tracebox

Korian Edeline (ULg)
WP1/WP2
Oslo, July 2017

measurement and architecture for a middleboxed internet

measurement architecture experimentation

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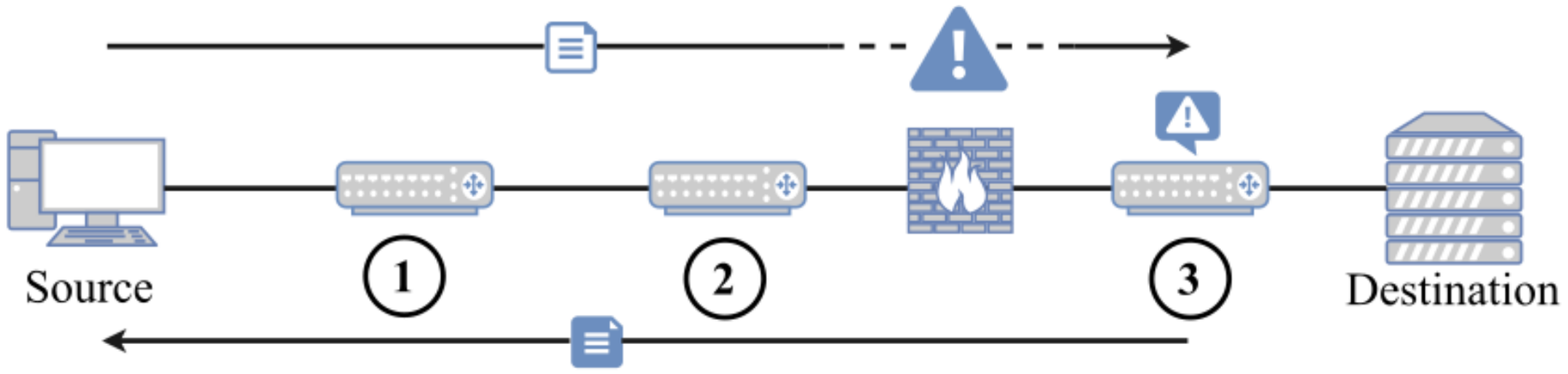
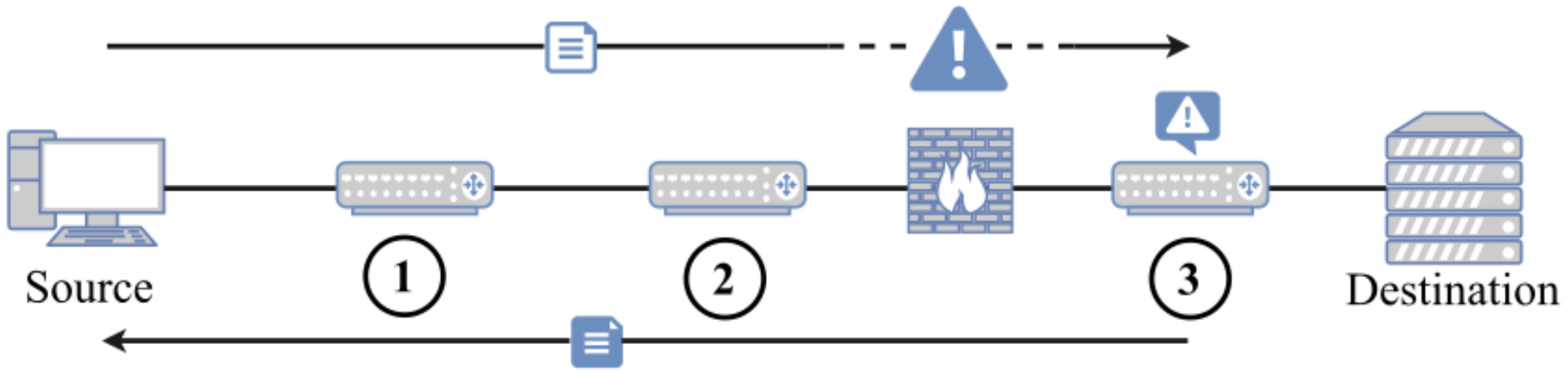
tion.

tracebox


Source
1
2
3
Destination


Router
Middlebox
TCP Probe
ICMP Message
Informant router
x
ICMP-triggering TTL

tracebox

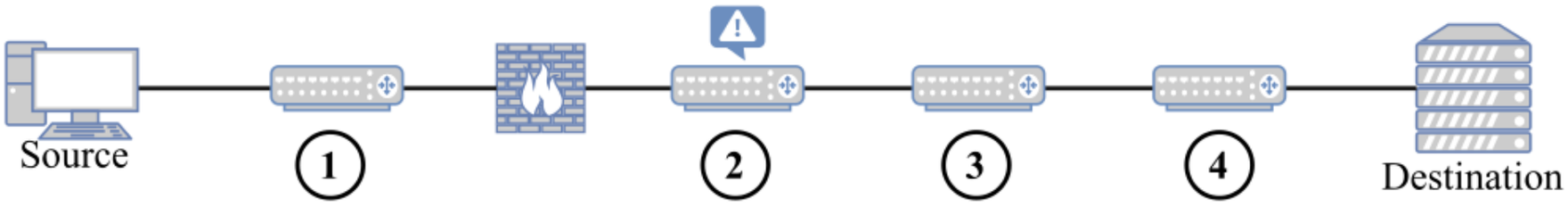


- RFC 792 : “The internet header plus the first 64 bits”
- RFC 1812 : “as much [...] as possible” (< 576 B)

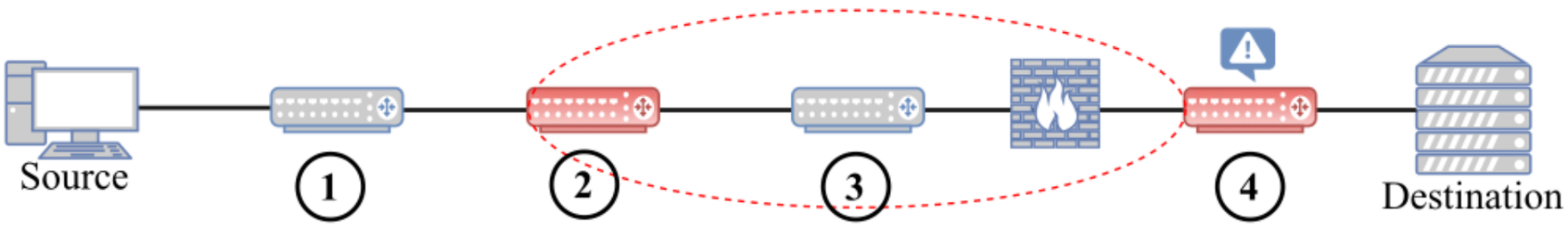
Dataset

- 14 Campaigns, one every ~5 day over 70 days.
- From 89 nodes to 594,241 destinations
- 948,457 responsive intermediate hops overall (59,861 HTTP(S)-only)
- 2,978 ASs crossed

tracebox



1. Modified field is within the first 48 bytes



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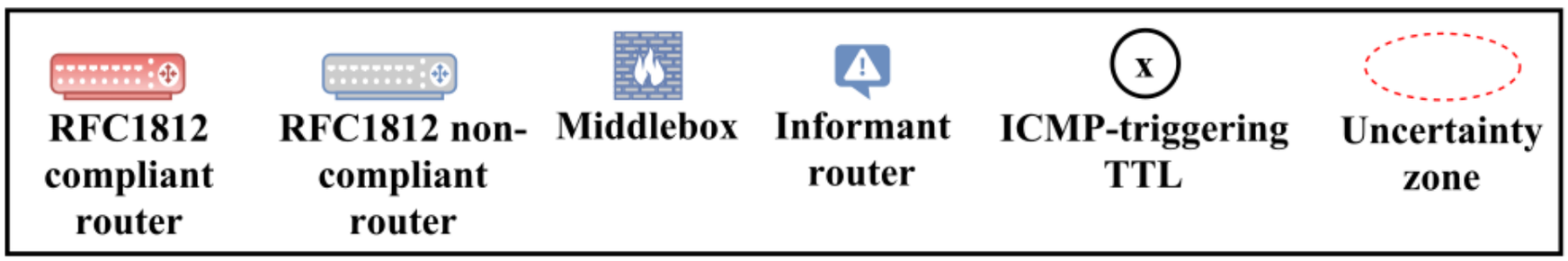

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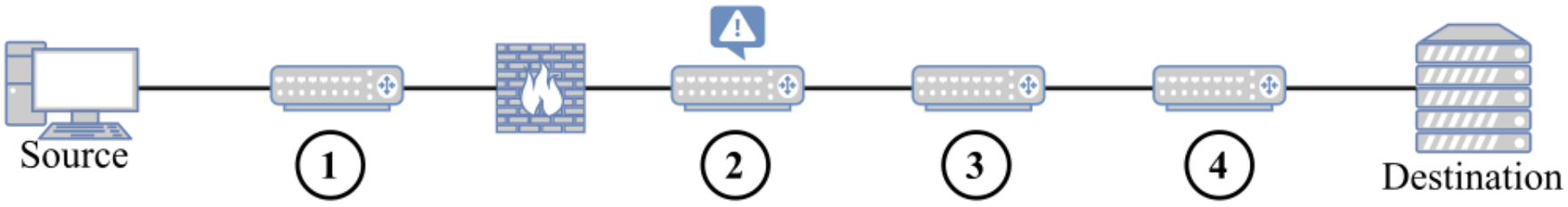

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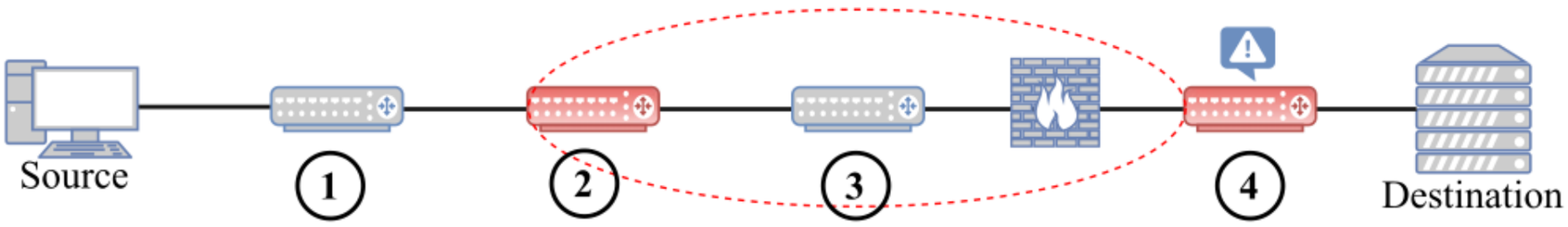

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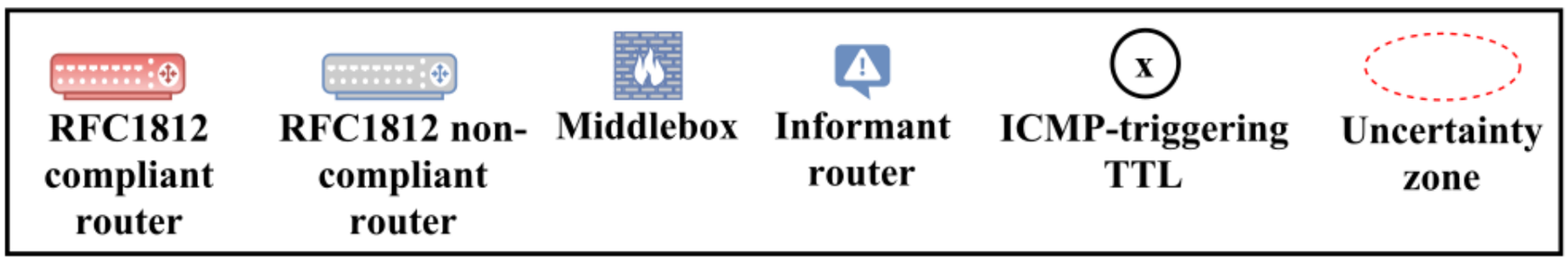
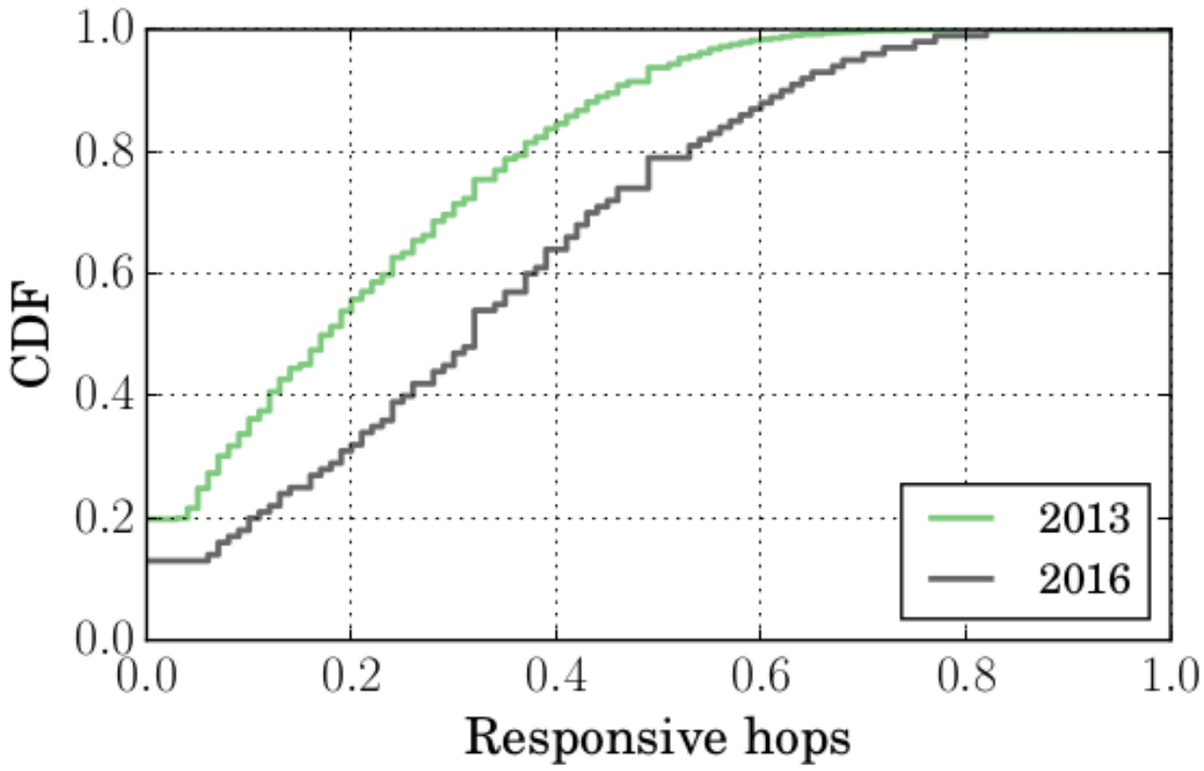
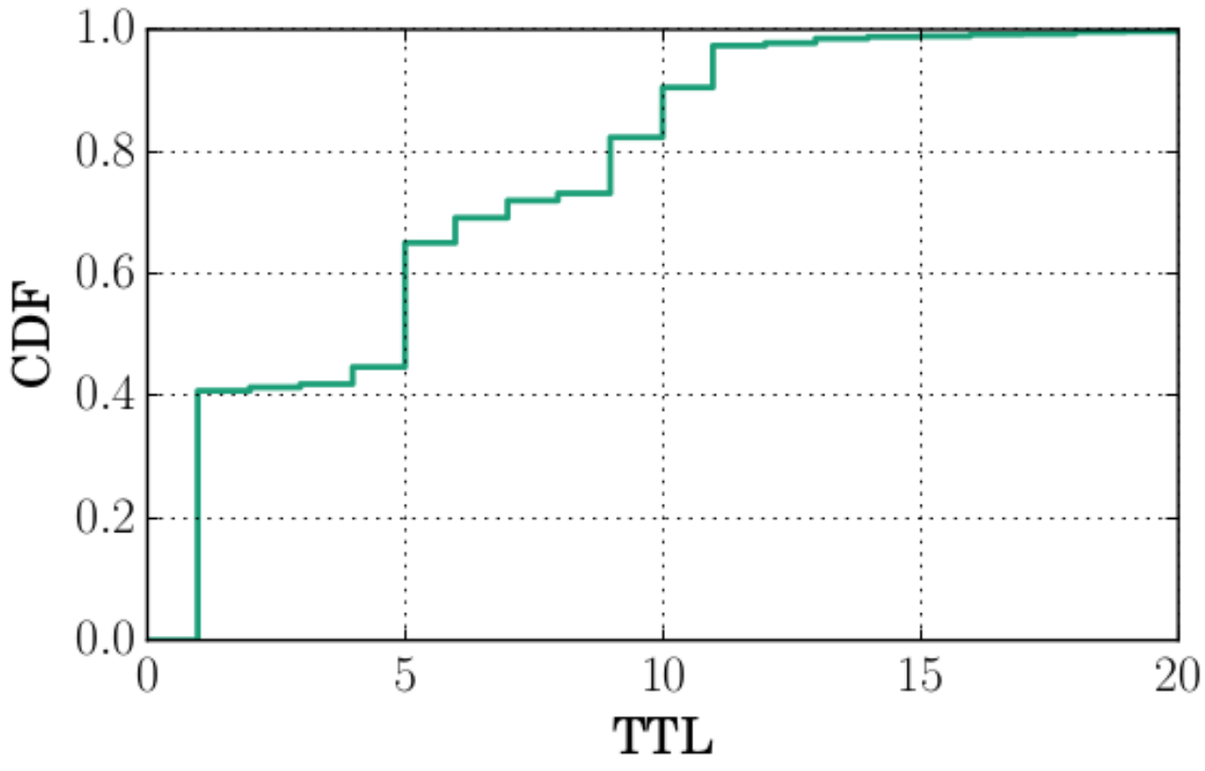


- U Zone : Observed sizes ? Workaround ?

U Zone

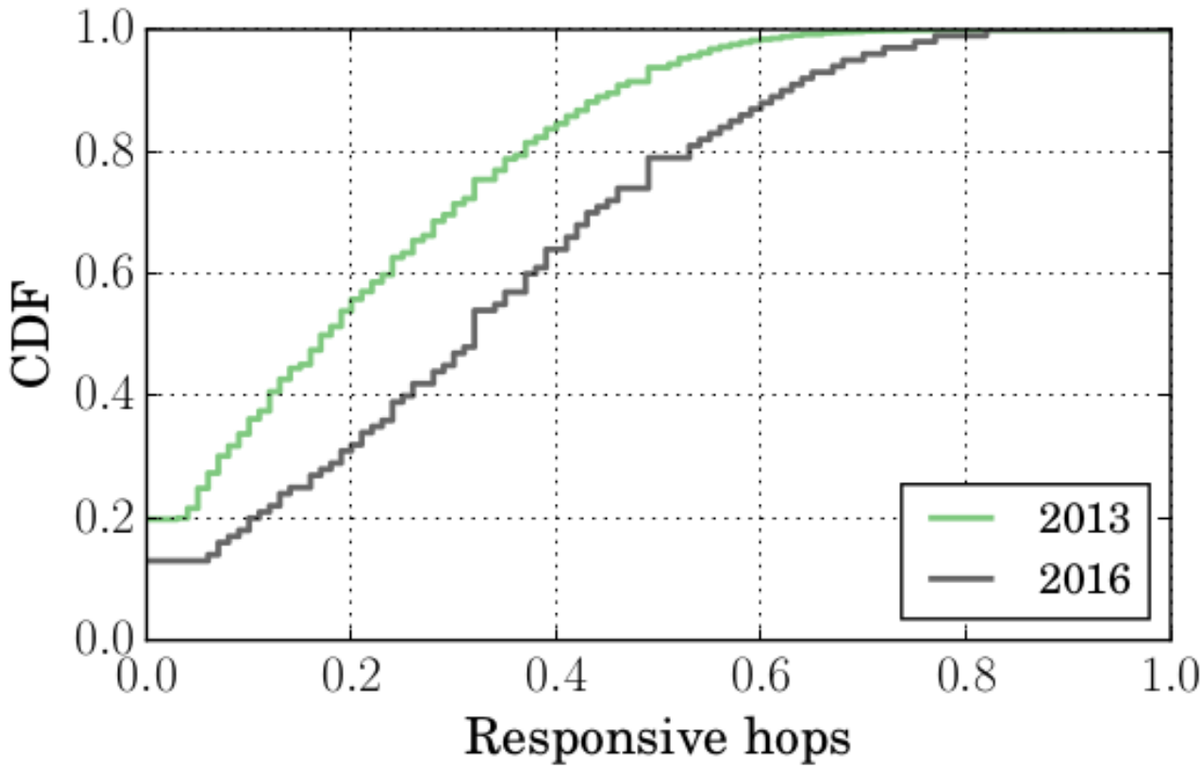


Proportion of RFC 1812 routers on observed paths



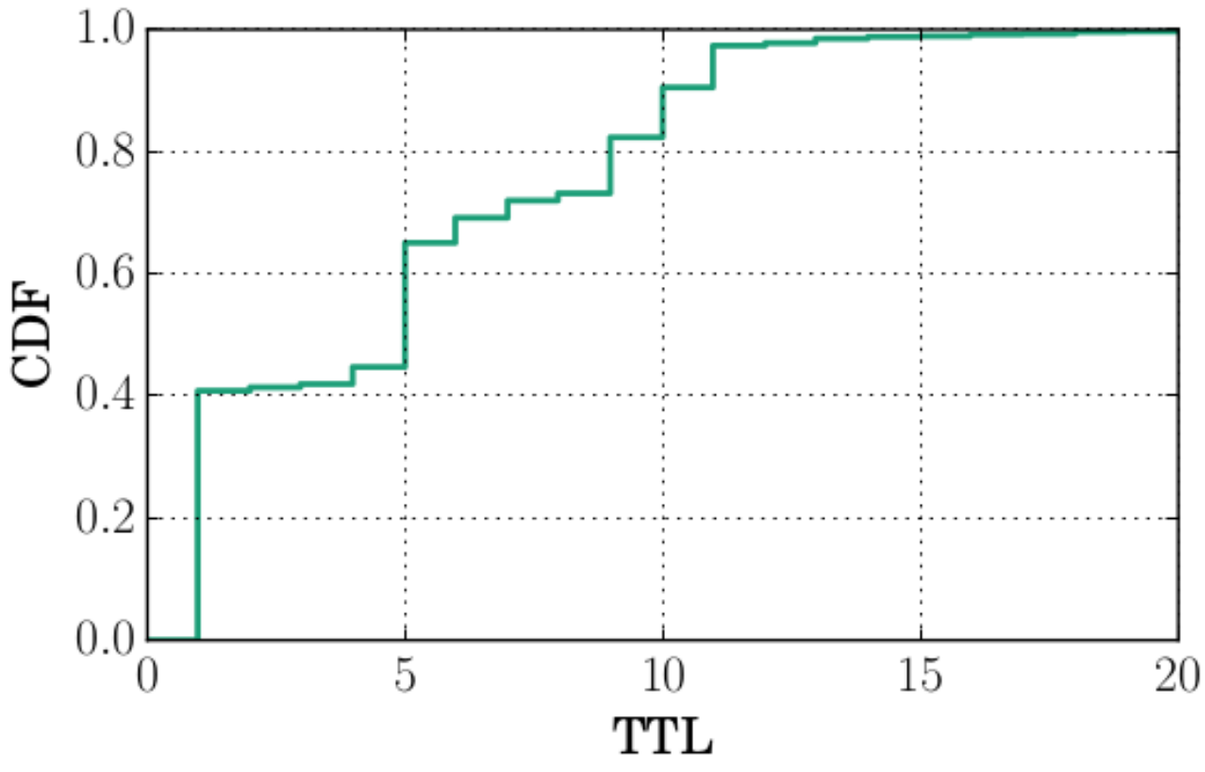
Sizes of U Zones

U Zone



Proportion of RFC 1812 routers on observed paths

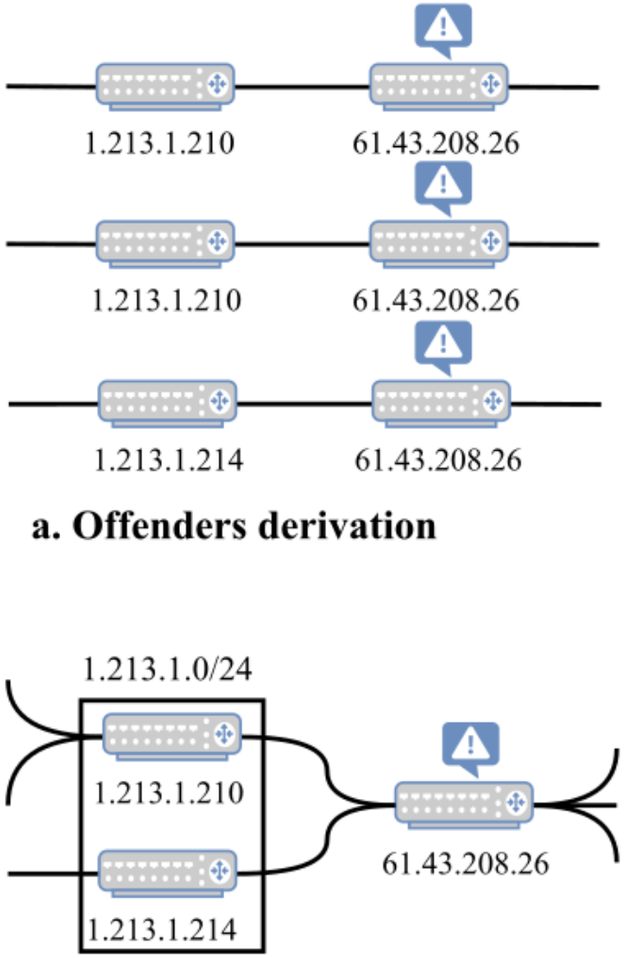
- Increases over time



Sizes of U Zones

- None for 15.5M obs. (41%)
- ≤ 5 for 23M obs. (60%)

Pre-processing: summary

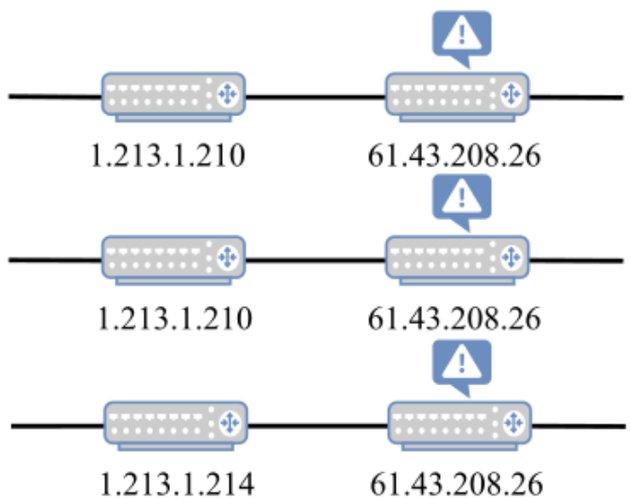


a. Label observations

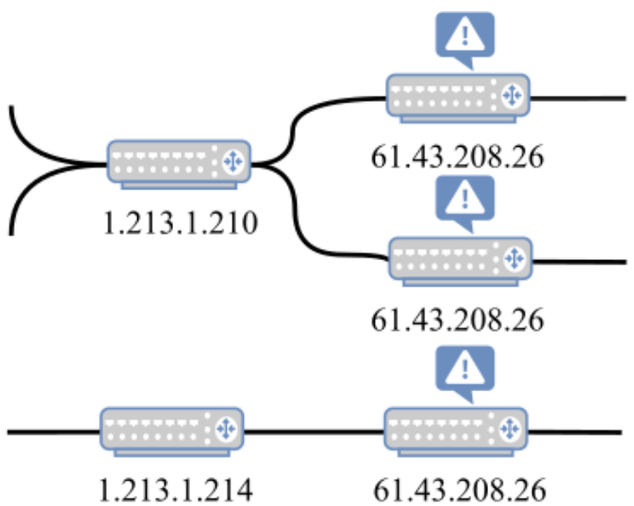
b. Aggregate observations

c. Merge offenders into middleboxes

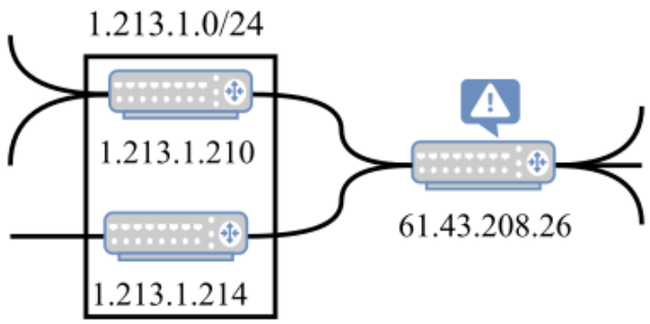
Pre-processing: derivation (Step 1)



a. Offenders derivation



b. Offenders grouping



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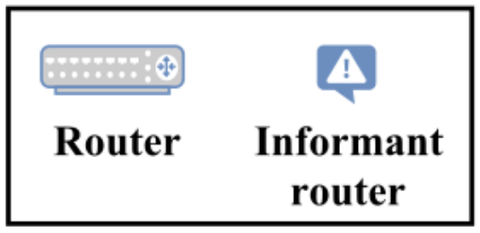

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- Offender : *The router preceding the middlebox on a given path*

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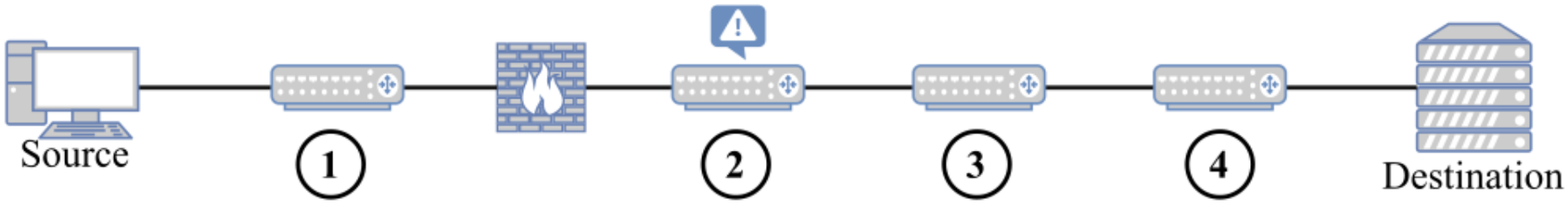

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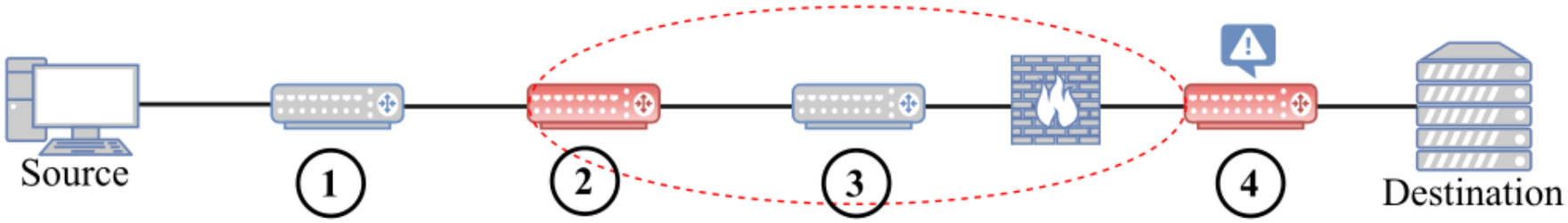

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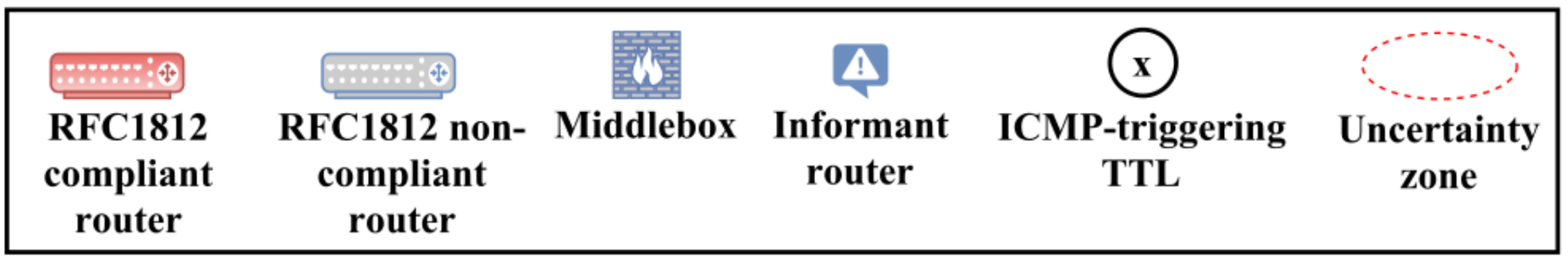

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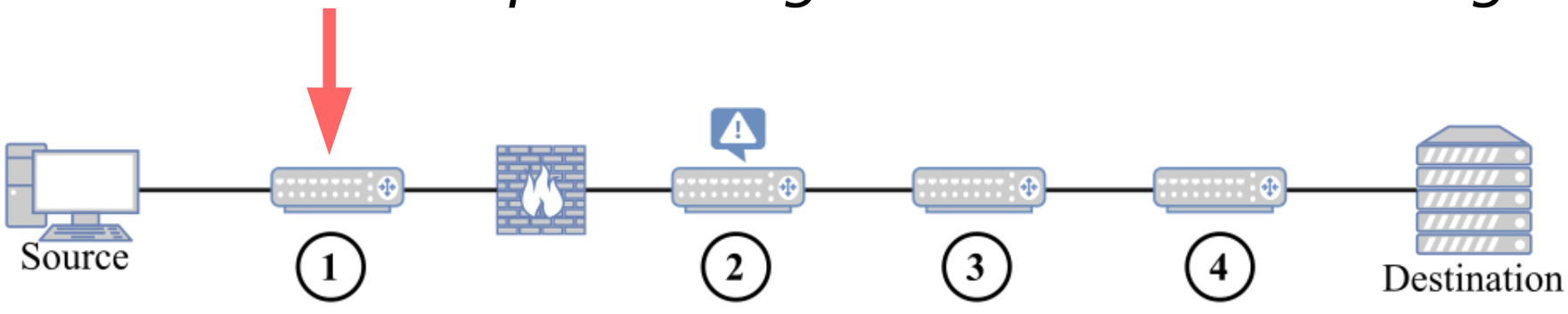

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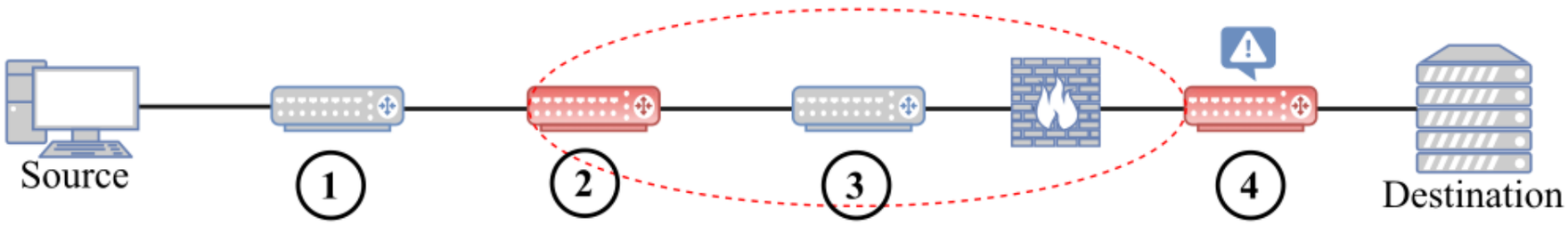

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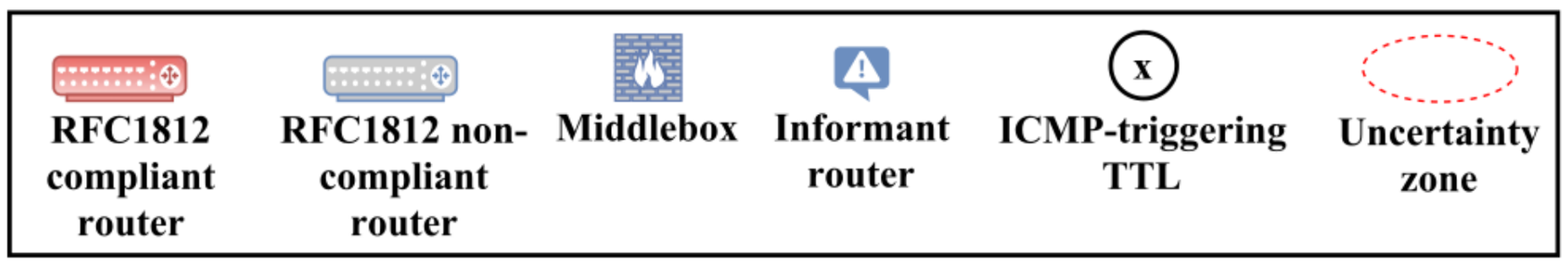

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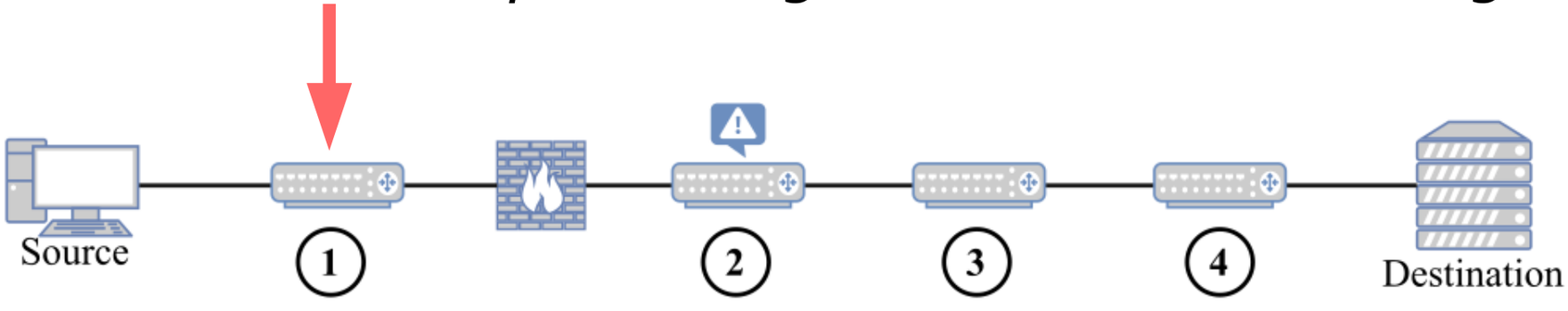

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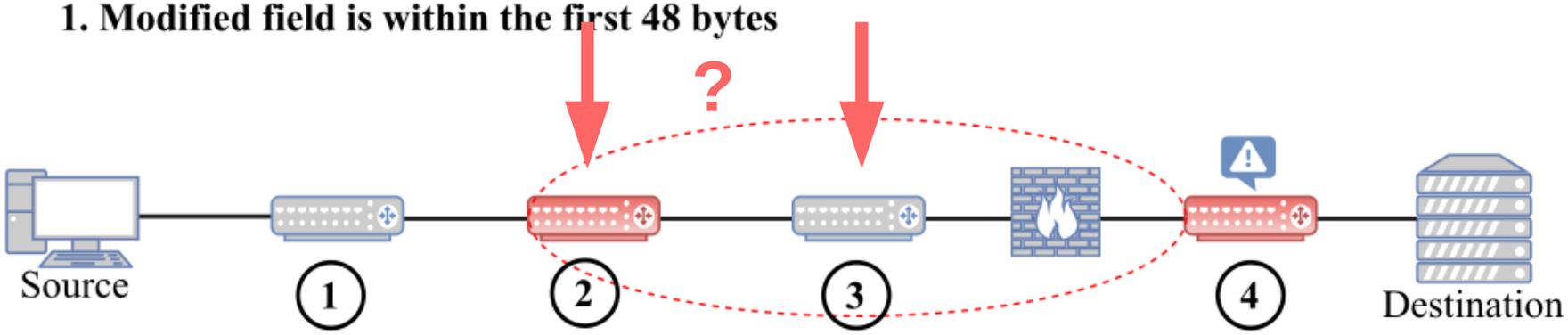

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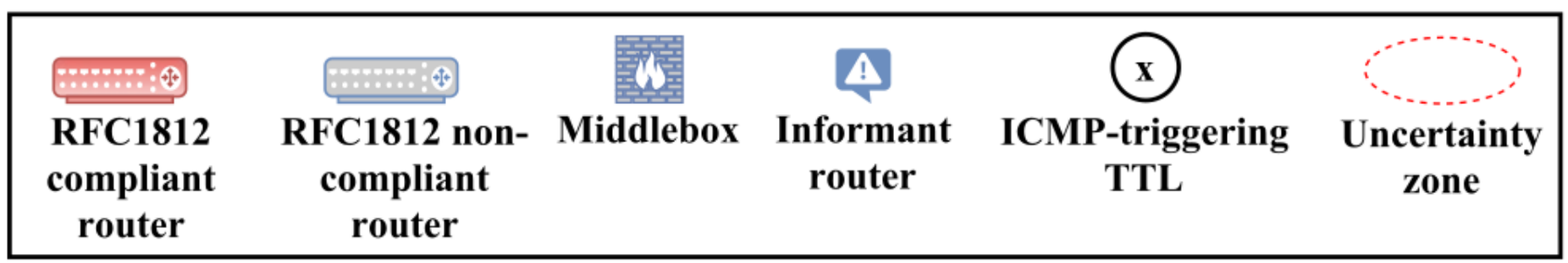

Pre-processing: derivation (Step 1)

def offender(probe):

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- No U zone: the router that precedes the informant router
- U zone: Heuristics

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- No U zone: the router that precedes the informant router
- U zone: Heuristics

1. * at informant_TTL–1 : offender at informant_TTL-2
2. * at informant_TTL-2 : offender at informant_TTL-3
3. a)Major AS in U zone, b)If a router was used for labeling, pick it
4. First router of U zone (if used for labeling)

Pre-processing: derivation (Step 1)

- 948,457 addresses observed

  Unresolved addresses:

- 21,330 (2.25%) from 10.0.0.0/8, 172.16.0.0/12 or 192.168.0.0/16
- 905 (0.1%) from 100.64.0.0/10
- 20,669 (2.18%) no AS (cymru)

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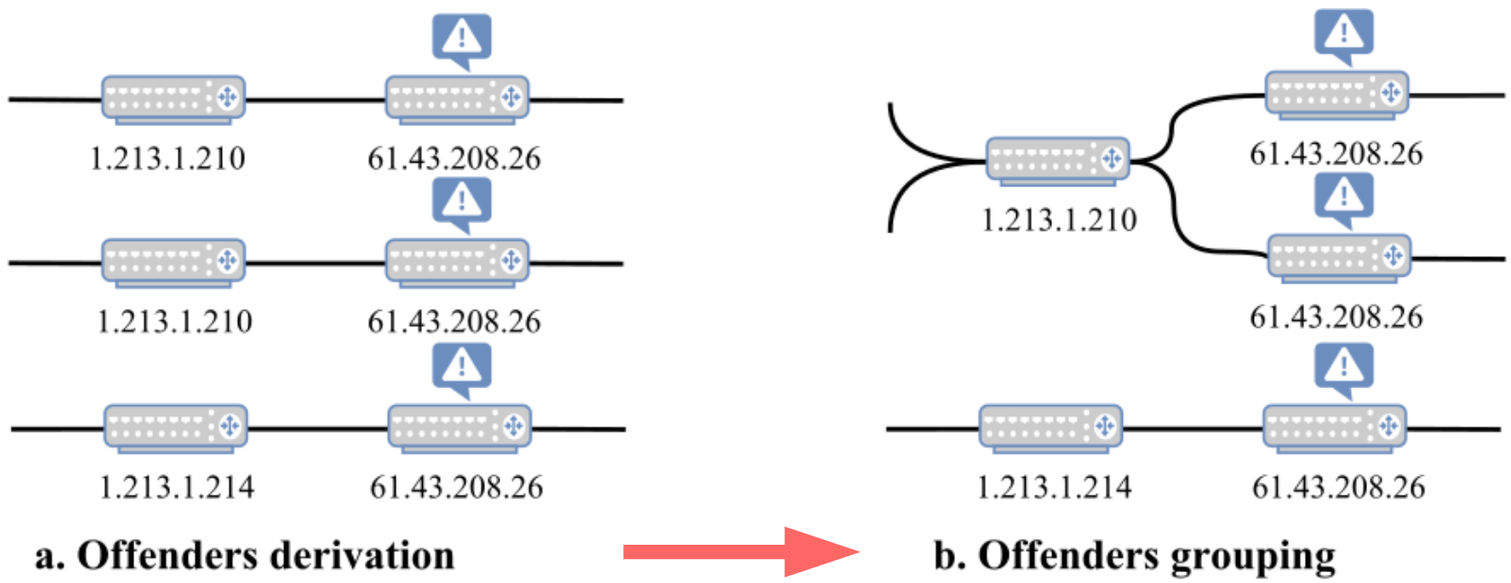
- Keep if ends of unresolved zone are mapped to same AS.

Pre-processing: derivation (Step 1)

Output:

- Offender AS for 99% obs.
- Offender IP for 52% obs. (20M)

Pre-processing: grouping (Step 2)



Pre-processing: grouping (Step 2)

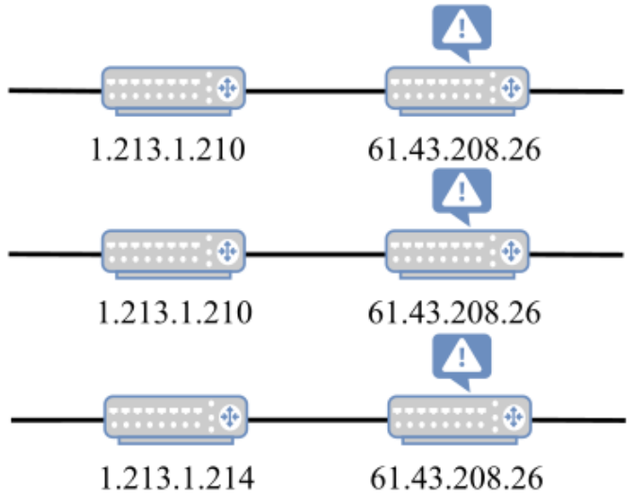
- MB profiles
- Cross-check heuristics: at least one trival case or Heuristic#1 per offender
- 5% threshold:
- inconsistent modifications: drop all obs.
- inconsistent positions: mark as conflict

Pre-processing: grouping (Step 2)

Output:

- 8,322 offenders

Pre-processing: merging (Step 3)



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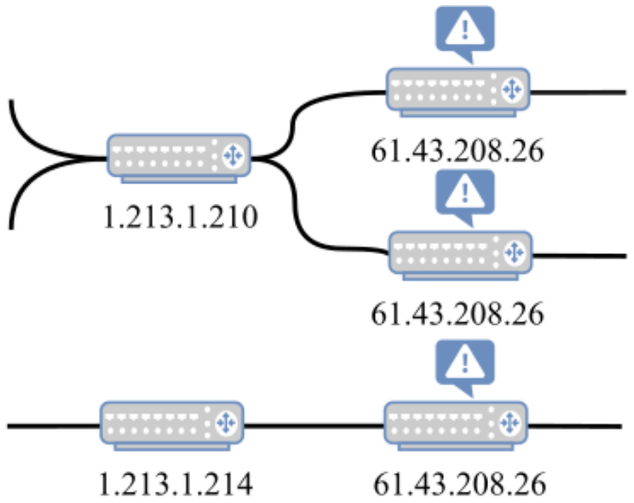

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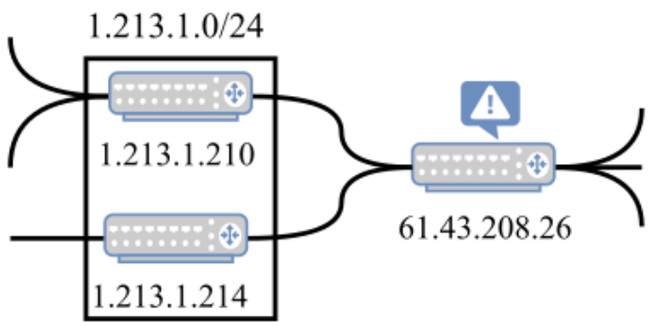

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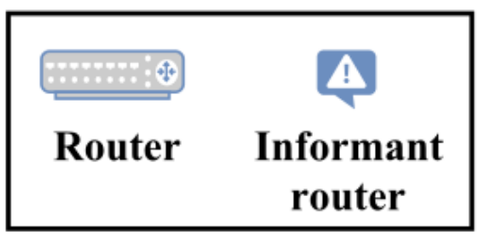


Pre-processing: merging (Step 3)

Merge offenders if:

1. Same subnet (/24)
2. Consistent modifications
3. Same set of next hops (offender_TTL+1)

Pre-processing: merging (Step 3)

Merge offenders if:

1. Same subnet (/24)
2. Consistent modifications
3. Same set of next hops (offender_TTL+1)

- 505 merged into 198
- (7 cases of Multi-Origin AS Conflicts)

Pre-processing: merging (Step 3)

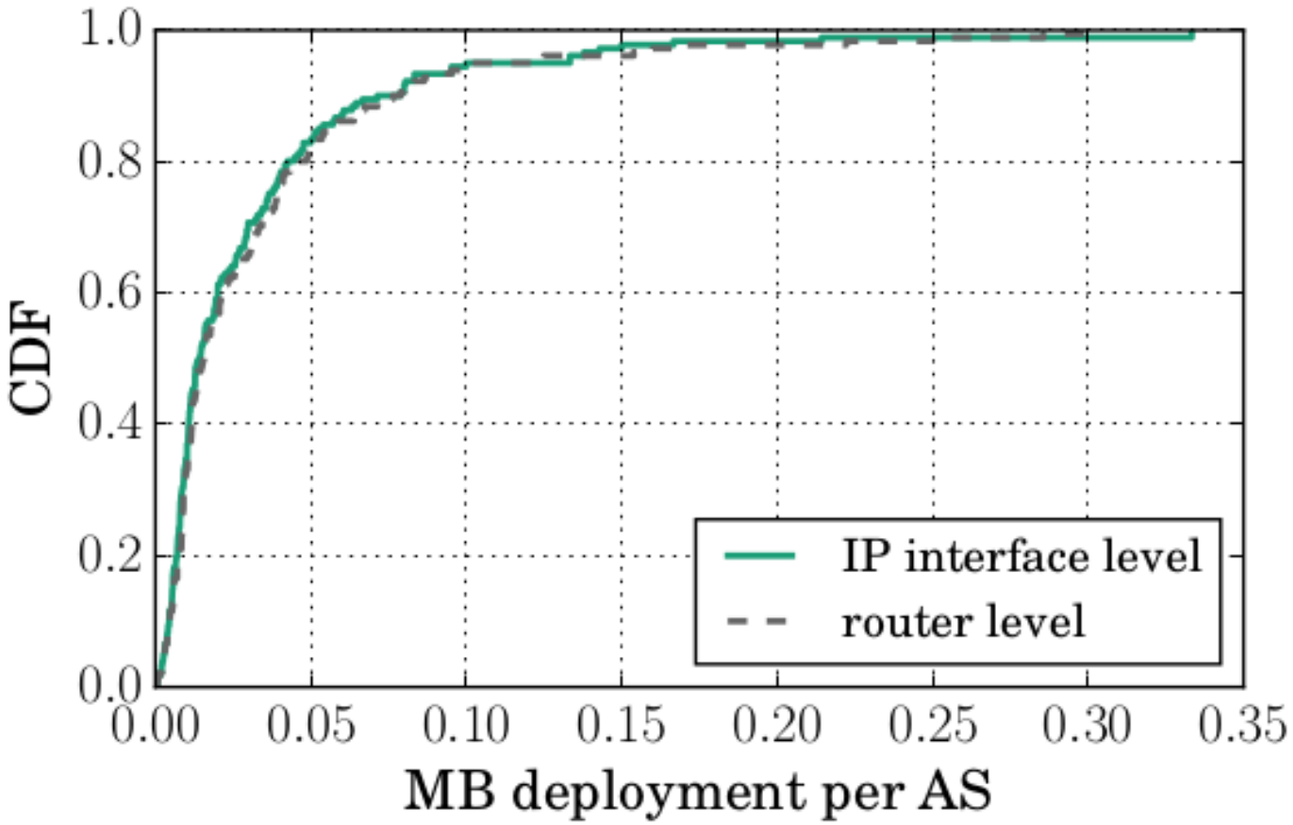
Output:

- 8,005 offenders

Results: prevalence

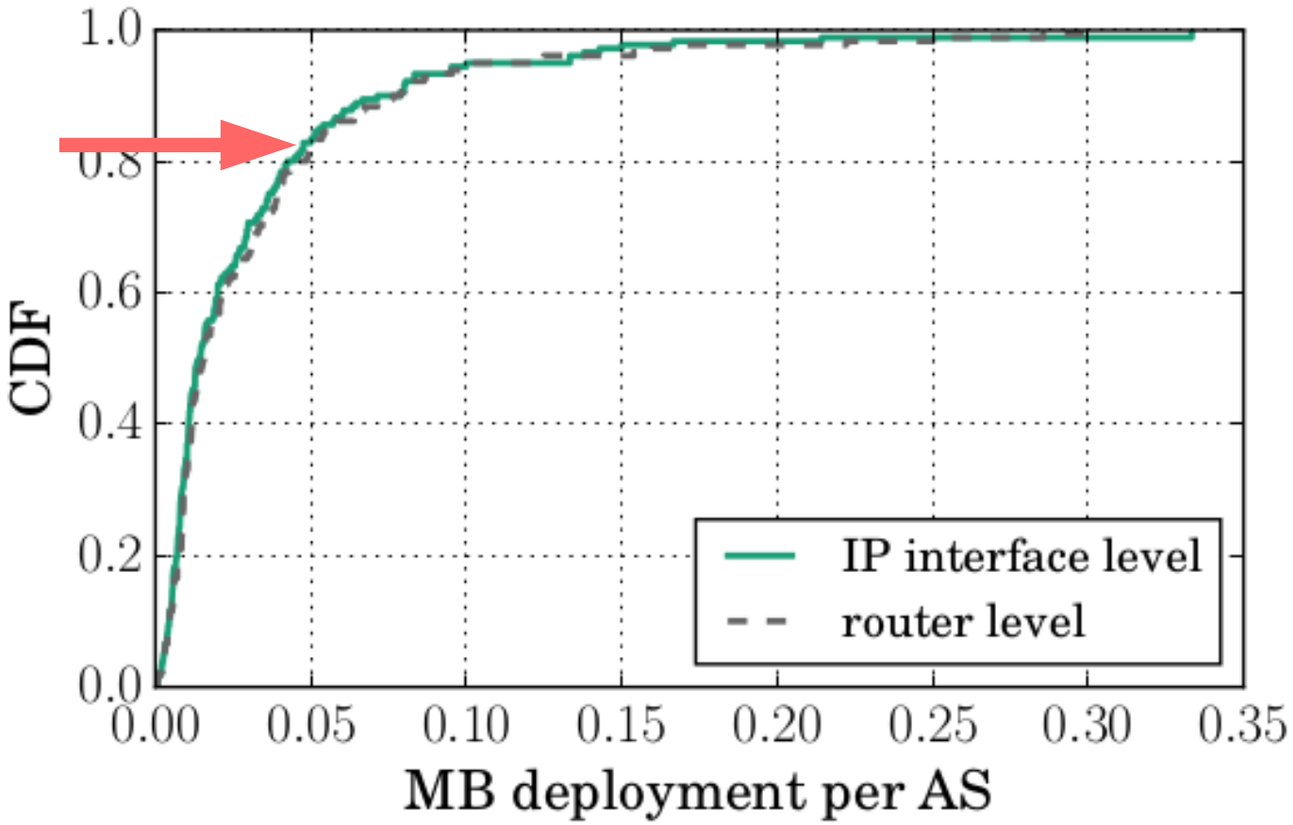
- Deployment: Proportion of MBs in AS
- Popularity: Paths affected by MB
- Position: Location of MB in AS topology

Prevalence: deployment



Deployed MB / IP interfaces, per AS. Alias resolution using CAIDA ITDK dataset.

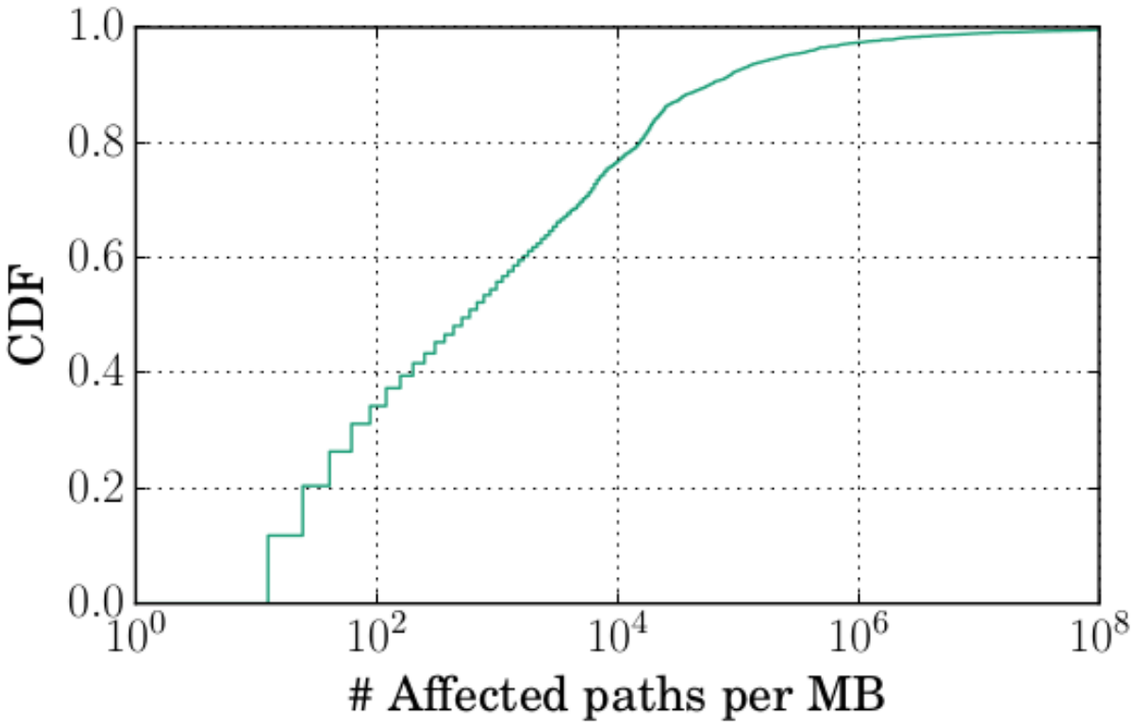
Prevalence: deployment



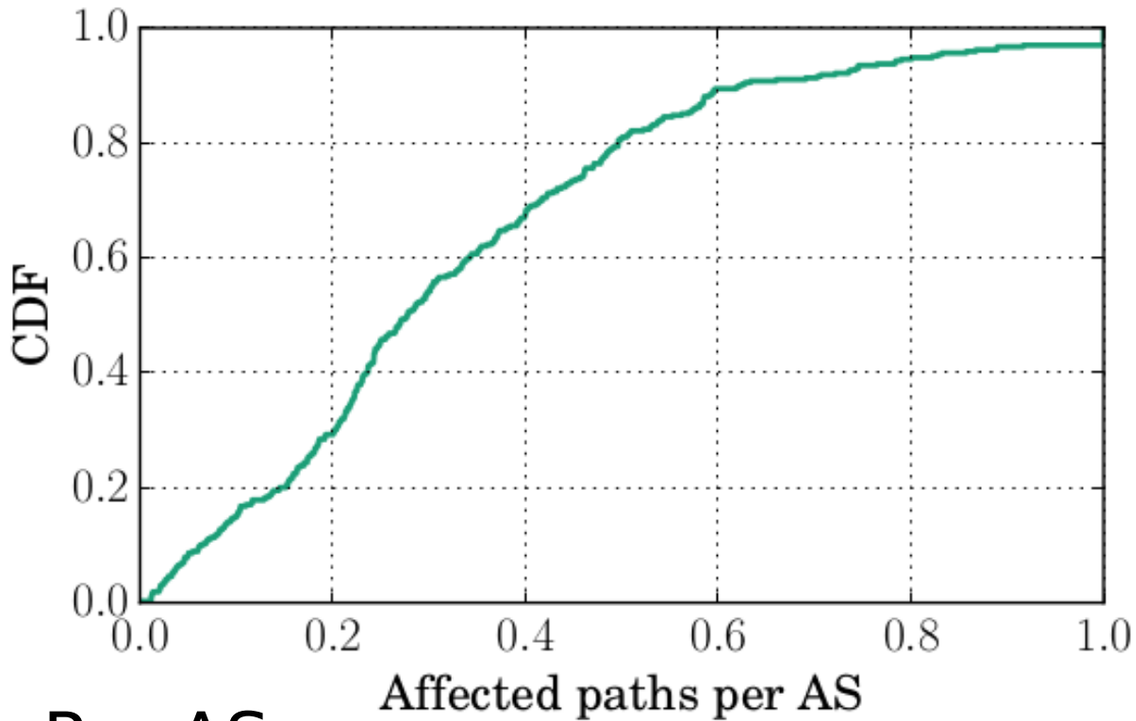
Deployed MB / IP interfaces, per AS. Alias resolution using CAIDA ITDK dataset.

- In general, less than 5%
- Cogent: 1 - 1.5%

Prevalence: popularity

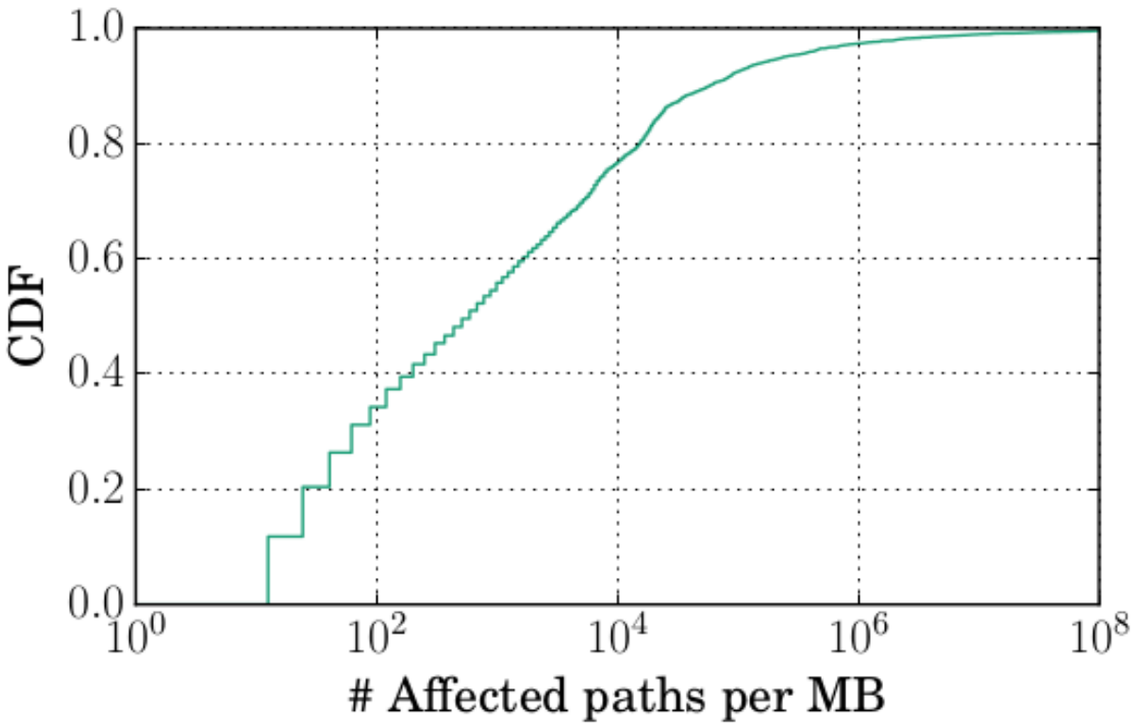


Per MB



Per AS

Prevalence: popularity



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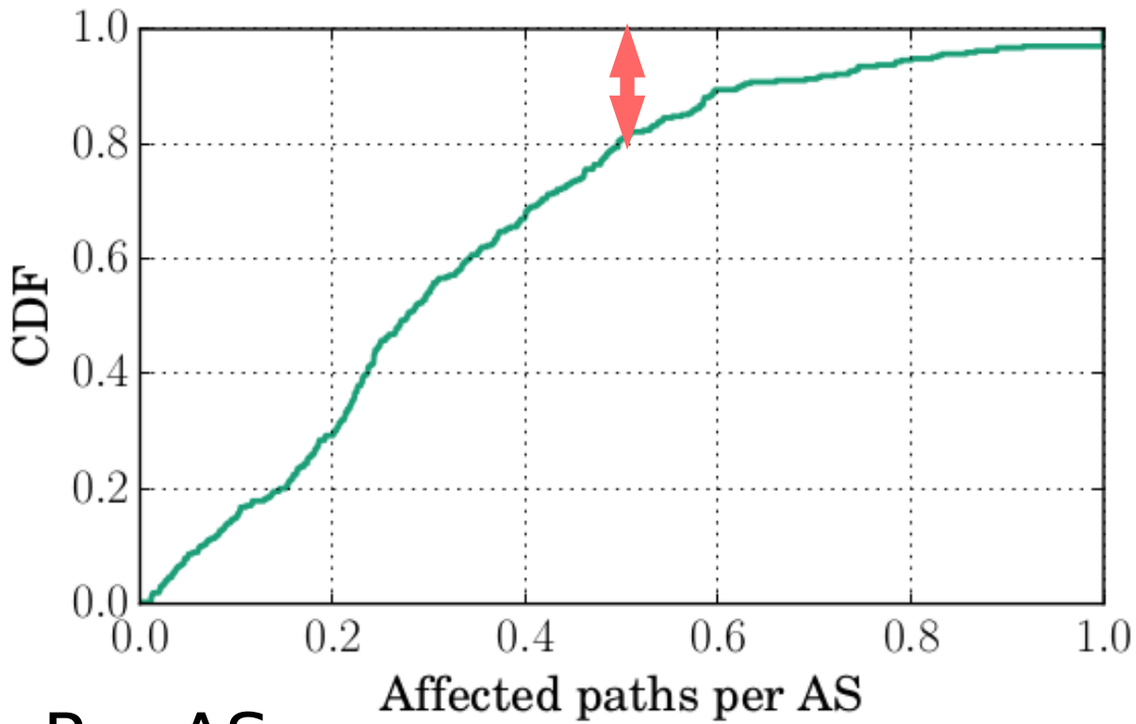
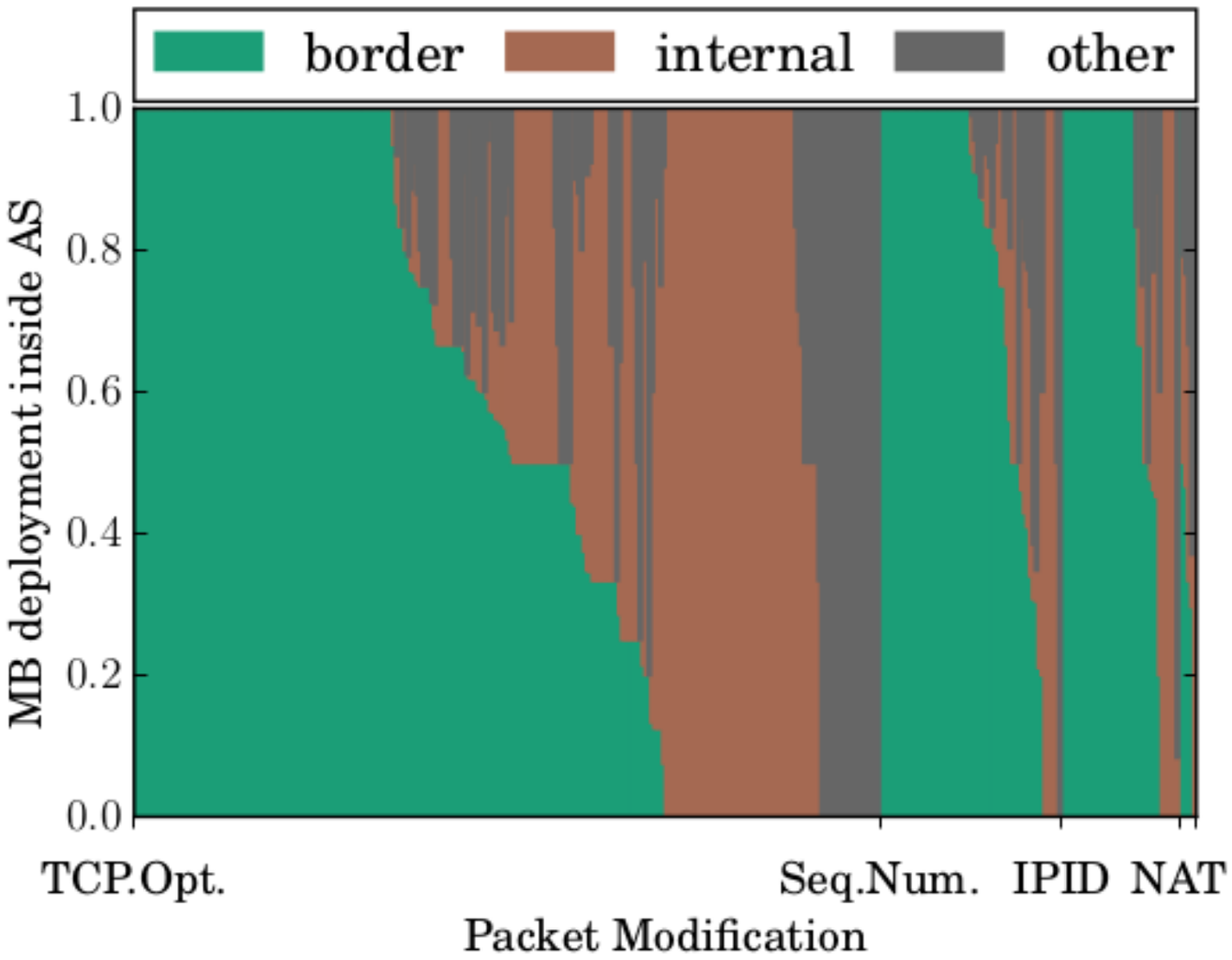


Per AS

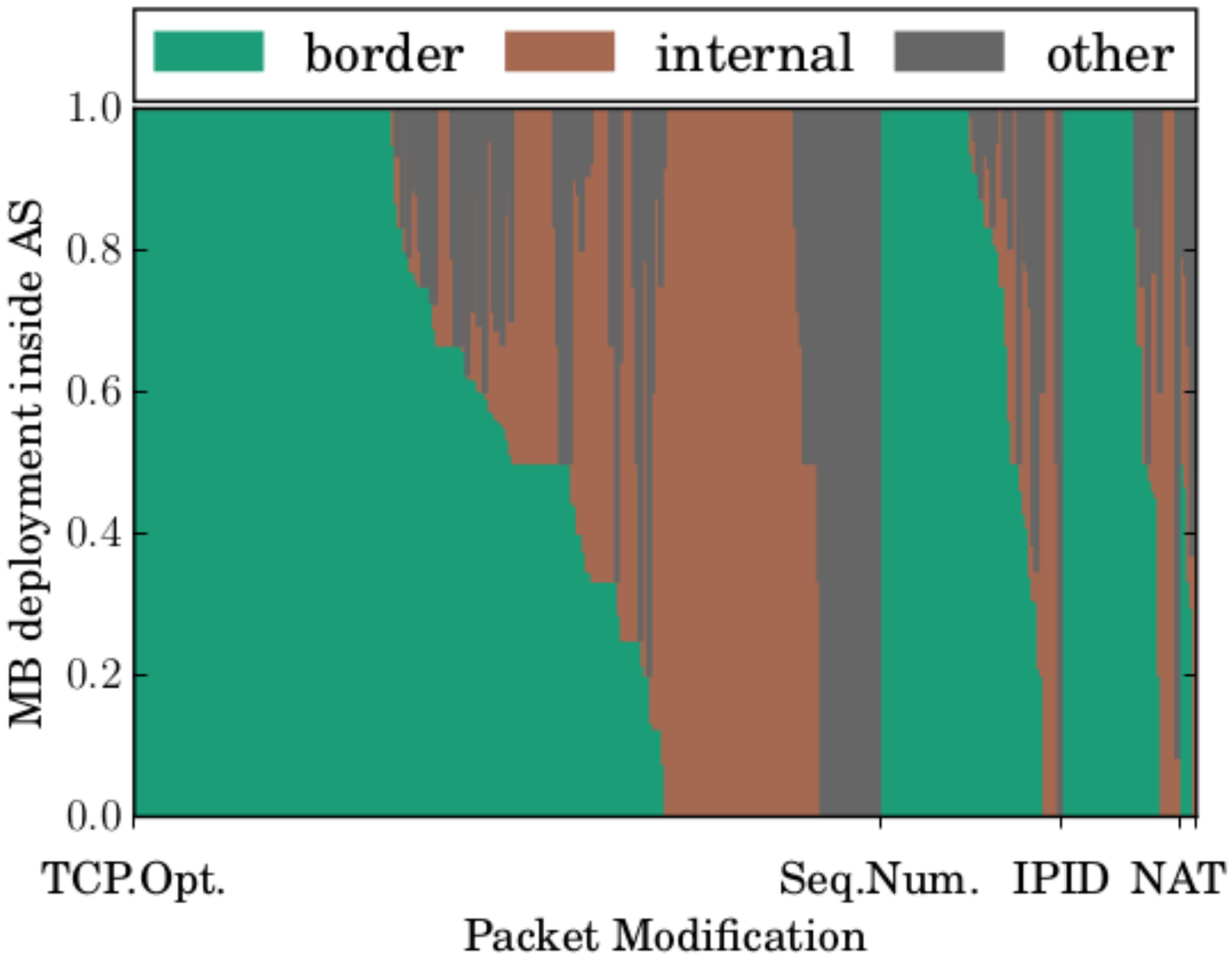
- For 20% of the ASes, more than 50% of path crossing it are affected by 1+ MB(s)
- Cogent: 44M paths, 2.1M affected: 5%

Prevalence: position



MB Positions, per categories of modif., per AS

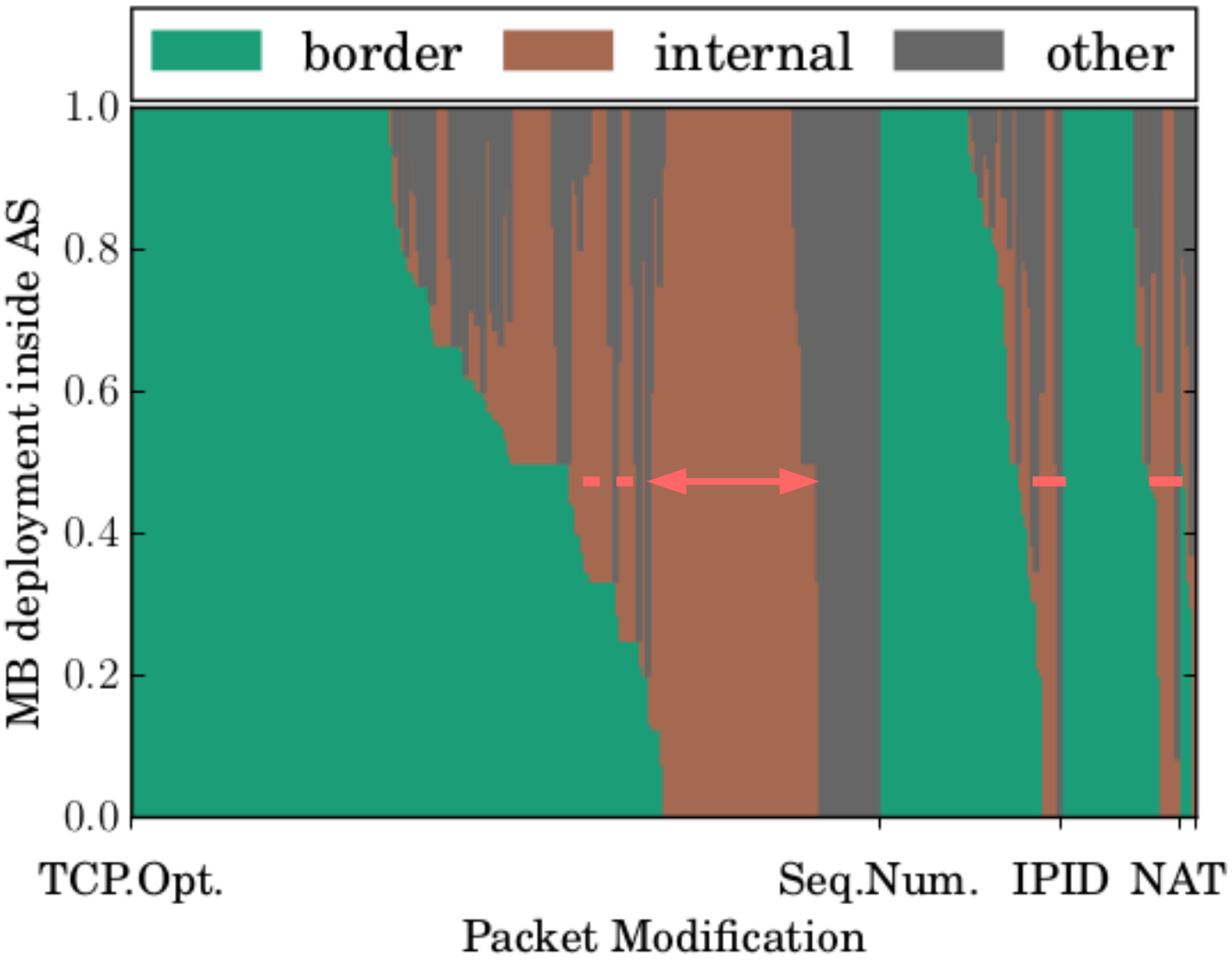
Prevalence: position



MB Positions, per categories of modif., per AS

- border: 4,210 (52.6%)
- internal: 2,931 (36.6%)
- Other: conflict or unable to derive position (9.1%), or moved ? (1.7%)

Prevalence: position



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- border: 4,210 (52.6%)
- internal: 2,931 (36.6%)
- Other: conflict or unable to derive position (9.1%), or moved ? (1.7%)

- At the exception of 65 ASes (19%) that deploys the majority of their MBs in their core, *most ASes tend to deploy most of their MBs at their border*.

Results: persistence

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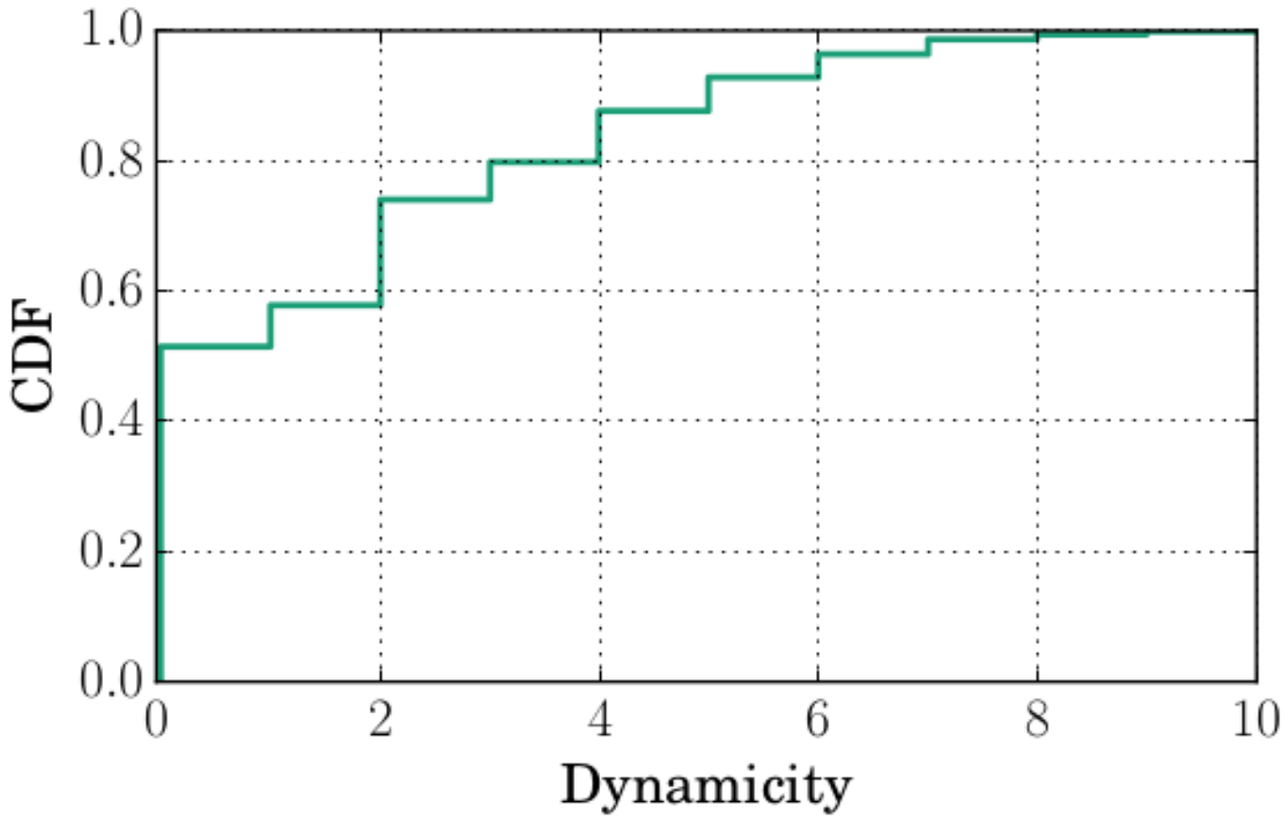
- Keep sub-paths visible with HTTP and non-HTTP probes
- 5,888 offenders

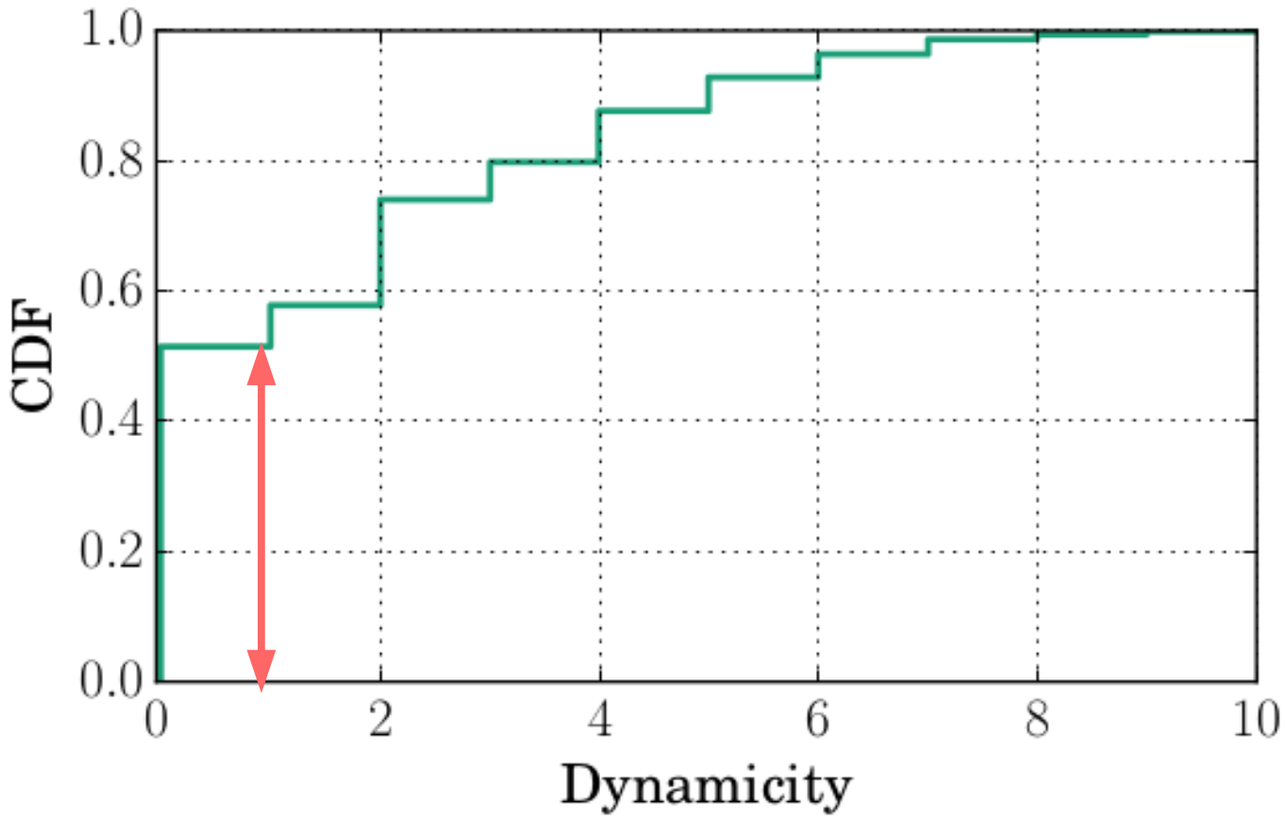
- Active: if it was used for labeling
- Inactive: if it was responsive, but not used for labeling
- Offline/invisible: it was not observed

Results: persistence



State changes per MB, Invisible == Active. 14 campaigns over 70 days.

results: persistence



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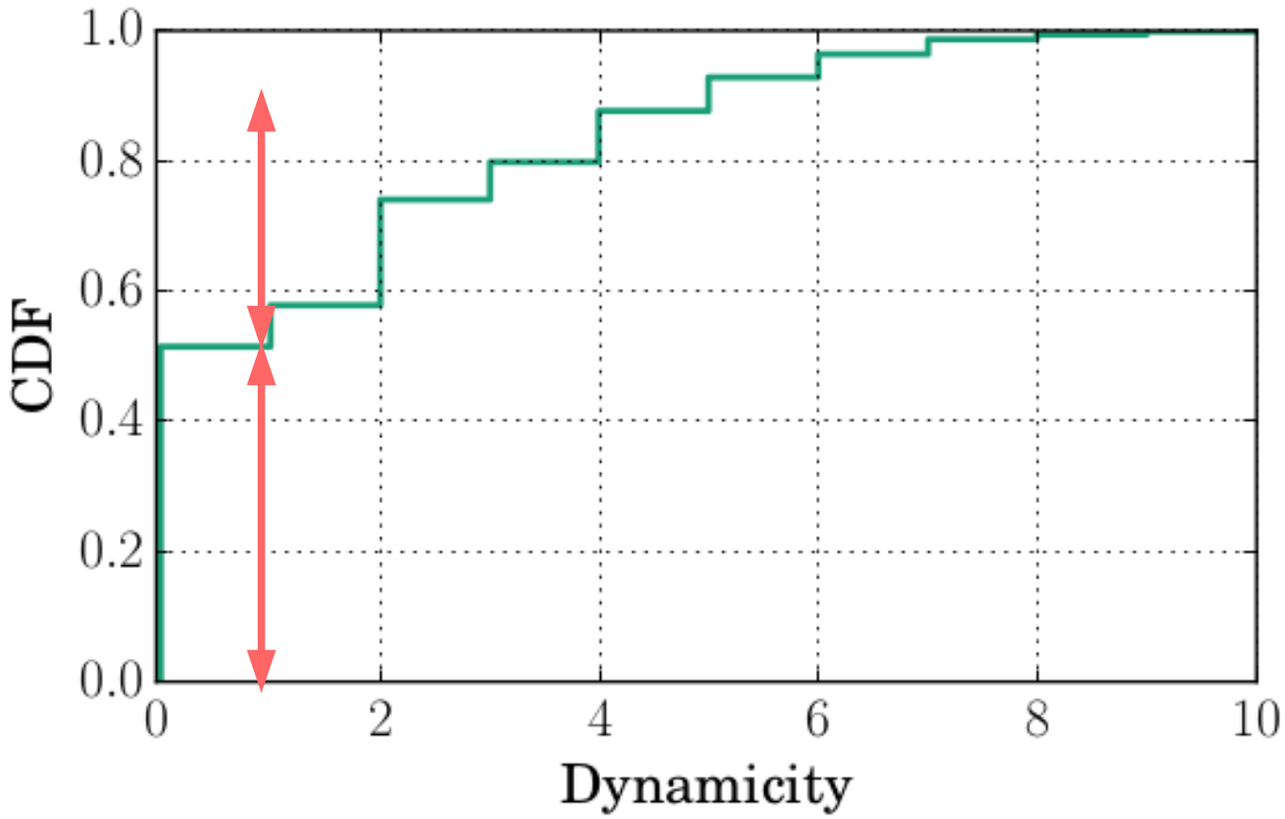
- 51% are stable

results: persistence



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- 38% are slightly intermittent/dynamic ([1;4])

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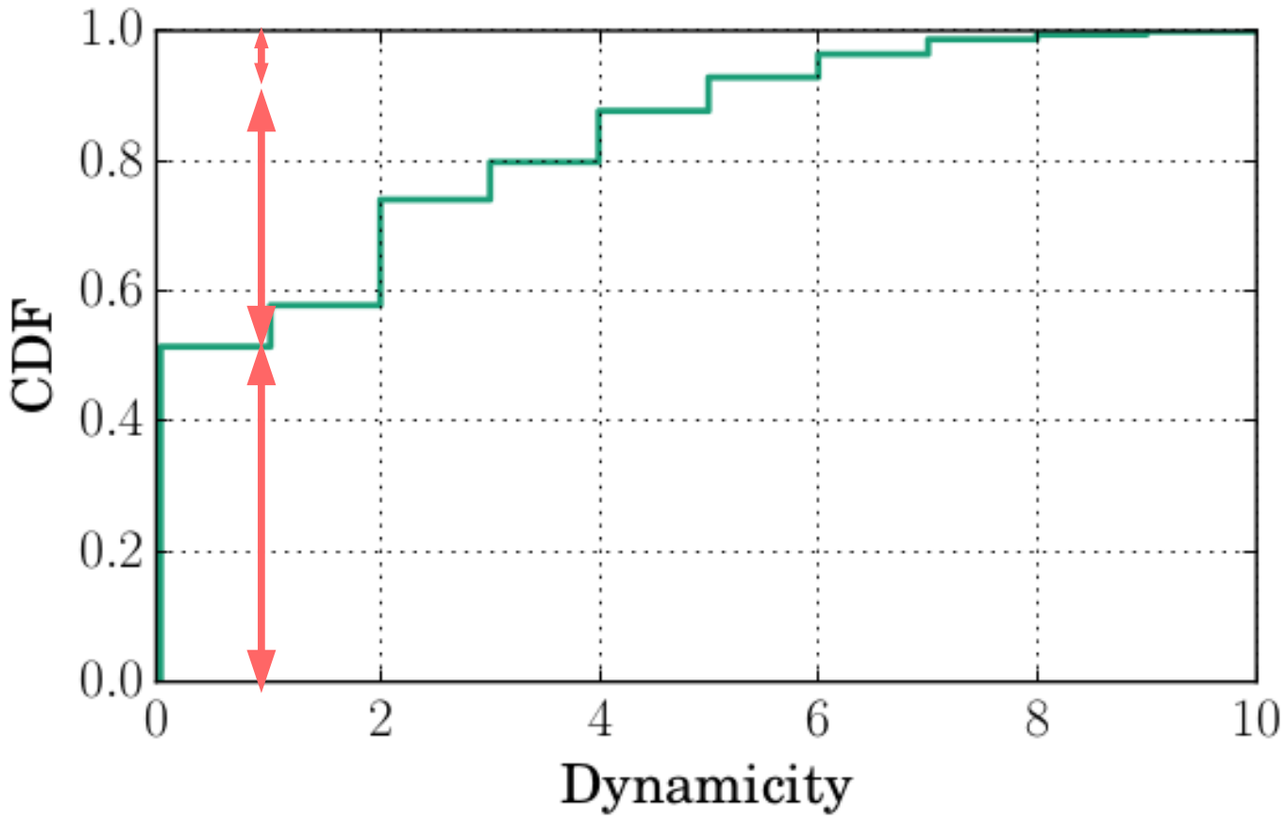

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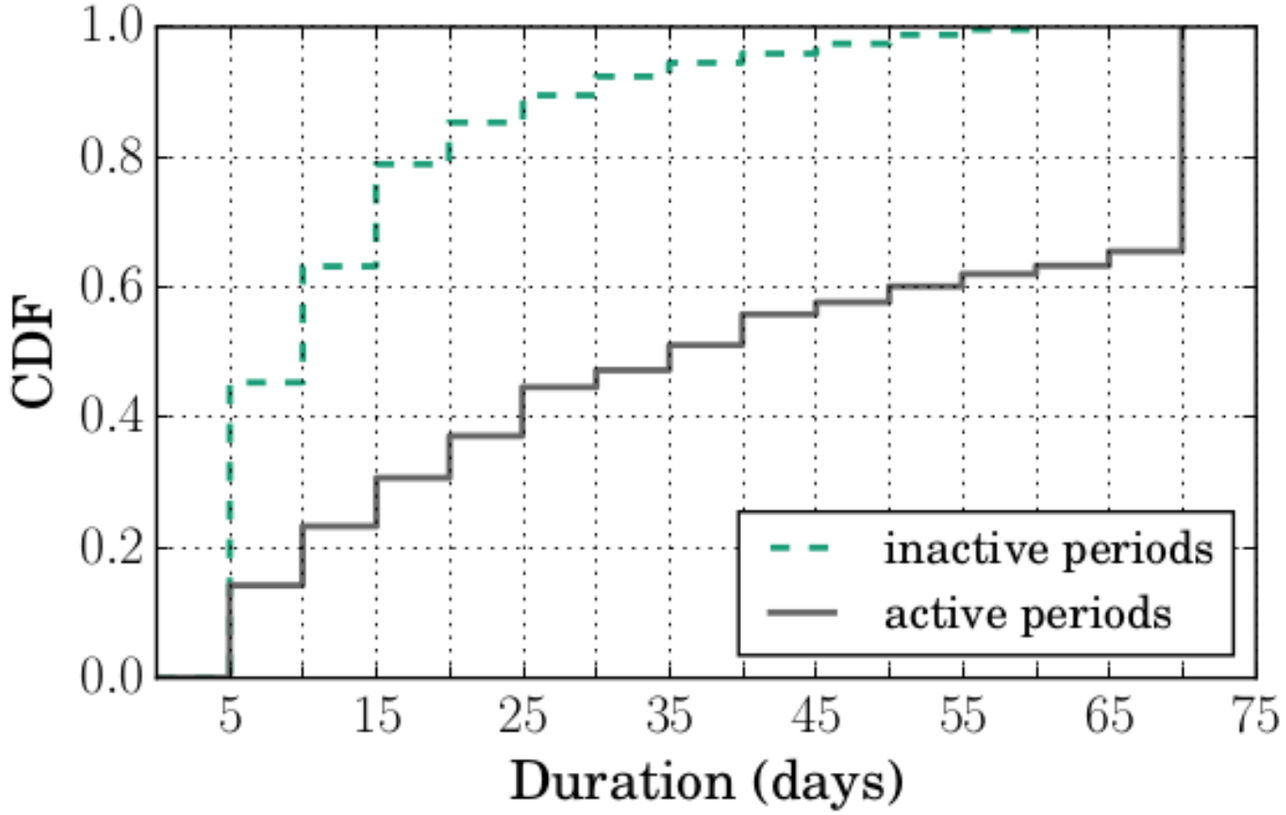
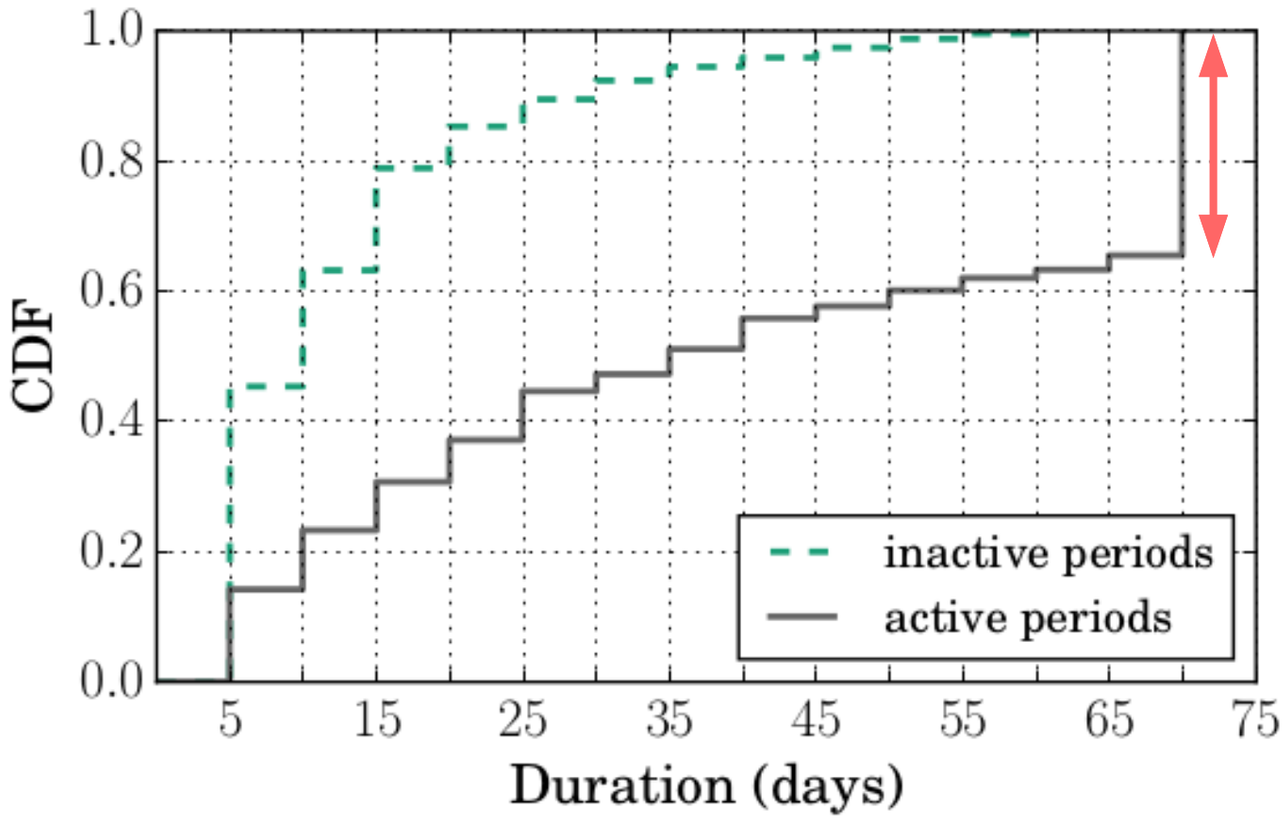
- 38% are slightly intermittent/dynamic ([1;4])
- 11% are highly intermittent ([4;10])

results: persistence



state durations (max 70 days)

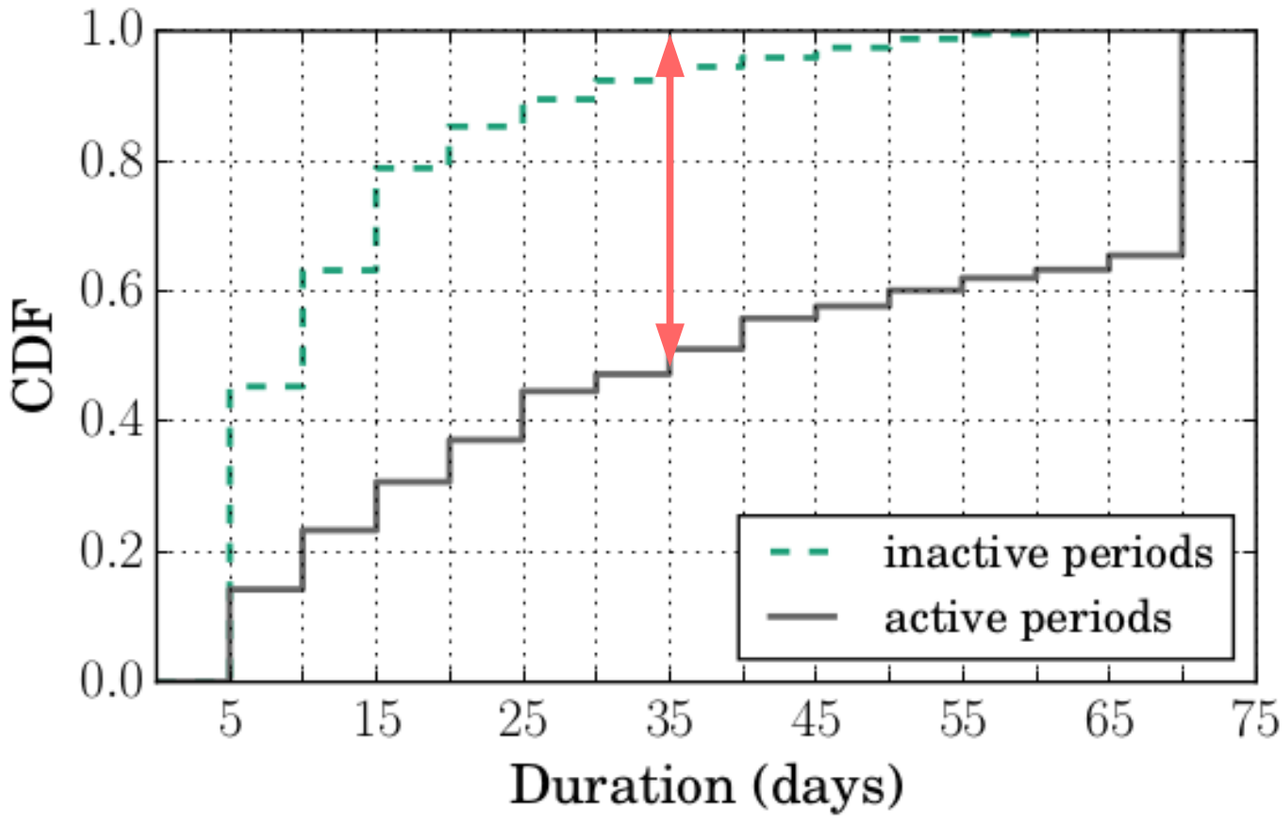
results: persistence



state durations (max 70 days)

- 38% of periods are 70 days (the 51% stable MBs)

results: persistence



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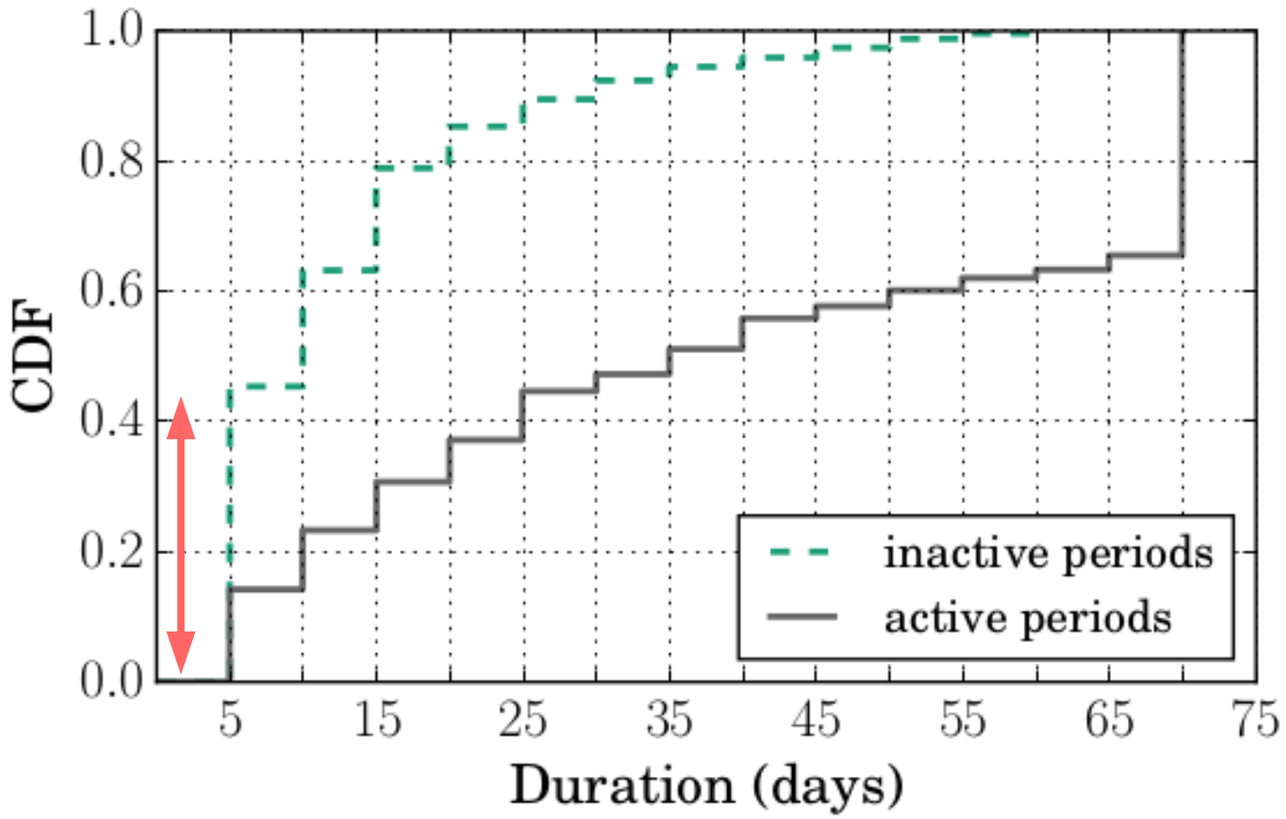
- 50% of active periods lasts more than 35 day

results: persistence



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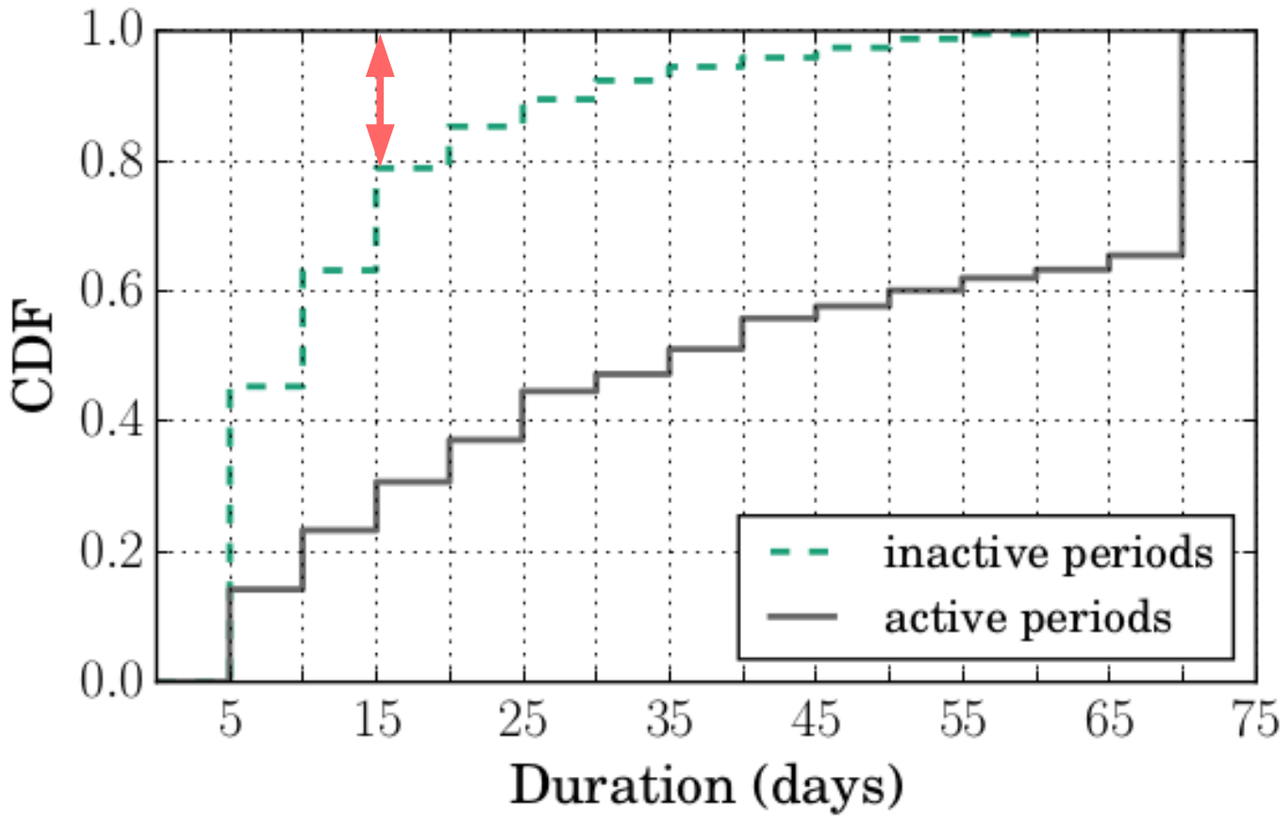

state durations (max 70 days)

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- 20% are longer than 15 days

summary

- Compared to Layer-3 devices, MB deployment is marginal
- MBs don’t affect a large portion of paths crossing its AS
- most ASes tend to deploy most of their MBs at their border
- MBs are relatively stable

Future works

- Investigate dynamicity
- NATs (MNM paper)
- 2-way tracebox-TCPExposure

- IPv6
- Mobile networks

Future works: NAT trick (MNM)

- **RFC 792** : “The internet header plus the first 64 bits”
- **RFC 1812** : “as much [...] as possible” (< 576 B)

- **RFC 5508** : “Revert the IP and transport headers […] to their original form”
- **RFC 5508**: “SHOULD NOT validate the transport checksum”

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- Correlation in transport checksums offsets == NATS ?

Comments ?