Investigating Location-Aware Advertisements in Anycast IP Networks

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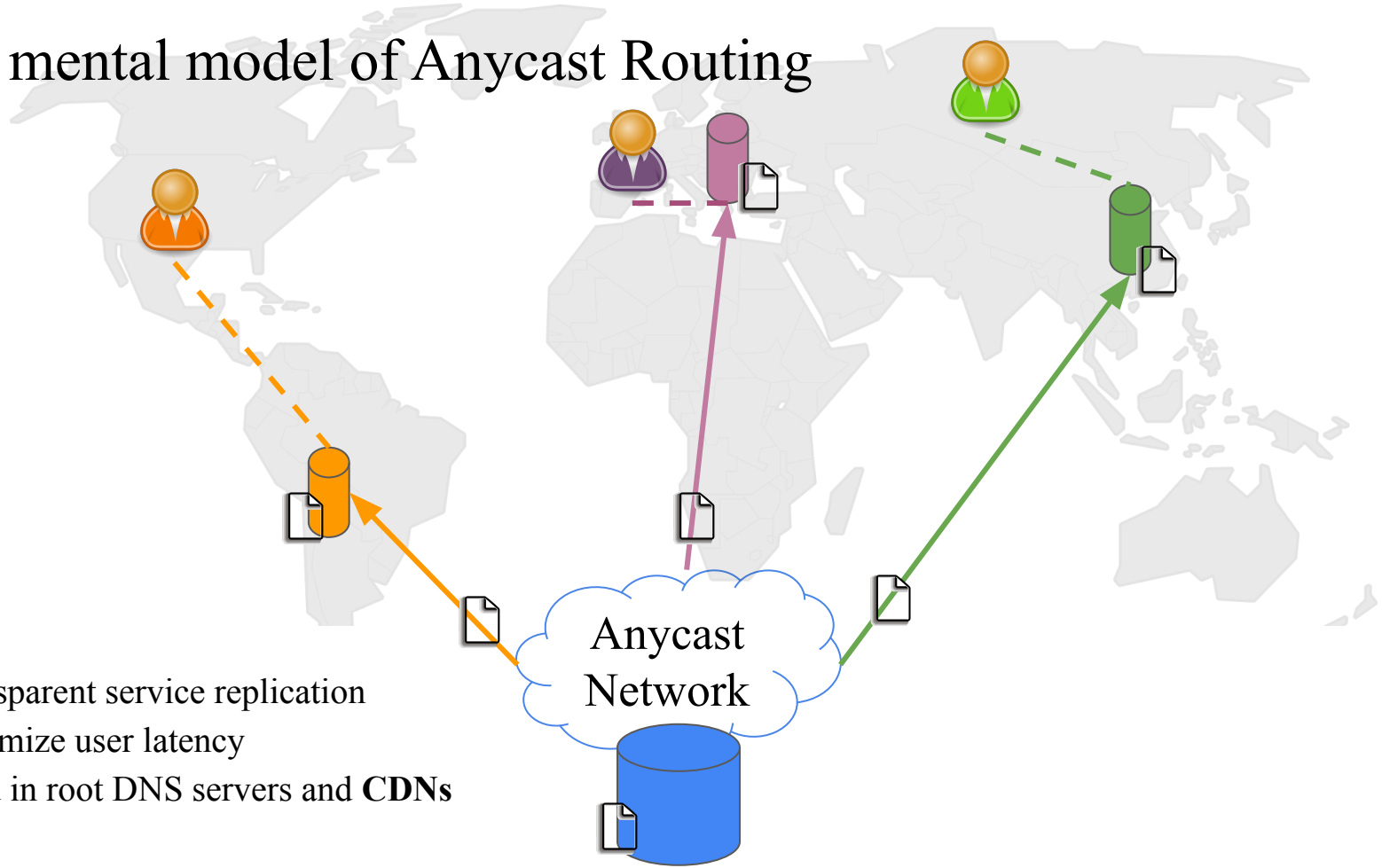
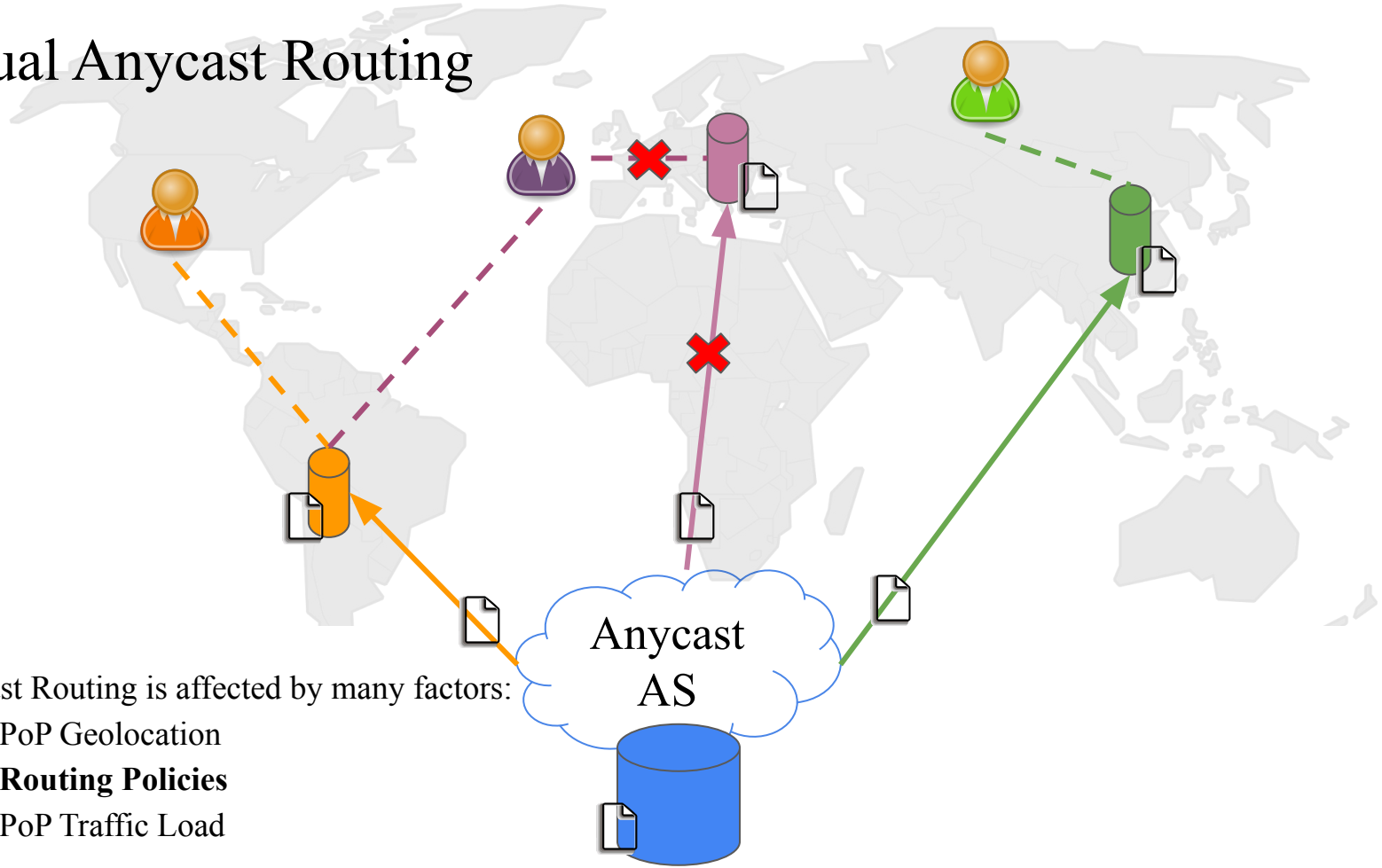
Our mental model of Anycast Routing



- Transparent service replication
- Minimize user latency
- Used in root DNS servers and **CDNs**

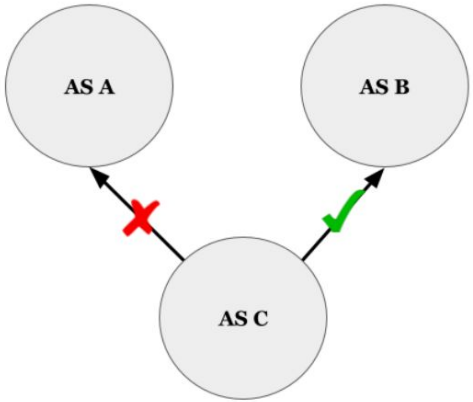
Actual Anycast Routing



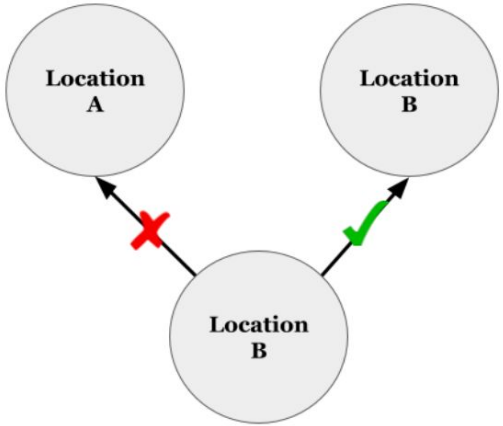
- Anycast Routing is affected by many factors:
  - PoP Geolocation
  - **Routing Policies**
  - PoP Traffic Load

Selective Announcements

IMC'23



(a) Selective announcement per AS.



(b) Selective announcement per location.

ANRW'24

An Anycast AS can selectively announce its prefixes to specific ASes or locations in order to load balance traffic and costs.

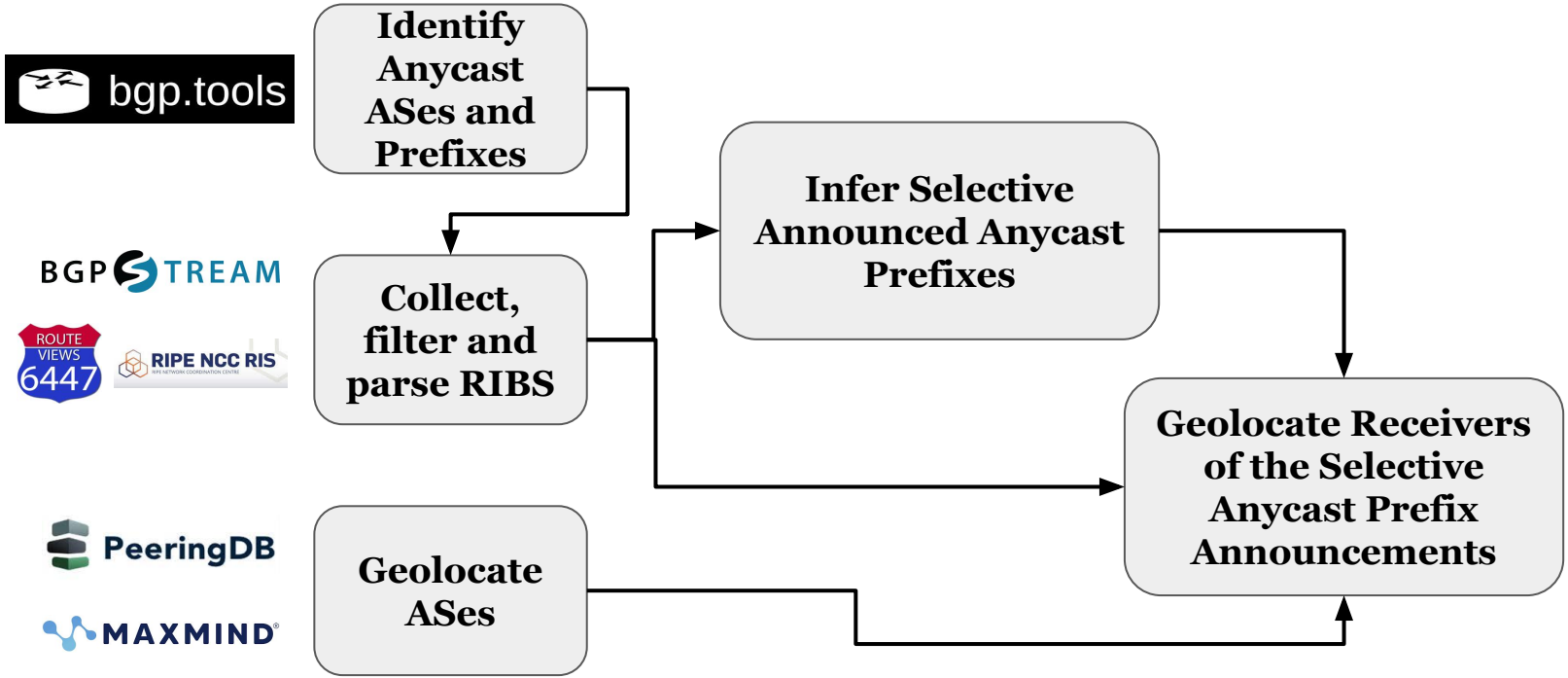
Contributions

In this work:

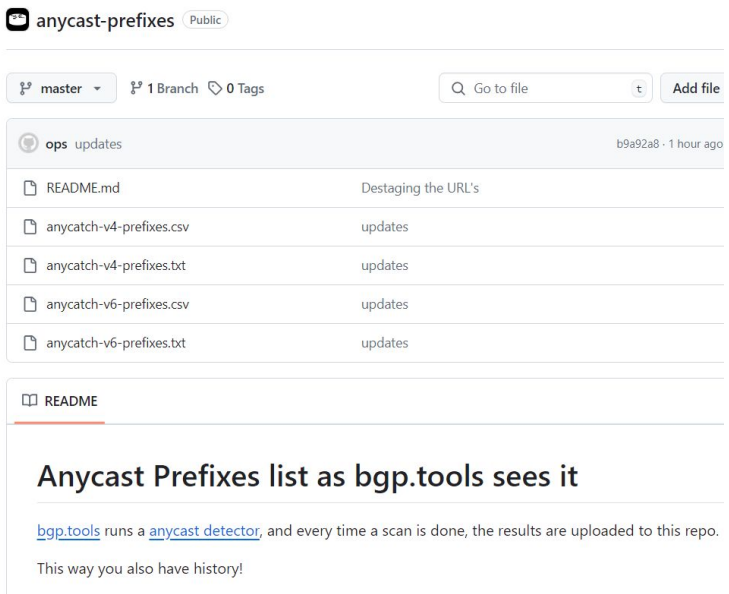
1. We measure the adoption of ***Selective Announcements*** across Anycast ASes
2. We identify the ***Receivers of Selective Anycast Prefix Announcements***
3. We measure the ***Regionality of Receivers***, i.e., the degree at which an AS decides to propagate an anycast prefix across regional over global neighbors

The results of our work underscore the necessity to ***take geolocation into consideration*** when modelling the Interdomain Routing System.

Methodology Overview: How to geolocate the Receivers of Selective Anycast Prefix Announcements?



Step 1: Identify Anycast IP Networks and IP Prefixes



We extract all anycast ASes and their respective anycast prefixes through the **bgp.tools API** and the **bgp.tools Github** repository

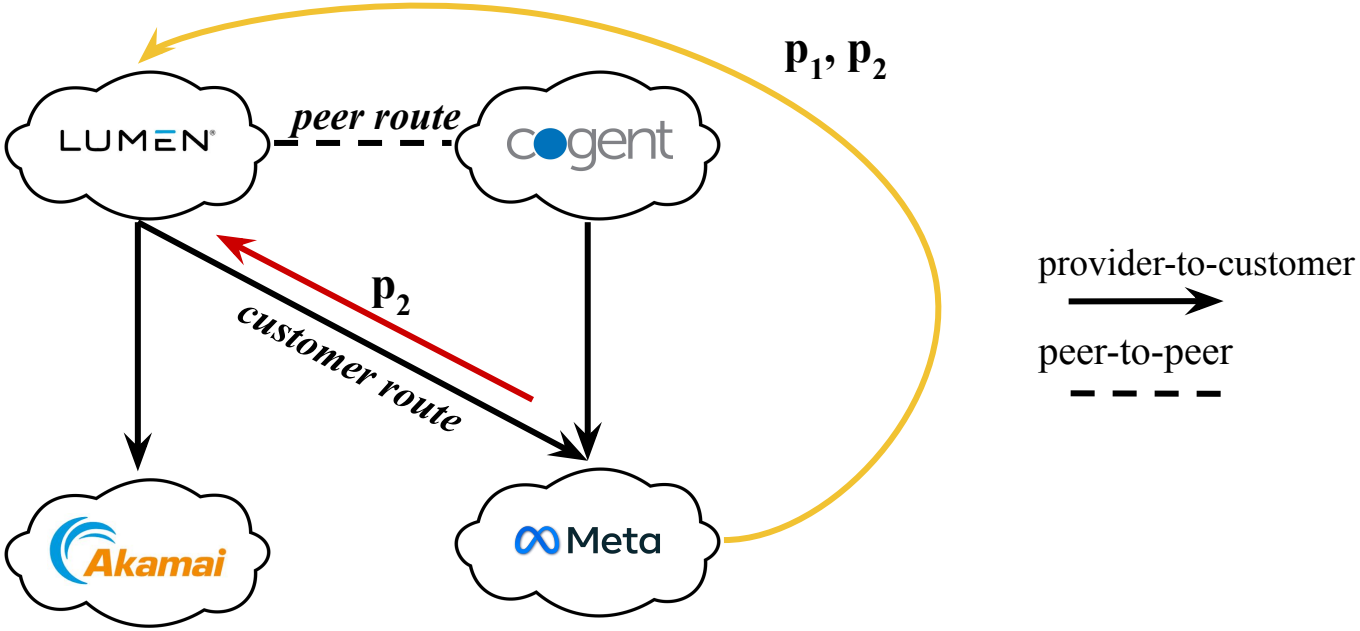
Step 2: Collect, Filter and Parse Routing Tables

Route Collectors | BGPStream API | Routing Table

```
<dump-type>|<elem-type>|<record-ts>|<project>|<collector>|
<router-name>|<router-ip>|<peer-ASn>|<peer-IP>|<prefix>|<next-hop-IP>|
<AS-path>|<origin-AS>|<communities>|<old-state>|<new-state>
```

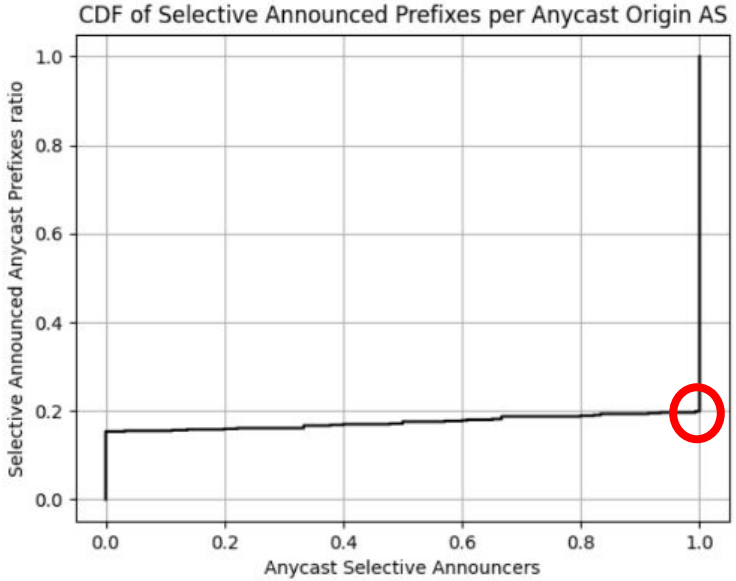
For each anycast ***prefix*** observed through BGPStream we collect all the ***AS-paths*** installed in the routing tables of the vantage points

Step 3: Infer Selectively Announced Anycast IP Prefixes



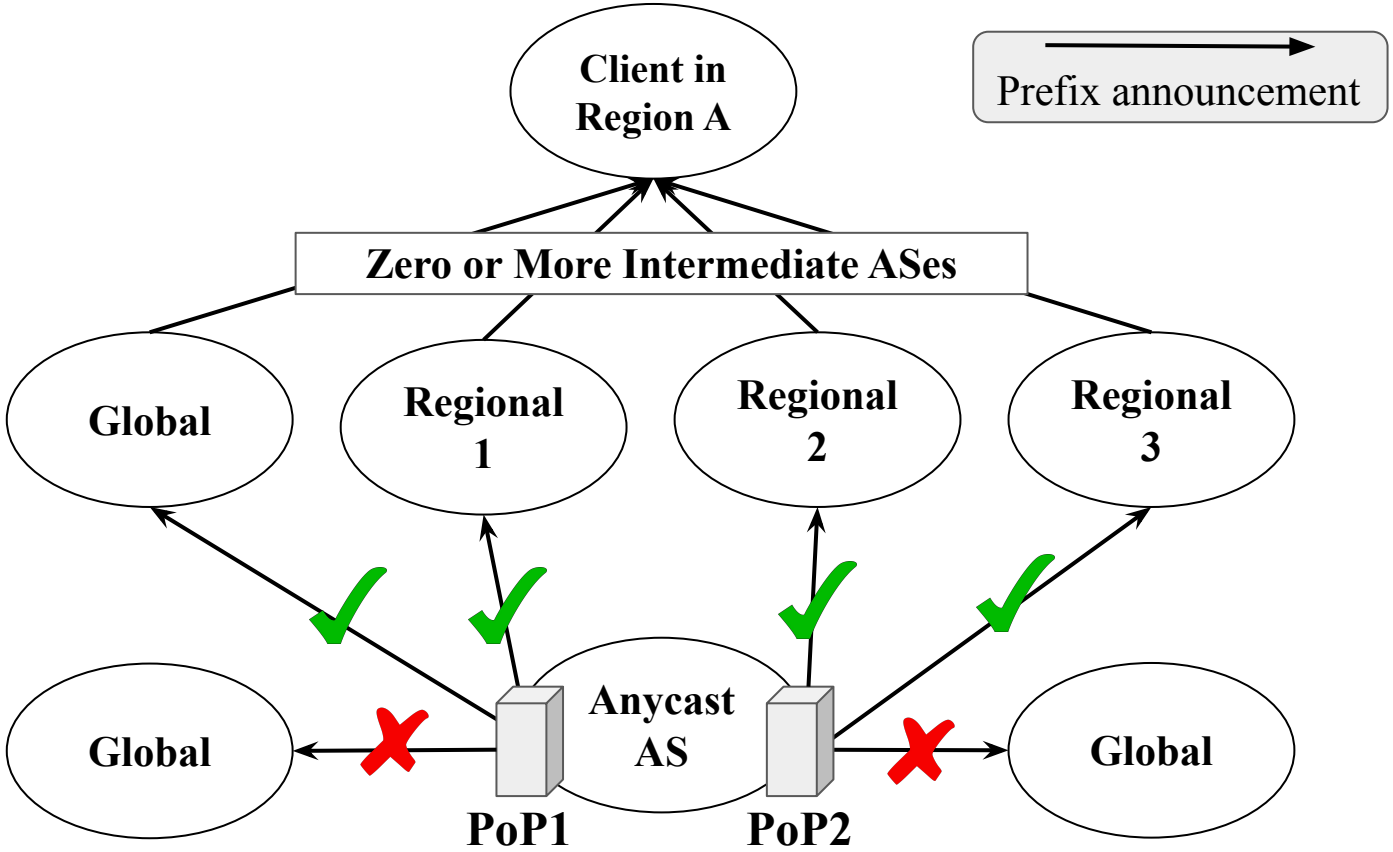
When an AS receives a route towards an anycast prefix through a more expensive route than expected, the prefix is labeled as ***Selective Announced Prefix***.

Selective Announcements is a common practice in Anycast ASes



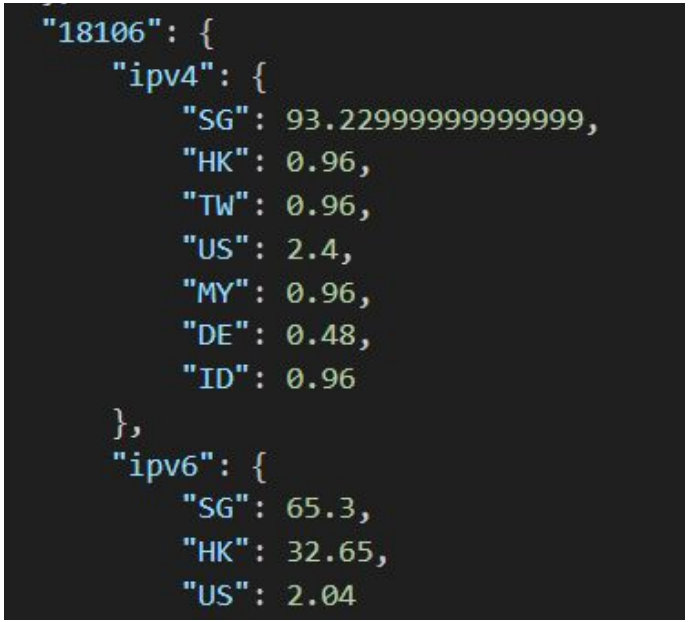
From a total of 691 anycast ASes, 84.06% announce at least one selective anycast prefix and **80% of the selective anycasters announce *all* of their prefixes selectively**.

Group the Receivers of Selective Announcements per Region



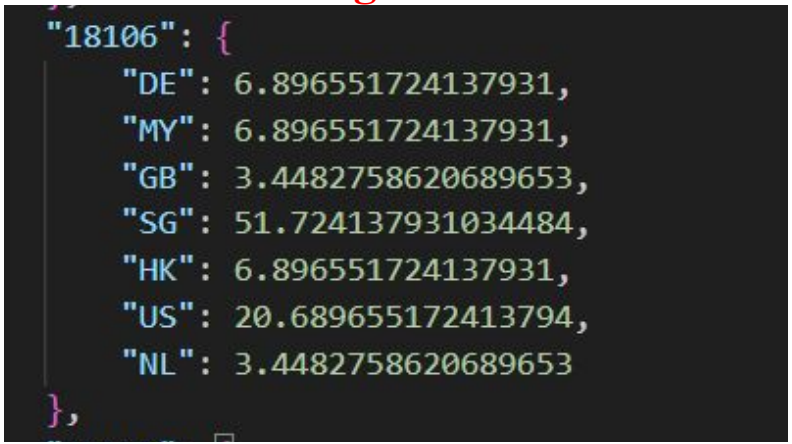
Step 4: Augment ASes with Country-level Characteristics

Prefixes Announced



```
"18106": {
    "ipv4": {
        "SG": 93.22999999999999,
        "HK": 0.96,
        "TW": 0.96,
        "US": 2.4,
        "MY": 0.96,
        "DE": 0.48,
        "ID": 0.96
    },
    "ipv6": {
        "SG": 65.3,
        "HK": 32.65,
        "US": 2.04
```

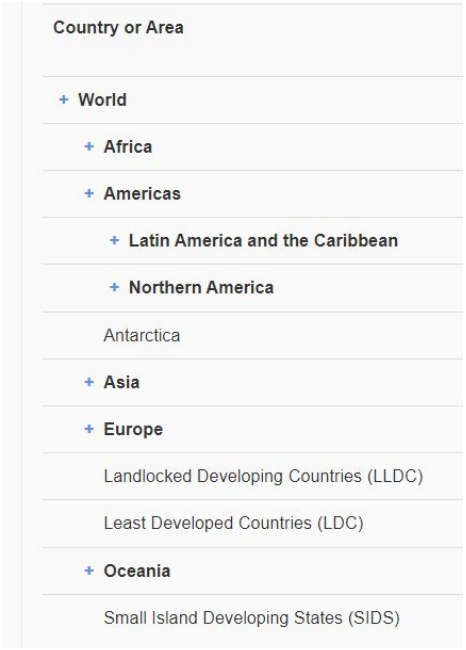
Peering Locations



```
"18106": {
    "DE": 6.896551724137931,
    "MY": 6.896551724137931,
    "GB": 3.4482758620689653,
    "SG": 51.724137931034484,
    "HK": 6.896551724137931,
    "US": 20.689655172413794,
    "NL": 3.4482758620689653
},
```

To uncover regional trends and disparities in anycast deployment we geolocate all ASes into their respective *countries* through Maxmind and PeeringDB.

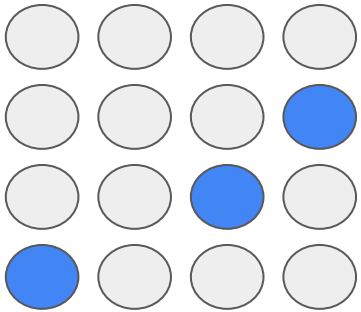
Step 4: Reduce the country-level to region-level granularity



An AS is labeled as ‘regional’ if: **more than 90% of its prefixes** AND **more than 90% of its peering locations** reside under the same region.

Step 5: Group the Receivers of Selective Announcements per Region

We group all direct neighbors of the Anycast AS per the end-user (source AS) region:



AS-path to a Selective Anycast Prefix

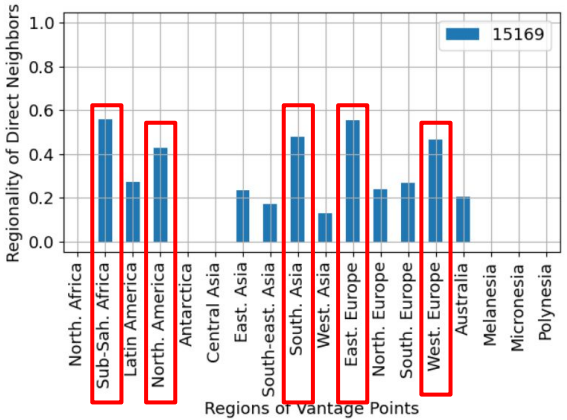
Anycast Origin AS

Receiver of Selective Anycast Prefix

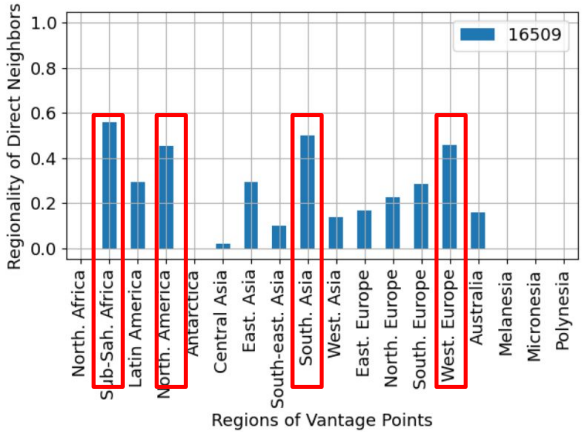
Region of Source AS


```
"10122": {
    "164.90.86.0/24": {
        "Northern America": {
            "US": [
                "174",
                "1299",
                "6453"
            ],
            "CA": [
                "1299",
                "174"
            ]
        },
        "Western Europe": {
            "DE": [
                "1299",
                "6453",
                "174",
                "41327",
                "33891",
                "21412",
                "23764"
            ],
```

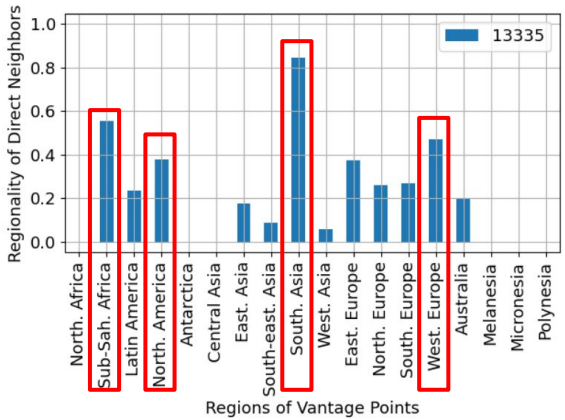
Regionality of the Receivers of Selective Announcements



(l) Google.



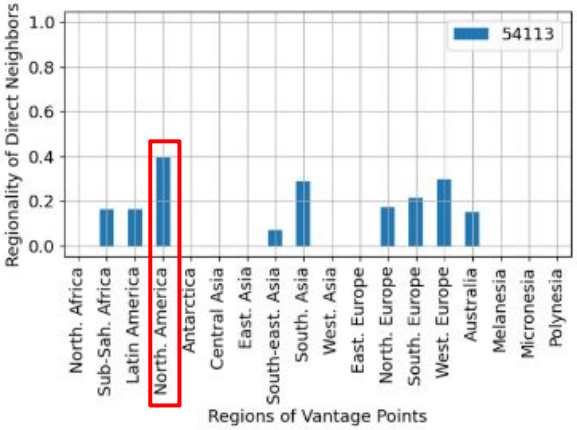
(d) Amazon.



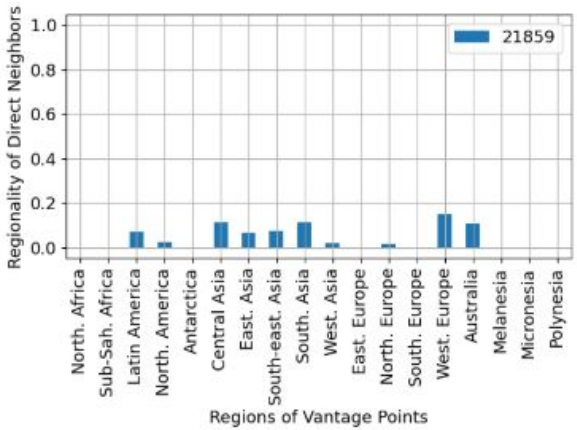
(a) Cloudflare.

Regionality = # of regional neighbors / # of total neighbors

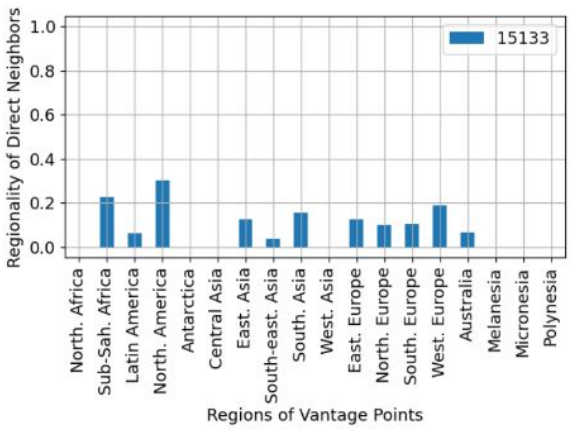
Regionality of the Receivers of Selective Announcements



(i) Fastly.



(f) Zenlayer.



(b) BytePlus.

Regionality = # of regional neighbors / # of total neighbors

Future Work: Reasoning on Regionality

Factors which drive the need for selective routing towards regional neighbors:

a. **deficiency of a centralized backbone** by the anycast AS 

b. lower transit fees 

c. strict regulatory conditions 

Take-away Message

A. User-to-site mapping in anycast deployments relies heavily not only on the geolocation factor but also on the routing policies across ASes.

B. Large part of anycast ASes deploy selective announcements for all of their anycast prefixes restricting the propagation of anycast prefixes for traffic engineering purposes.

C. Anycast networks often resort to leveraging regional providers to establish connections between their PoPs and the end-users.

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