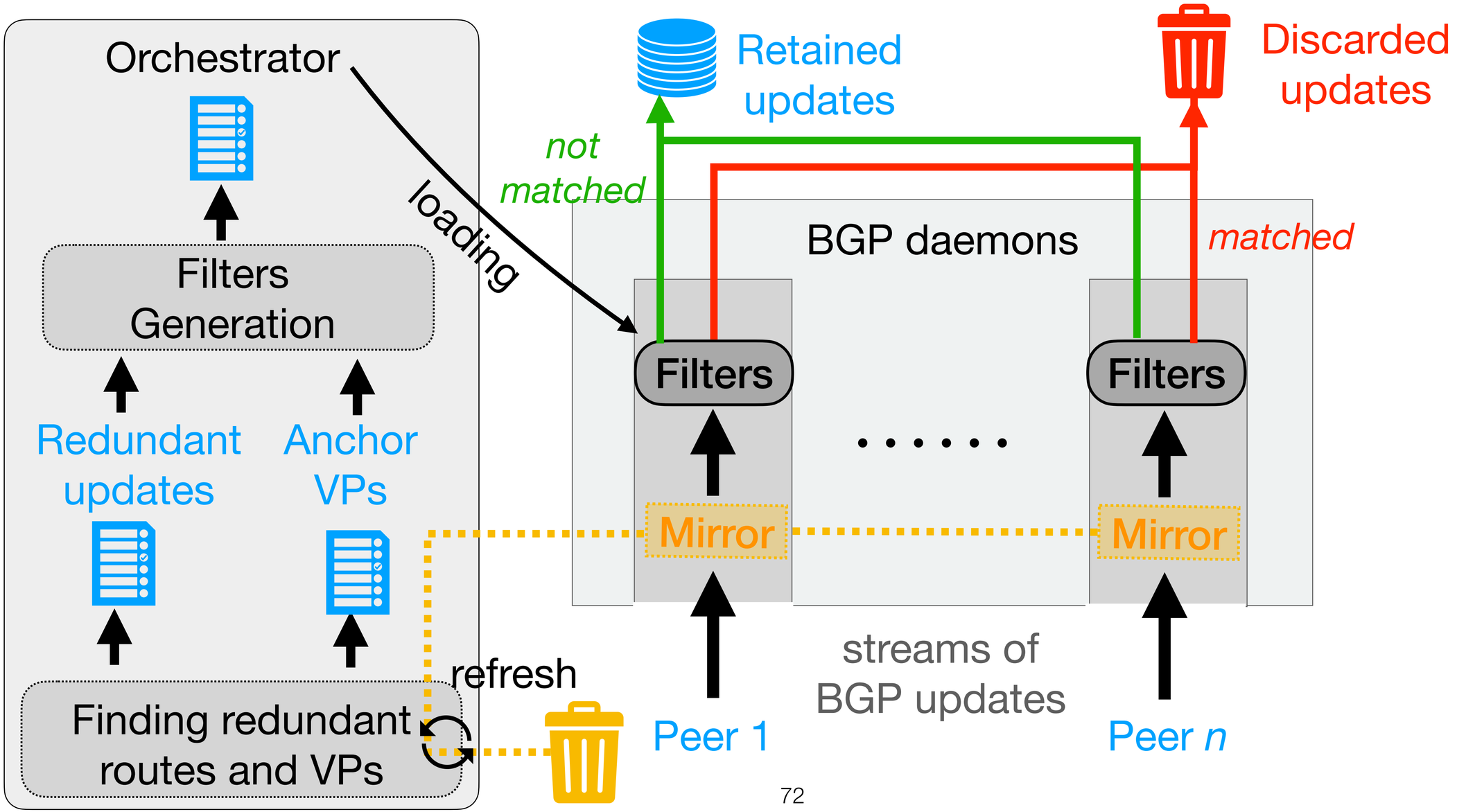


GILL computes filters, loads them into the BGP deamons and discards the filtered routes



GILL updates filters over time using an out-of-band mirroring scheme



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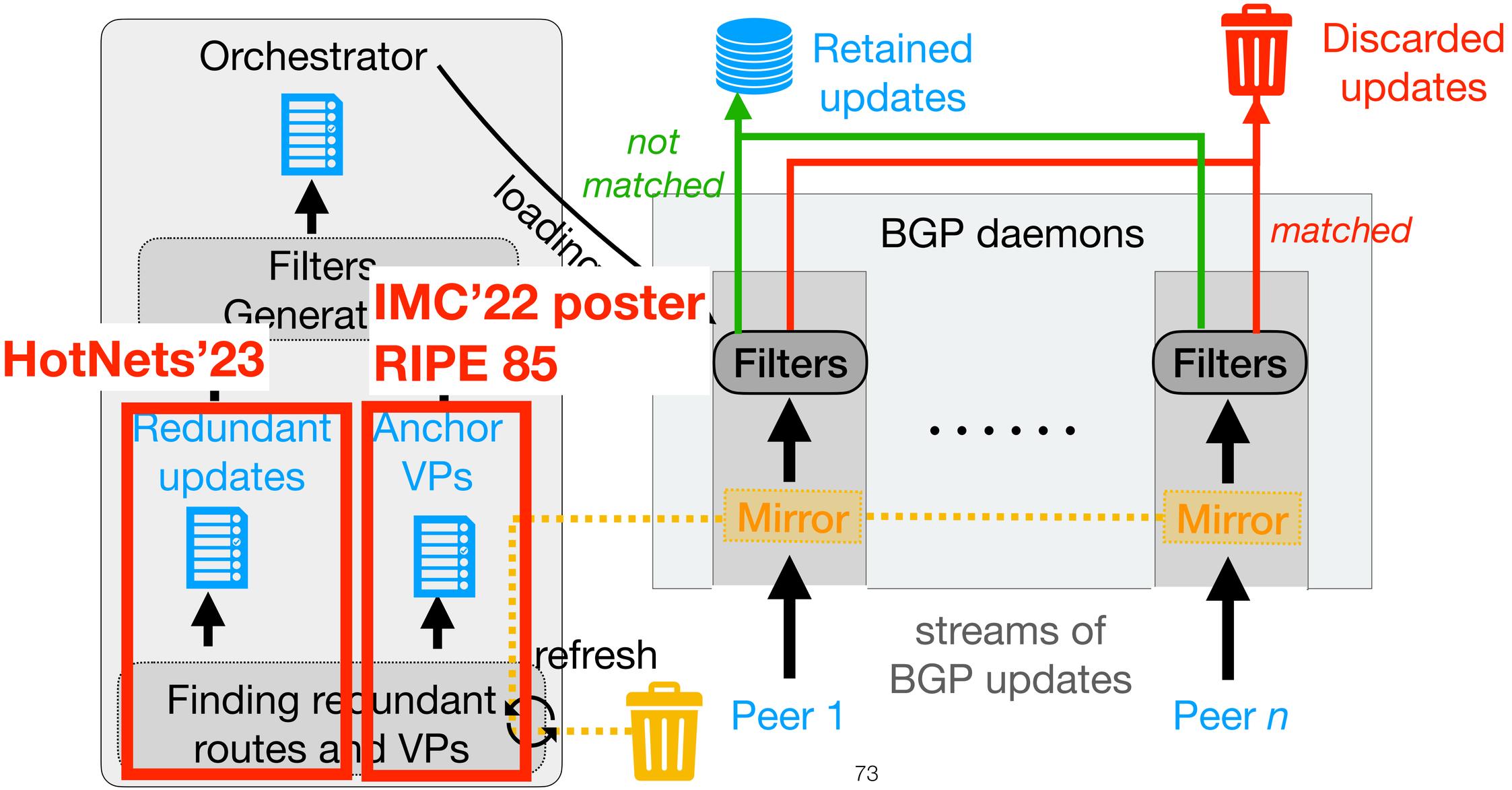

Gill finds redundant BGP data
without optimising a particular objective

<u>Key Intuition:</u> ***A set of BGP updates is redundant if it can probabilistically be reconstituted from another set of updates***

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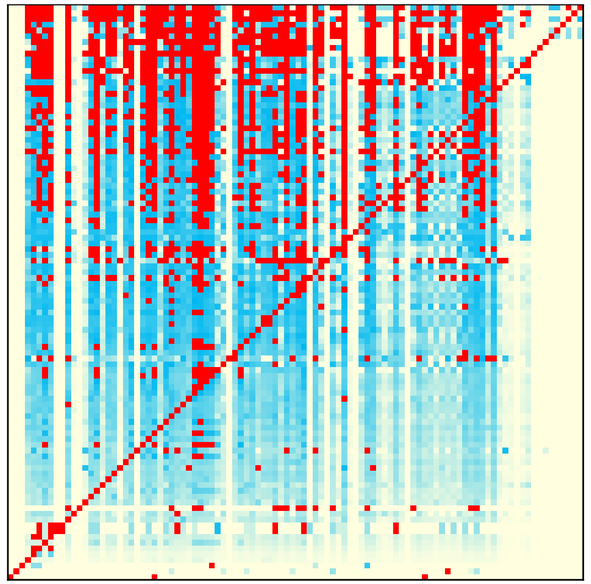
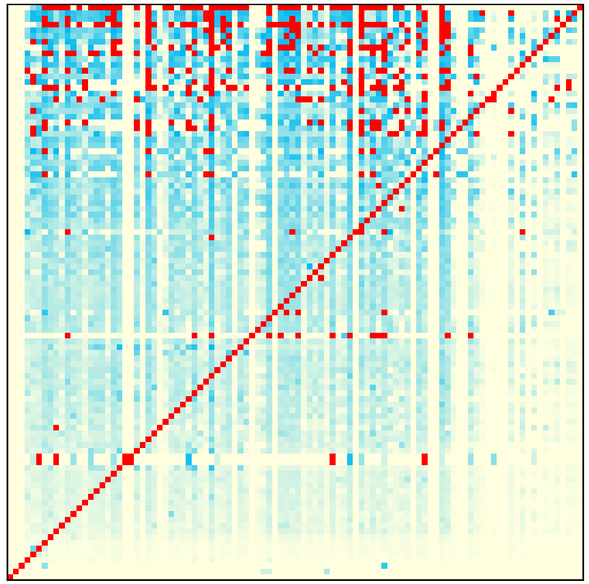
See our HotNets'23 paper

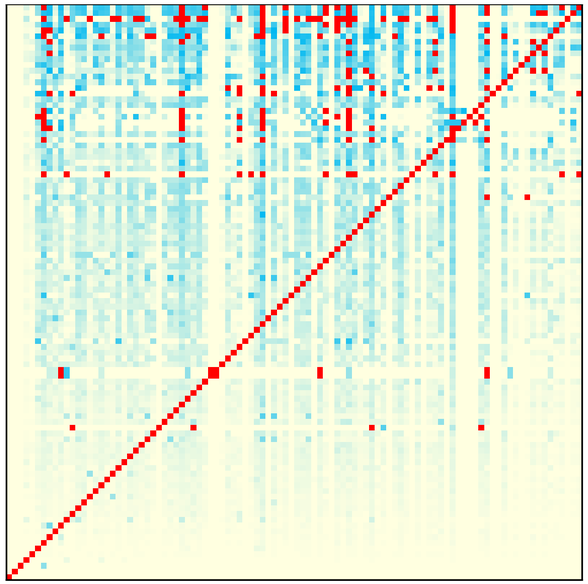
There is a high level of redundancy in BGP data



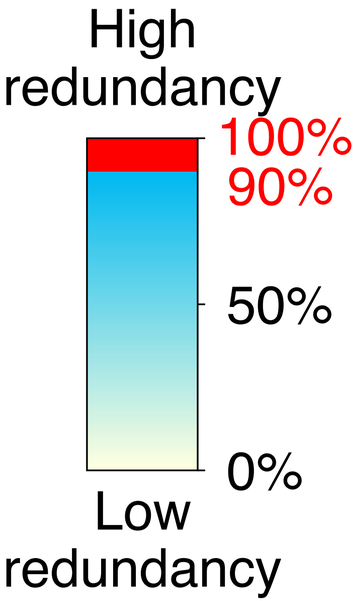
Time + Prefix



Time + Prefix +
AS path



Time + Prefix +
AS path + Comm.



Naive baselines fail to assess redundancy in BGP data