Diagnosing the Location of Bogon Filters

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Outline

- Advertising a new prefix
- Methodology
- In-probes
- Out-probes
- Relationship in- and out-probes
- Further work

Problem: “Bogon filters”

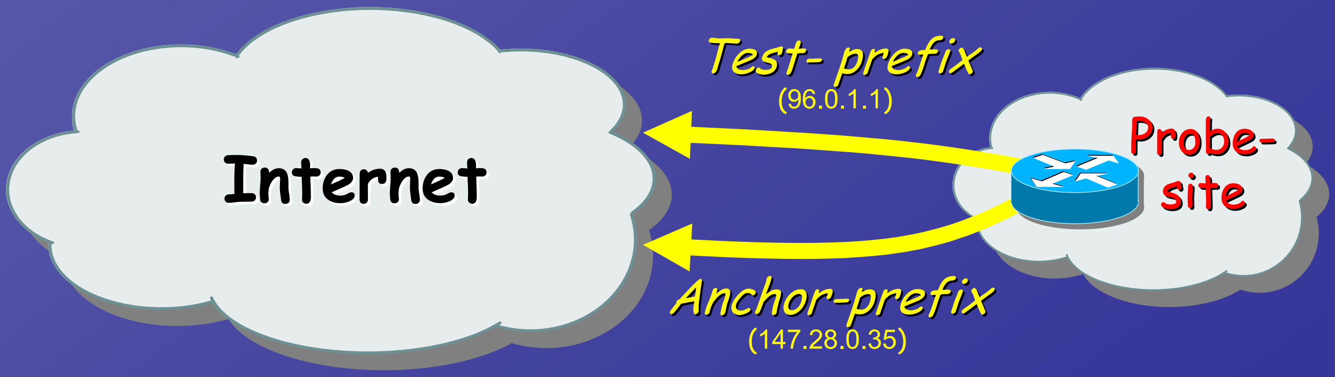
- ISPs often filter unallocated address space to protect themselves from malicious attacks and unwanted traffic
- Over time unallocated address space may become allocated and legitimately announced address space...
- Problem: Filters need to be updated but seem often not to be

Objectives

- Develop methodology that is capable of detecting filters that are blocking newly allocated address space
- Analyze reachability status of a newly allocated prefixes
- For the experiment, ARIN loaned us
  96.0.0.0/16 97.64.0.0/16
  98.128.0.0/16 99.192.0.0/16

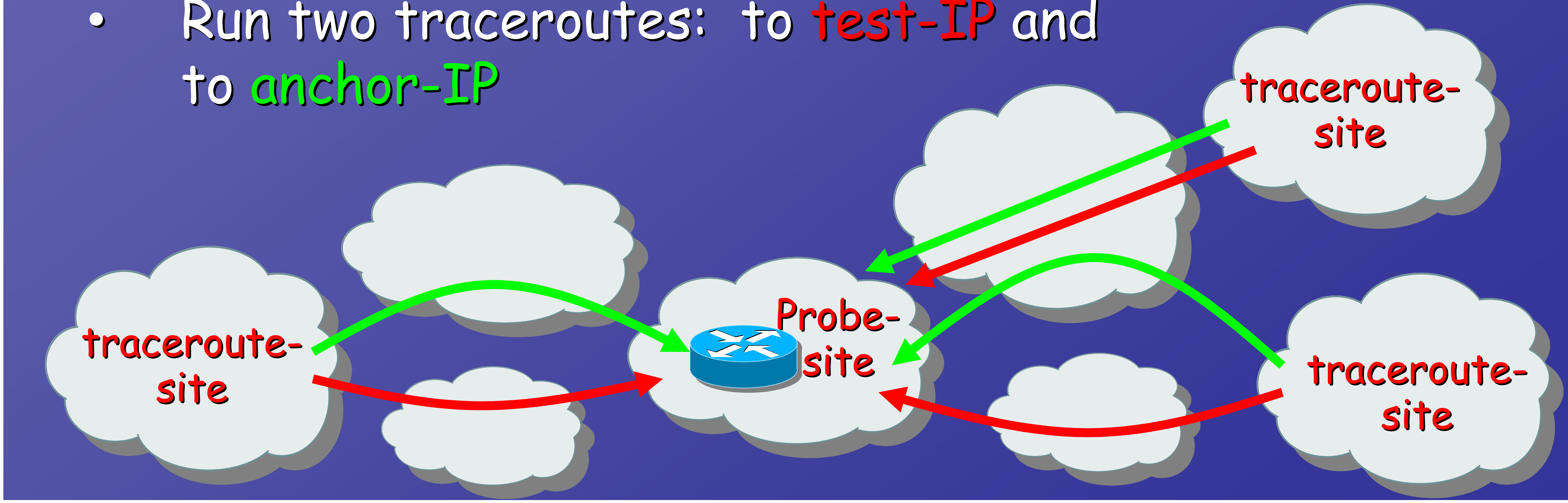
Testing reachability of a new prefix

- Terminology:
  - *Test-prefix*: newly allocated prefix to be tested
  - *Anchor-prefix*: well-established prefix whose reachability should be fine
  - *Probe-site*: router that announces *both* the test-prefix and the anchor-prefix



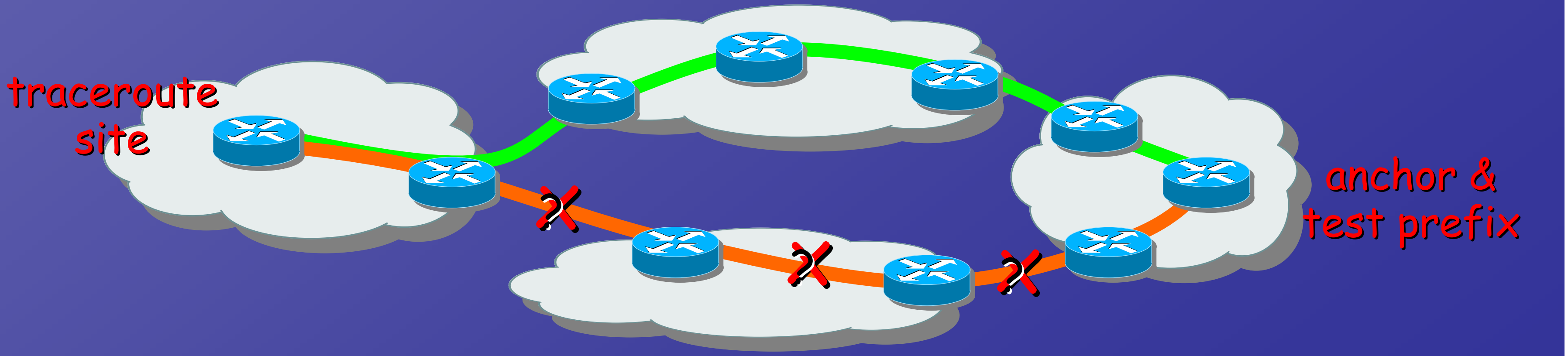
Testing reachability of a new prefix: In-Probes

- Two IPs hosted at the same location:
  - anchor IP : well established, hopefully unfiltered
  - test IP : newly allocated address
- Assume that they are propagated in the same way (as they are announced from the same location)
- Run two traceroutes: to test-IP and to anchor-IP



In-Probes: Principles

- *In-probe* : traceroute performed from external IP addresses towards the test and anchor prefixes
- In-probes give reachability information towards the test and anchor prefixes
- If traceroute from test-prefix address diverges at some point, we conjecture that some *bogon filter* is responsible



In-Probes: measurements

- Advertise test and anchor prefixes from 4 probe-sites: Seattle (USA), Munich (DE), Wellington (NZ), Tokyo (JPN)
- 2,052 traceroutes in total (test+anchor counting as one):
  - from up to 744 different locations
  - from NANOG-posting: 881 (towards two locations)
  - from Traceroute-sites: 981 (towards four locations)
  - from PlanetLab: 190 (towards four locations)

In-Probes: results

Categories:

- "good" (anchor and test take exactly same path)
  - 66.9% (1,373)
- "diverging inside" (anchor and test take different paths)
  - 20.6% (423)
- Test stops, but anchor ok
  - 8.6% (177)
- Failure (either anchor or anchor and test failed)
  - 3.9% (79)

In-Probes: results

- Derive candidate links, eliminate unlikely candidates.
- Remaining candidate links:
  - ~ 32 ASs that may contain wrongly configured filters.

- http://psg.com/filter-candidates.txt

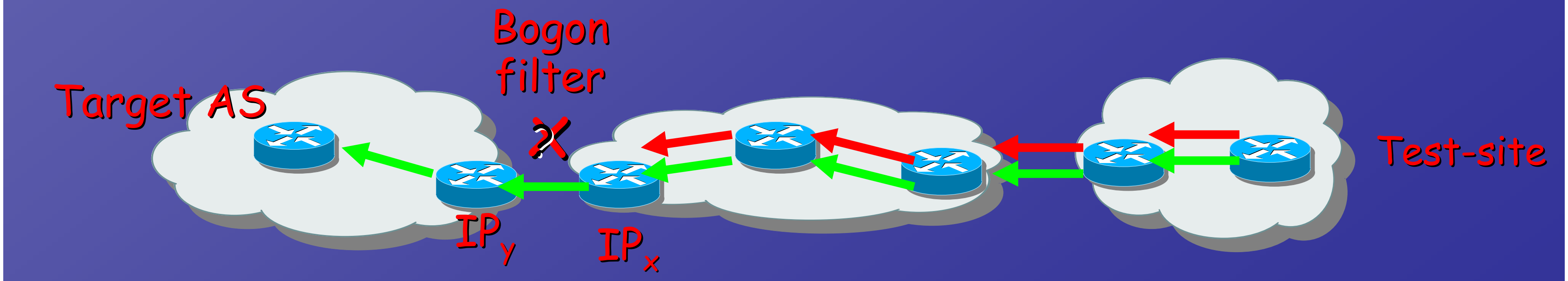
In-Probes: evaluation

- Advantages:
  - traceroutes go around bogon filters
  - known details about IP-level path
- Disadvantages:
  - traceroute site MUST be "behind" bogon filter
  - Not many traceroute sites available

- Goal: test as many ASs as possible for reachability
- Solution: "*out-probes*"

Testing for usable reachability: Out-Probes

- *Out-probe* : ping and traceroute performed from test-IP and anchor-IP towards external IP addresses
- *Target-AS* : AS towards which we perform out-probes
- If out-probe towards target AS from test-IP stops while the out-probe from anchor-IP goes on, we conjecture a *bogon filter of the form* <IP X, IP Y>:



Out-Probes: measurements

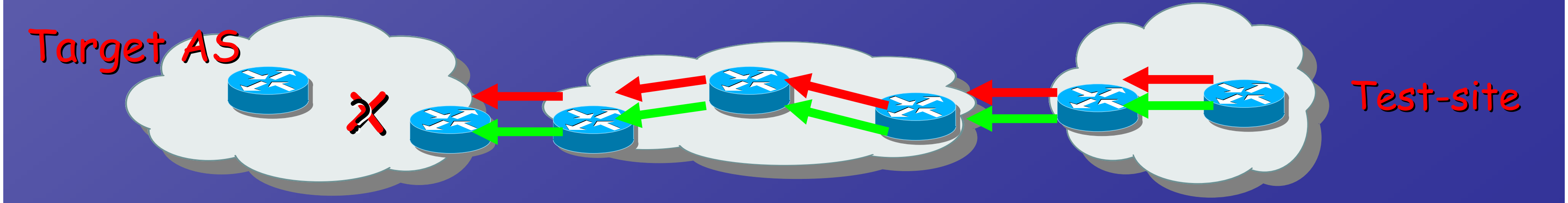
- Perform ping from *test-sites* (*test-IP* and *anchor-IP*) towards a large set of *target-IP* addresses (58,766) in 20,142 different ASs
- If ping comes back => usable reachability from *target-IP*
- If ping does not come back => run traceroutes to find out location of *bogon-filter(s)*
- Traceroute return path is interesting, but unknown: only usable reachability of the IPs on the path towards *target-IP* is obtained

Out-Probes: measurements

- Finding pingable IPs with acceptable AS coverage:
  - Probing IPs inside many prefixes to get 58,766 *target-IP* addresses that answer to ping probes
  - Among those *target-IPs*, not all may answer during the actual out-probe measurements
    (e.g., host might have been dial-up and down at the time of measurement)
- Data:
  - 197,825 traceroutes in total (test+anchor counting as one) from the 4 sites

Out-Probes: IP-level results

- Results of out-probes:
  - 65% successful pings
  - 13% test-only fails
  - 15% both pings fail
  - 6% of ping artefacts
- If ping does not reach *target-IP* but traceroute gets inside *target -AS* => ICMP artefact



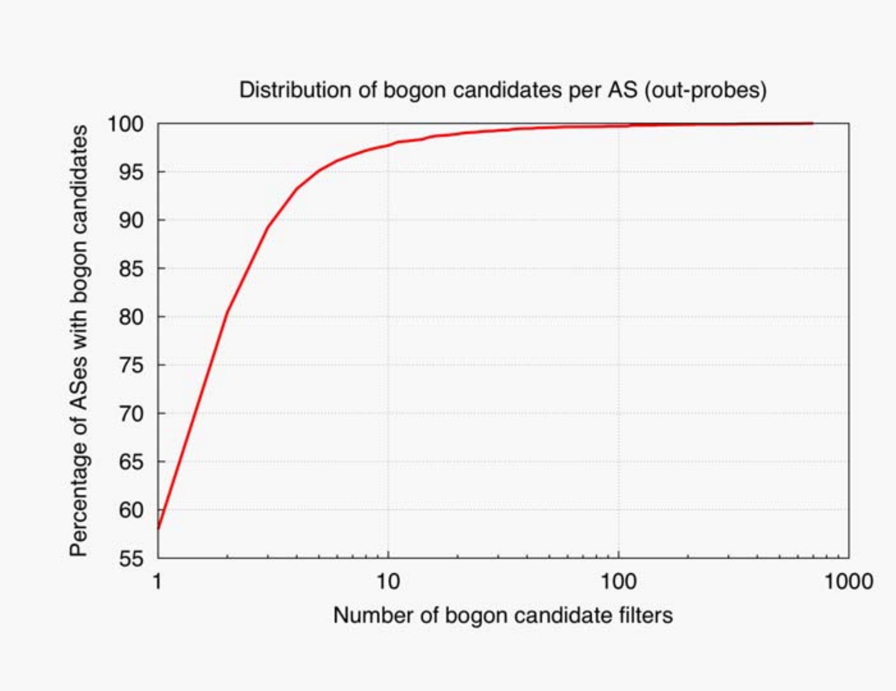
Out-Probes: AS-level results

- *Successful out-probe* : ping success for test towards all IPs within a target AS
  Unsuccessful out-probe : ping failure for test towards all IPs within a target AS
  Undefined out-probe : inconsistent results for test towards the IPs within a target AS
- Results:
  - 7,677 ASs with *successful out-probes* only
  - 2,298 ASs with *unsuccessful out-probes* only
  - 10,167 ASs with undefined out-probes
  - 50% of the 20,142 target ASs see a mix of successful and unsuccessful out-probes!

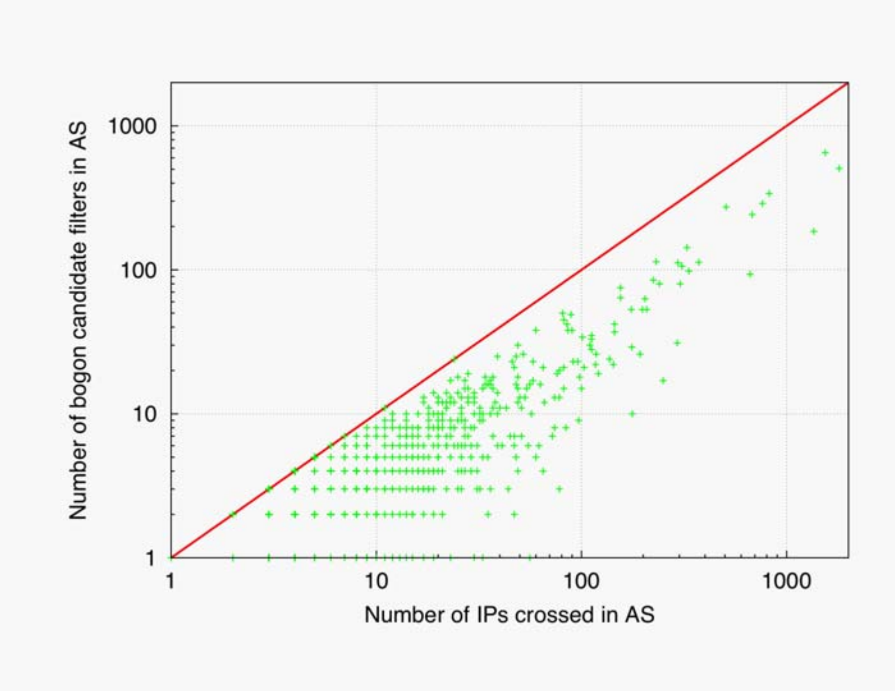
Out-Probes: *bogon filters*

- Identification of bogon filters gives 16,471 candidate links in 5,538 ASs
- Among the candidate links many are of the form <IP,?>, probably an artefact of ICMP filtering

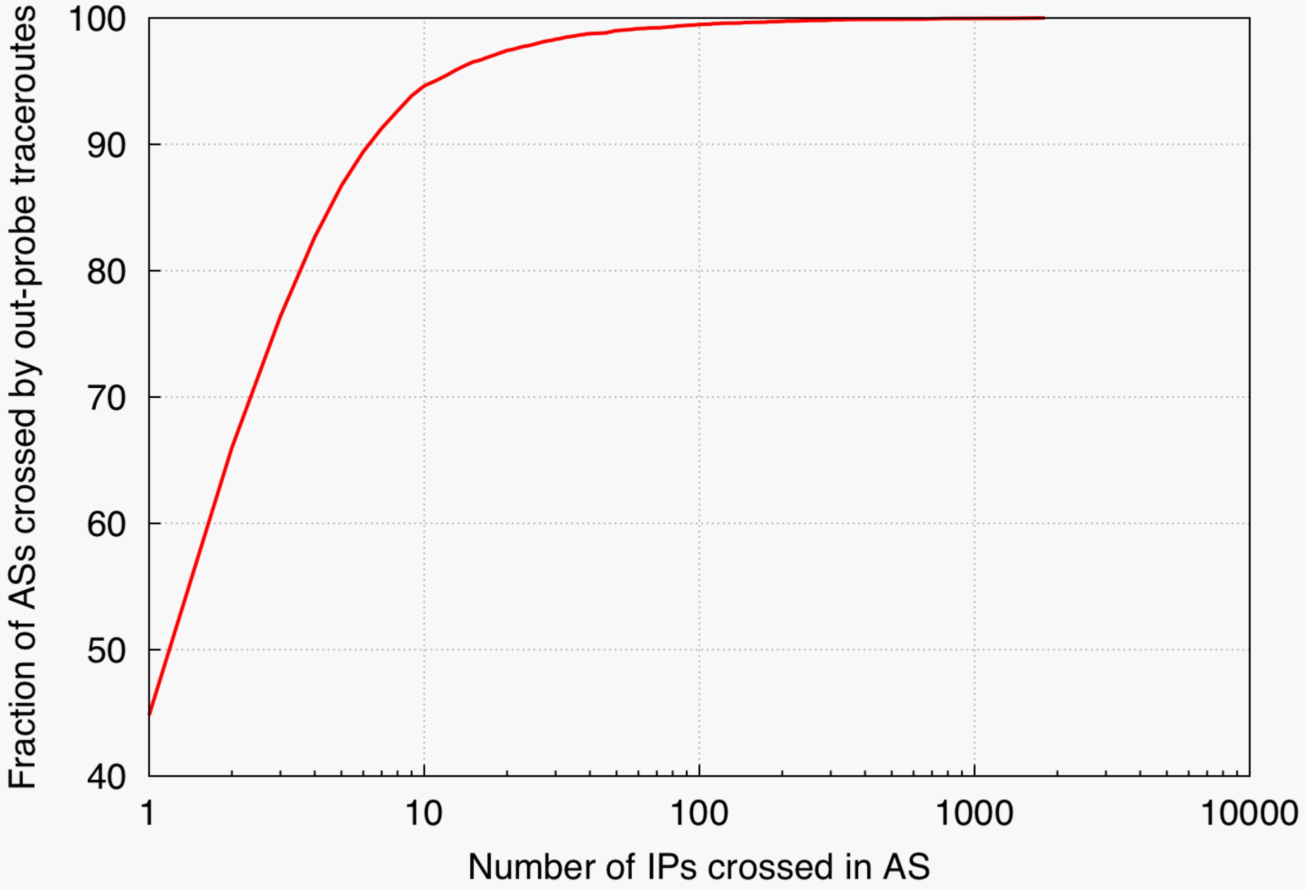
Some ASs have more candidate links than others:



Candidate links seem proportional to sampled IPs in each AS:

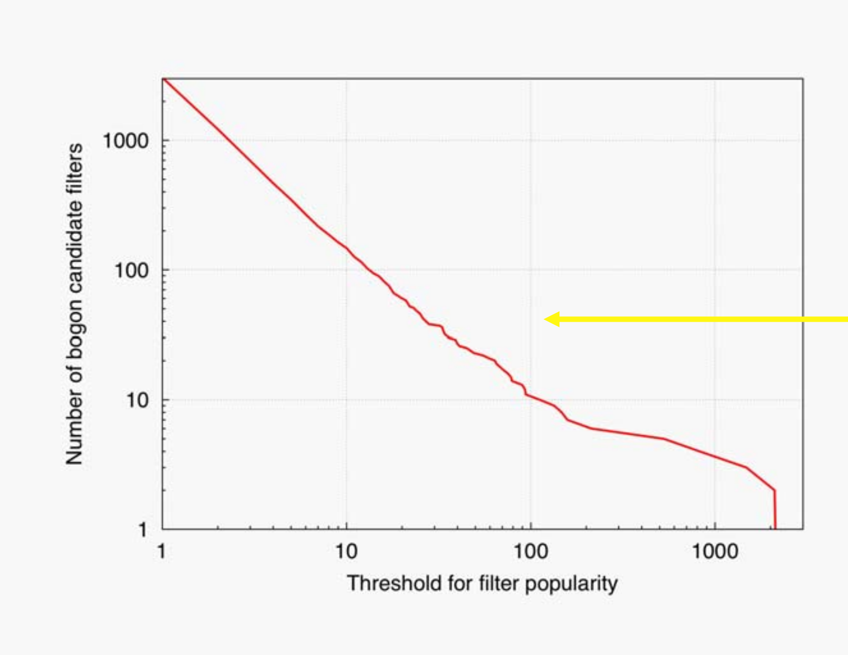


CDF of Number of Links Crossed



Out-Probes: popular *bogon filters*

- Building a list of likely bogon filters based on out-probes:
  - Remove the potential ICMP artifacts <IP,?>
  - Associate with each candidate a *popularity counter* that tells how many times a given bogon filter was identified in the traceroutes (for different sites and target IP addresses)
  - Number of candidates as a function of the threshold:



Power-law

=

no natural threshold

Relationship In- and Out-Probes

- Out-probes tell about “usable reachability”:
  - Find areas of non-reachability
  - Larger coverage (currently > 85% of Internet ASs)
  - No information about: return path and thus non-optimal paths
- In-probes tell us about filters on the path:
  - Reachability available - goal: detect intermediate filters
  - Smaller coverage
  - Many traceroute servers are needed at the “edge”

Further Work

- Sent list of candidate suspected bogon filtering links to ISPs, waiting for their feedback to validate our analysis
- Increasing number of in-probes to have more information about location of bogon filters and their number
- How accurate can we be in identifying bogon filters using measurements?
- How would we quantify that accuracy?
- How many out-probes are needed/useful

Results – Out-Probes

- We can identify unreachable places: Via out-probes we can see if an IP is not well routed.
- Aside from small issues related to ICMP, we know that if the probe doesn't come back that there is NO usable connectivity. That's simple and straight forward.
- The main contribution here is: it is possible to achieve a reasonable coverage of the Internet (~20k ASes).
- The methodology produces useable results.

Results – In-Probes

- We can go a step further and detect places where there is "non-optimal" connectivity.
- Keep in mind that with the in-probes we mainly look at traceroutes that BOTH reach the destination.
- We are talking "only" about sites that CAN reach the desired destination... so, we are looking at "interesting" routing scenarios and this is more like optimizing routing
- We are very curious to see where this will lead us.
- We would very much like more validation by the operational community

Thanks To

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- CityLink - NZ
- IIJ - JP
- SpaceNet - DE
- Universities of Adelaide, Delft, and Oregon