Effects of anycast on K-root

Some early results

Current deployment

- 5 global nodes (BGP transit)
  - LINX
  - AMS-IX (since 7/2004)
  - Tokyo (since 5/2005)
  - Miami (since 7/2005)
  - Delhi (since 8/2005)

- 11 local nodes (announced with no-export)
  - Frankfurt, Athens, Doha, Milan, Reykjavik, Helsinki, Geneva, Poznan, Budapest, Abu Dhabi, Brisbane

Node structure

- 2 machines running nsd, switches, routers
- Production IP: OSPF load balancing
  - K-root IP address: 193.0.14.129
- Service interfaces
  - Normally firewalled, don't reply to queries
    - LINX: 193.0.16.1, 193.0.16.2
    - AMS-IX: 193.0.17.1, 193.0.17.2
    - ...
- Management interfaces, ...

Why anycast?

- Reasons for anycasting:
  - Provide resiliency and stability
  - Reduce latency
  - Spread server and network load, contain DOS attacks
  - ...

- Is it effective?

- Measurements taken April-July 2005

Latency

Latency comparison

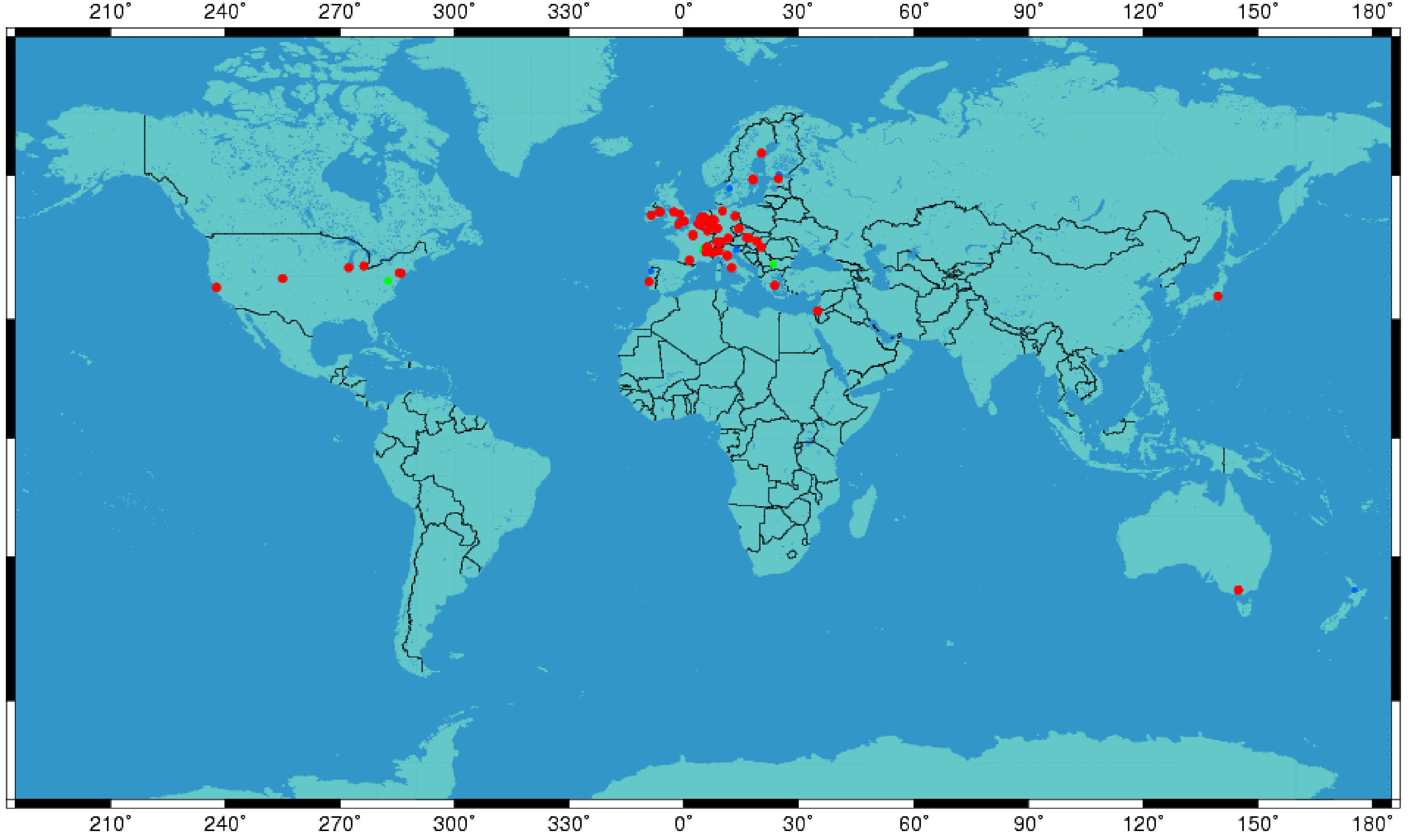
- Ideally, BGP should choose the node with the lowest RTT.
- Does it?

- Measure RTTs from the Internet to:
  - Anycasted IP address (193.0.14.129)
  - Service interfaces of global nodes (not anycasted): LINX, AMS-IX
    - At the time, there were only two global nodes

- Compare results

- Just to make sure this is apples to apples:
  - Are AS-paths to service interfaces the same as to production IP?
  - According to the RIS, “mostly yes”

Probe locations: TTM (bias?)

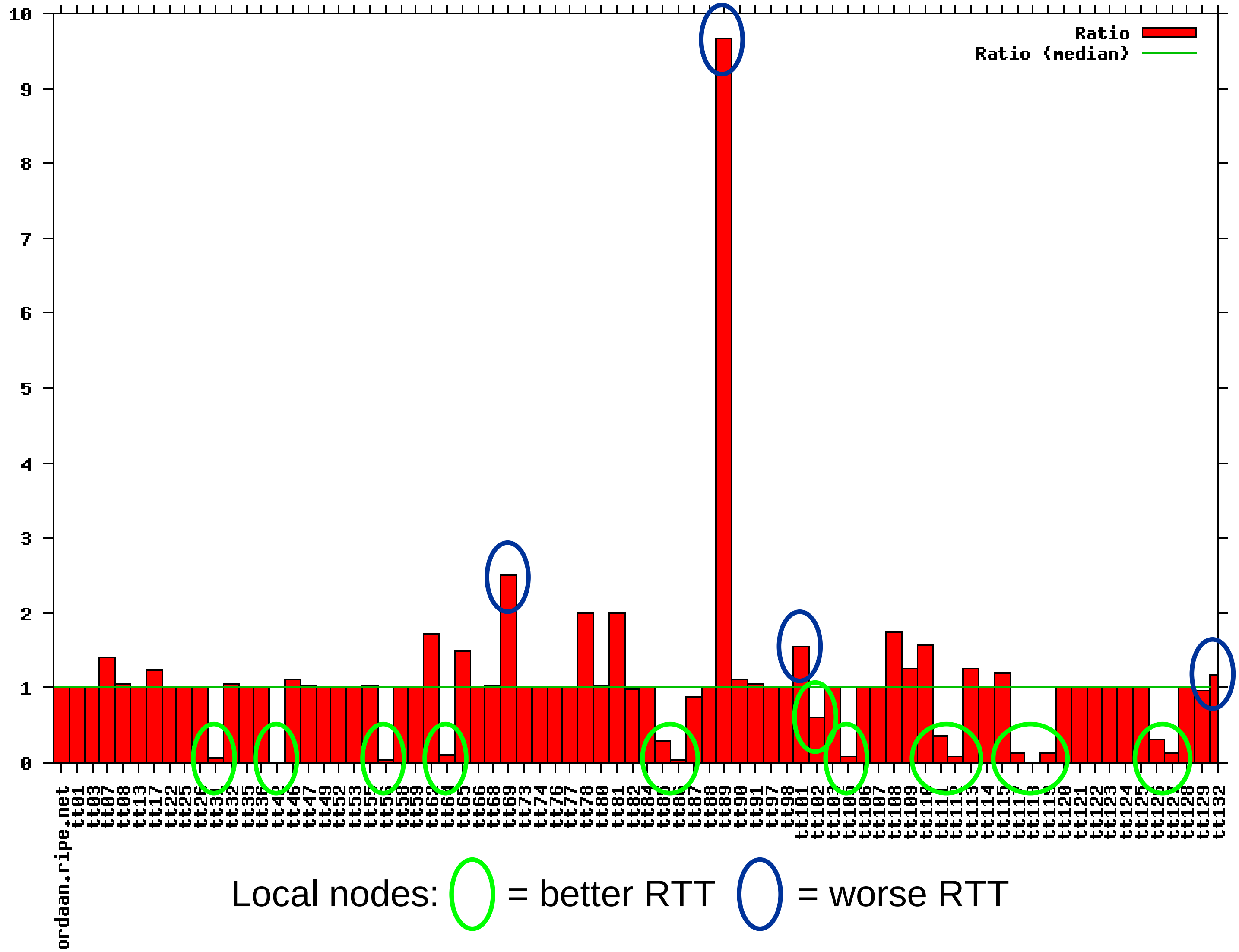


Method

- Send DNS queries from all test-boxes
  - For each K-root IP:
    - Do a “dig hostname.bind”
    - Extract RTT
    - Take minimum value of 5 queries
  - Compare results of anycast IP with those of service interfaces

- $\alpha = RTT_K / \min(RTT_i)$
  - $\alpha \approx 1$: BGP picks the right node
  - $\alpha > 1$: BGP picks the wrong node
  - $\alpha < 1$: local node?

Latency comparison



Local nodes: = better RTT = worse RTT

Local worse than global?

```
$ cat tt89
193.0.14.129 k2.denic 29 k2.denic 30 k2.denic 29 k2.denic 30 k2.denic 29
193.0.16.1 k1.linx 4 k1.linx 3 k1.linx 3 k1.linx 3 k1.linx 3
193.0.16.2 k2.linx 3 k2.linx 3 k2.linx 3 k2.linx 3 k2.linx 4
193.0.17.1 k1.ams-ix 12 k1.ams-ix 11 k1.ams-ix 12 k1.ams-ix 13 k1.ams-ix 13
193.0.17.2 k2.ams-ix 12 k2.ams-ix 13 k2.ams-ix 11 k2.ams-ix 12 k2.ams-ix 13
```

(This example has since been fixed)

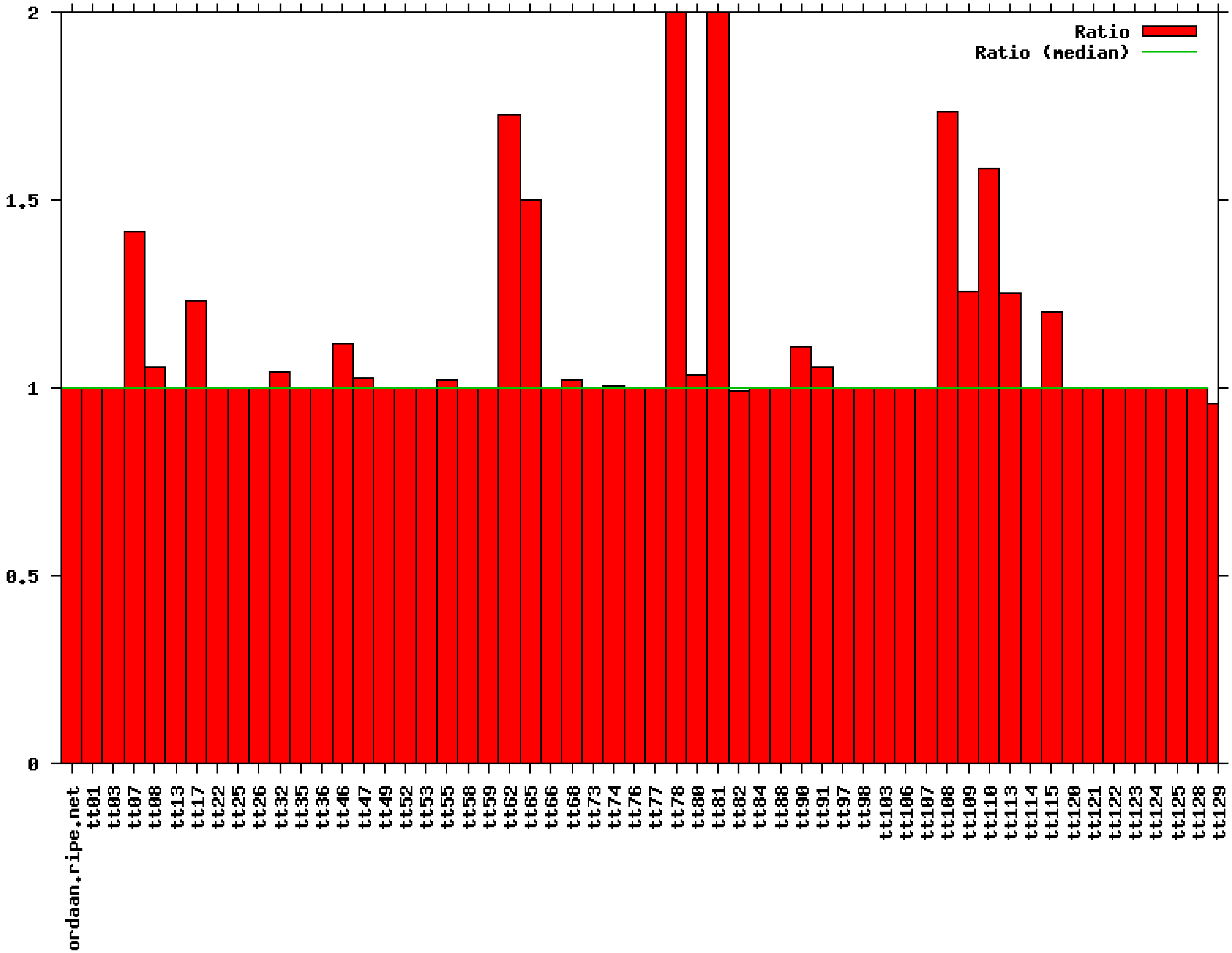
- What's going on here? Perhaps:
  - Local node announcements don't necessarily leak
  - But they do get announced to customers

    …and customers of customers

    …where they compete with announcements from global nodes

    …which lose out due to prepending

Latency comparison (global)



Latency: conclusions

- Local nodes “confuse” the situation due to transit and prepending
- But all in all, BGP does a surprisingly good job

- This contrasts with other work (Ballani & Francis)
  - Perhaps it is because we only saw two global nodes
    - Will it get worse when more nodes are deployed?
  - Perhaps it is because both nodes are in Europe and we are measuring from Europe

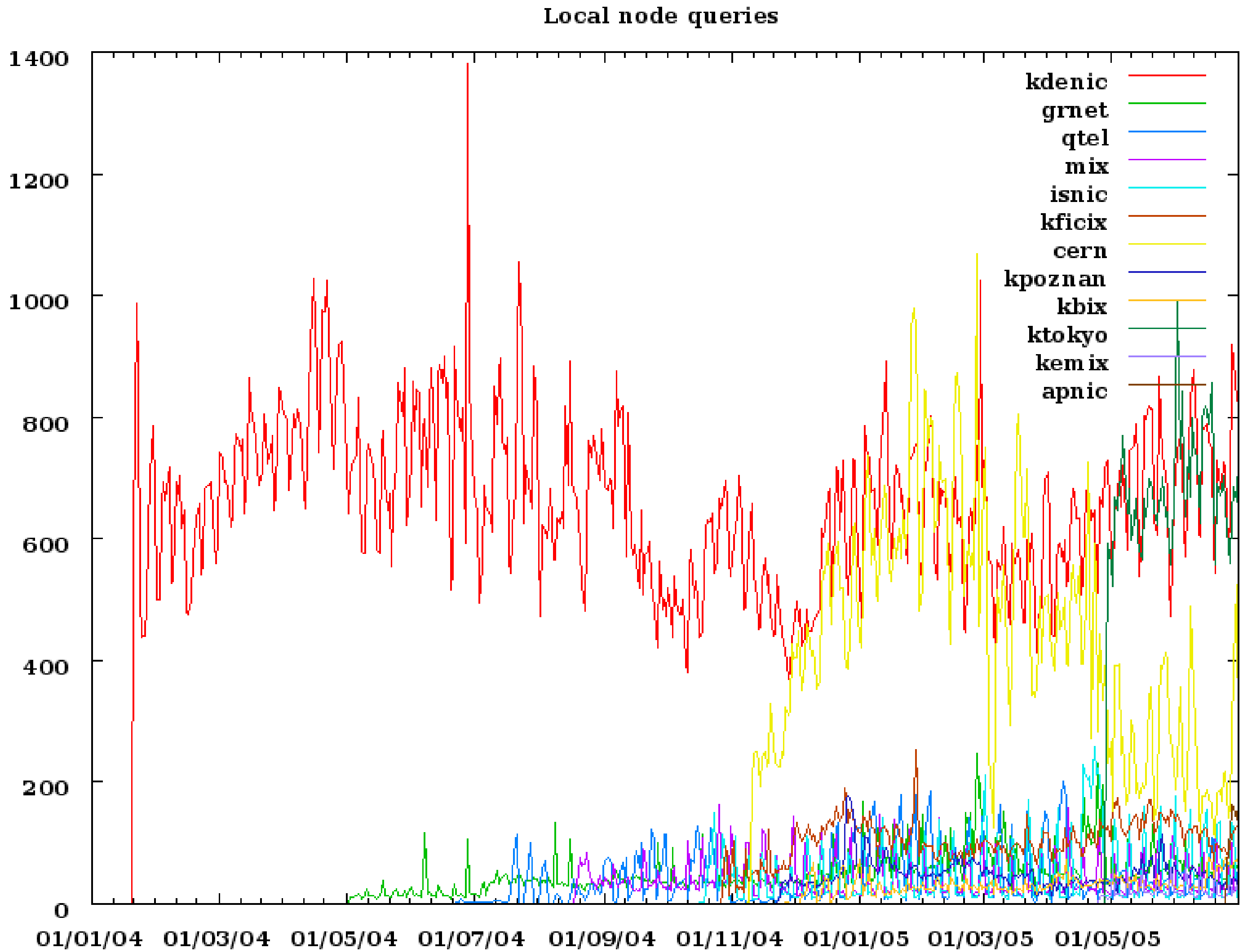
- When this was done there were only two global nodes

Load balancing

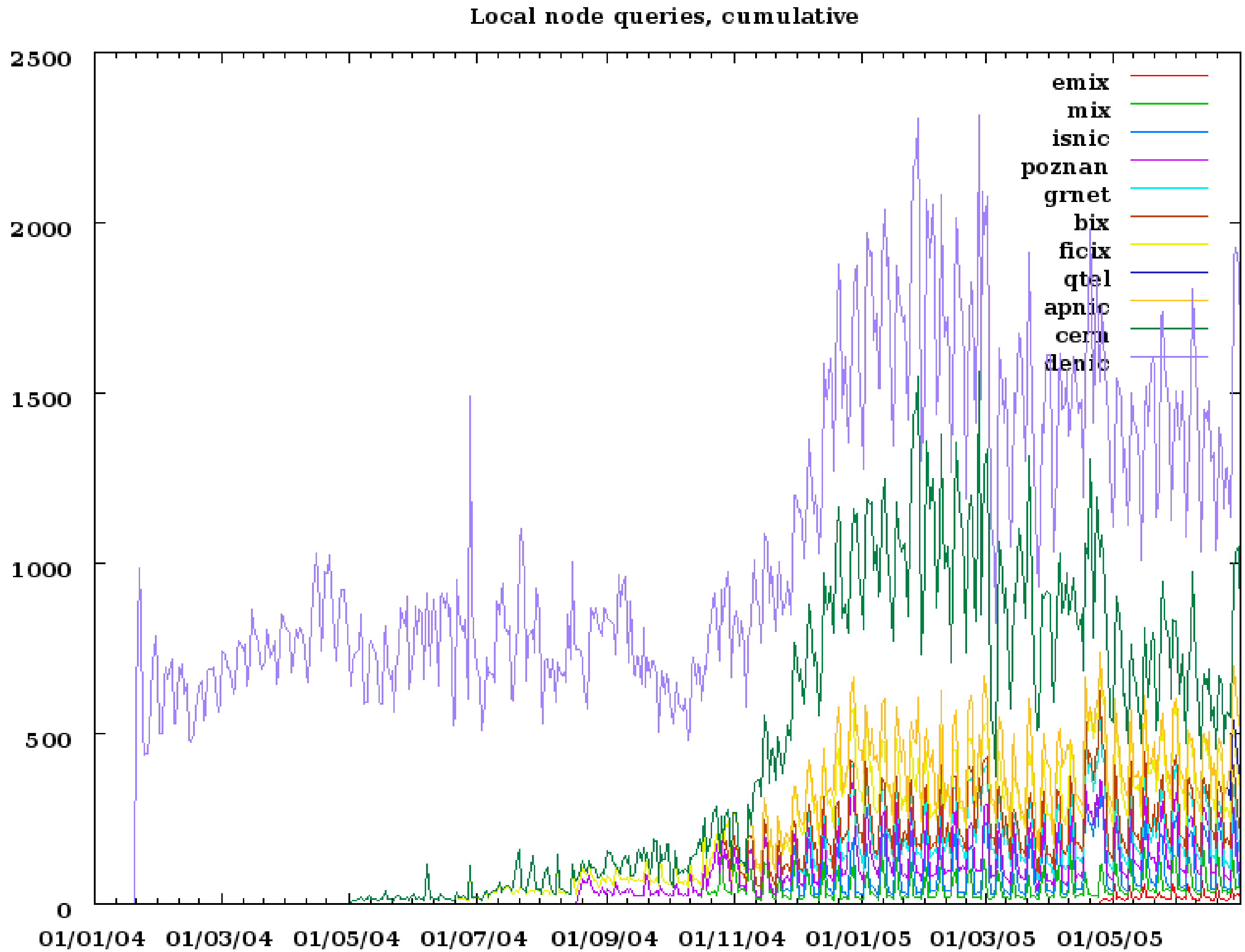
Usefulness of local nodes

- How much traffic does a local node get?
- Do local nodes take load off the global nodes?
- Where do local queries come from?
  - From the global K nodes?
  - From the other root servers?

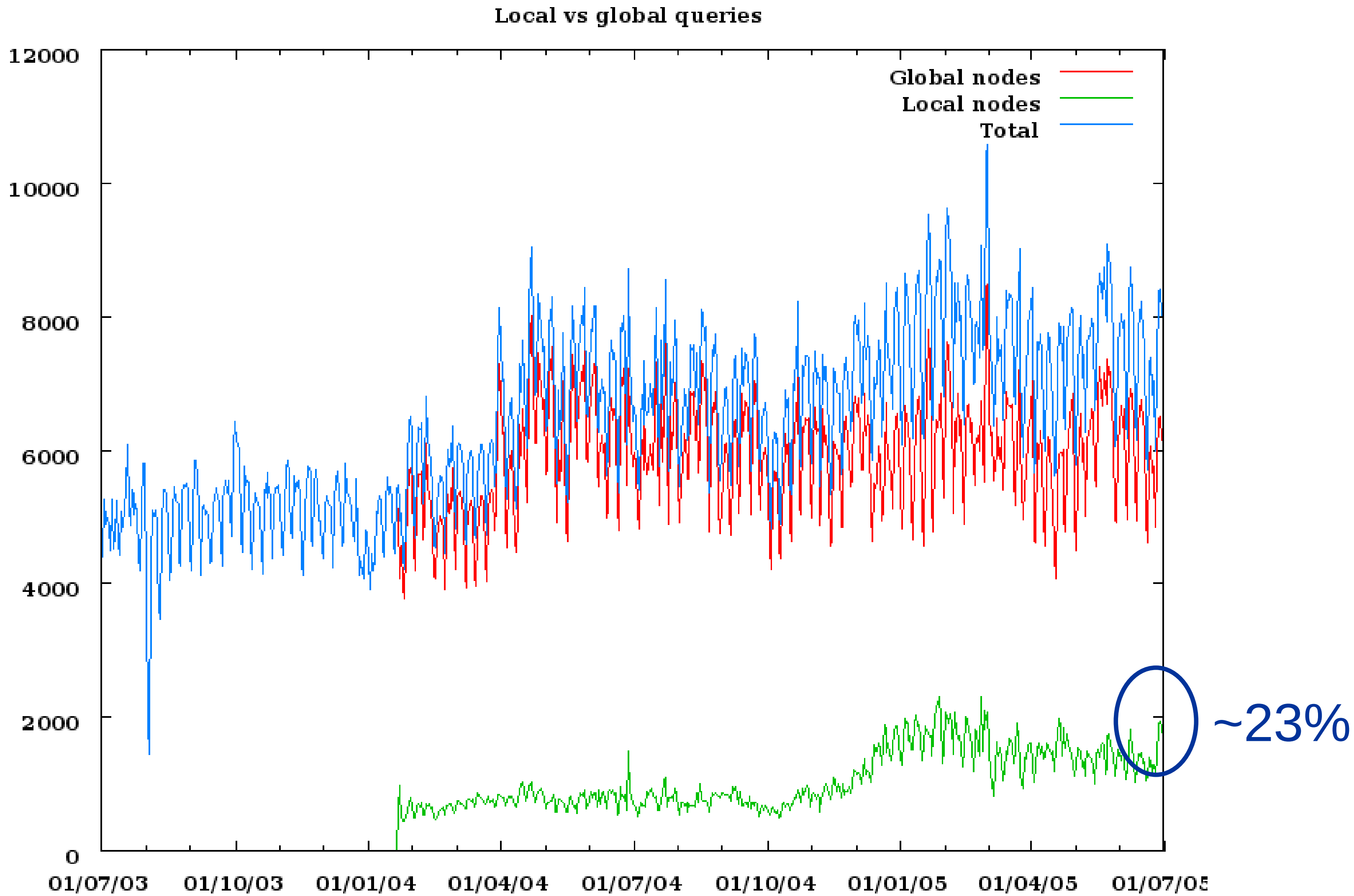
Local queries



Local queries (cumulative)



Local vs global



Load balancing: conclusions

- The traffic a local node gets depends on where it is
- Wide variation
  - 2 orders of magnitude!
- We need a way to choose where to put a new node
- Local nodes do take load off the global nodes
  - but not much
- Increase in local traffic does not correspond to decrease in global traffic
  - Traffic mostly seems to come from the other roots

Stability

Node switches

- Didn't measure resiliency
  - Pretty much a given: the more servers there are,
    - the more they can withstand
    - the more localised the impact of an attack
- What about stability?
  - The more routes competing in BGP, the more churn
  - Doesn't matter for single-packet exchanges (UDP)
  - Does matter for TCP queries
- How frequent are node switches?

Detecting node switches

- Measure at the server
- Look at node switches that actually occur

- Procedure:
  - – Look at packet dumps
    - At the time, there were only 2 global nodes
  - – Extract all port 53/UDP traffic
  - – For each IP address, remember where it was last seen
  - – If the same IP is seen elsewhere, log a switch

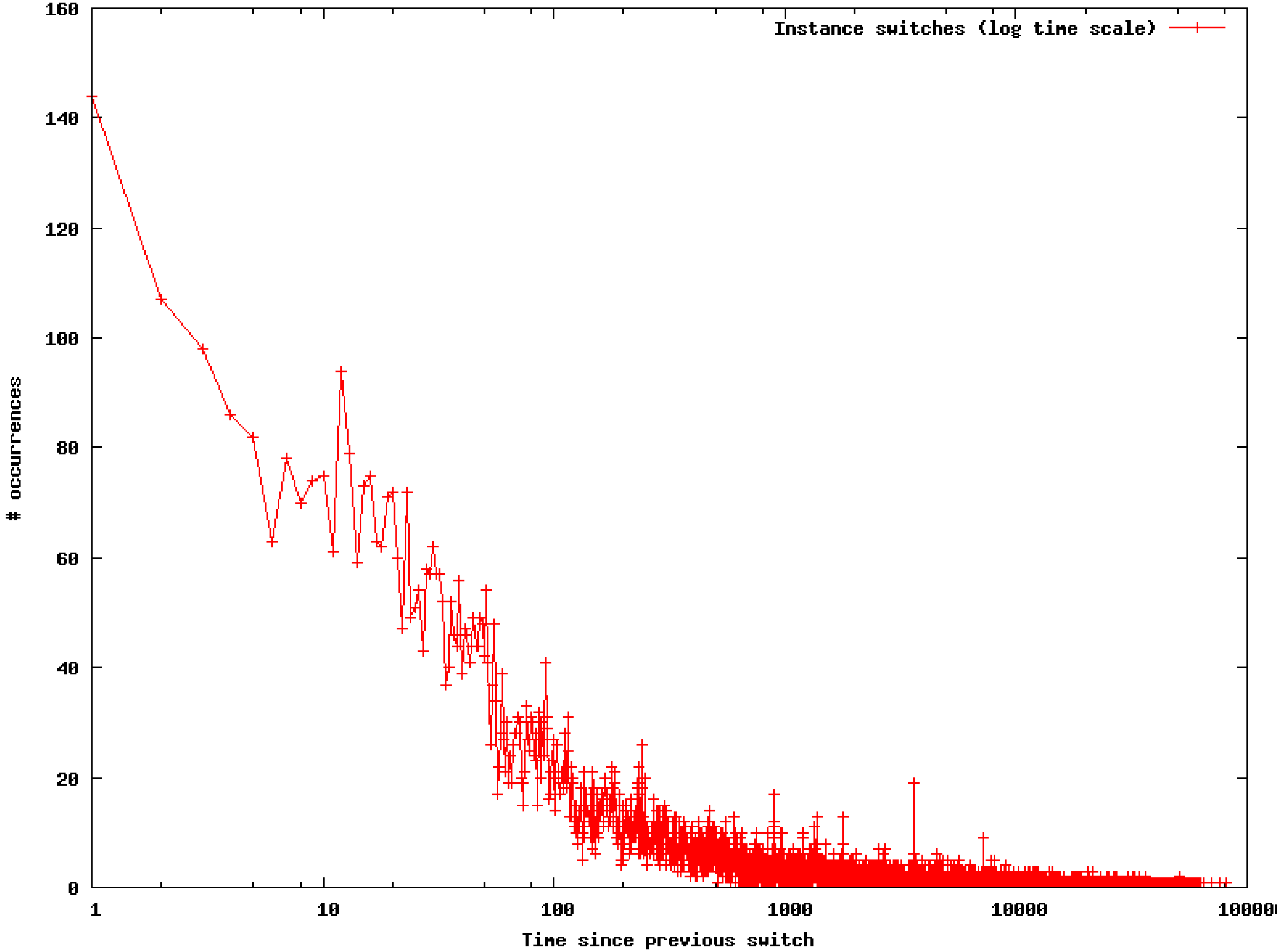
- Caveats:
  - – K nodes are only NTP synchronized

Node switches: results

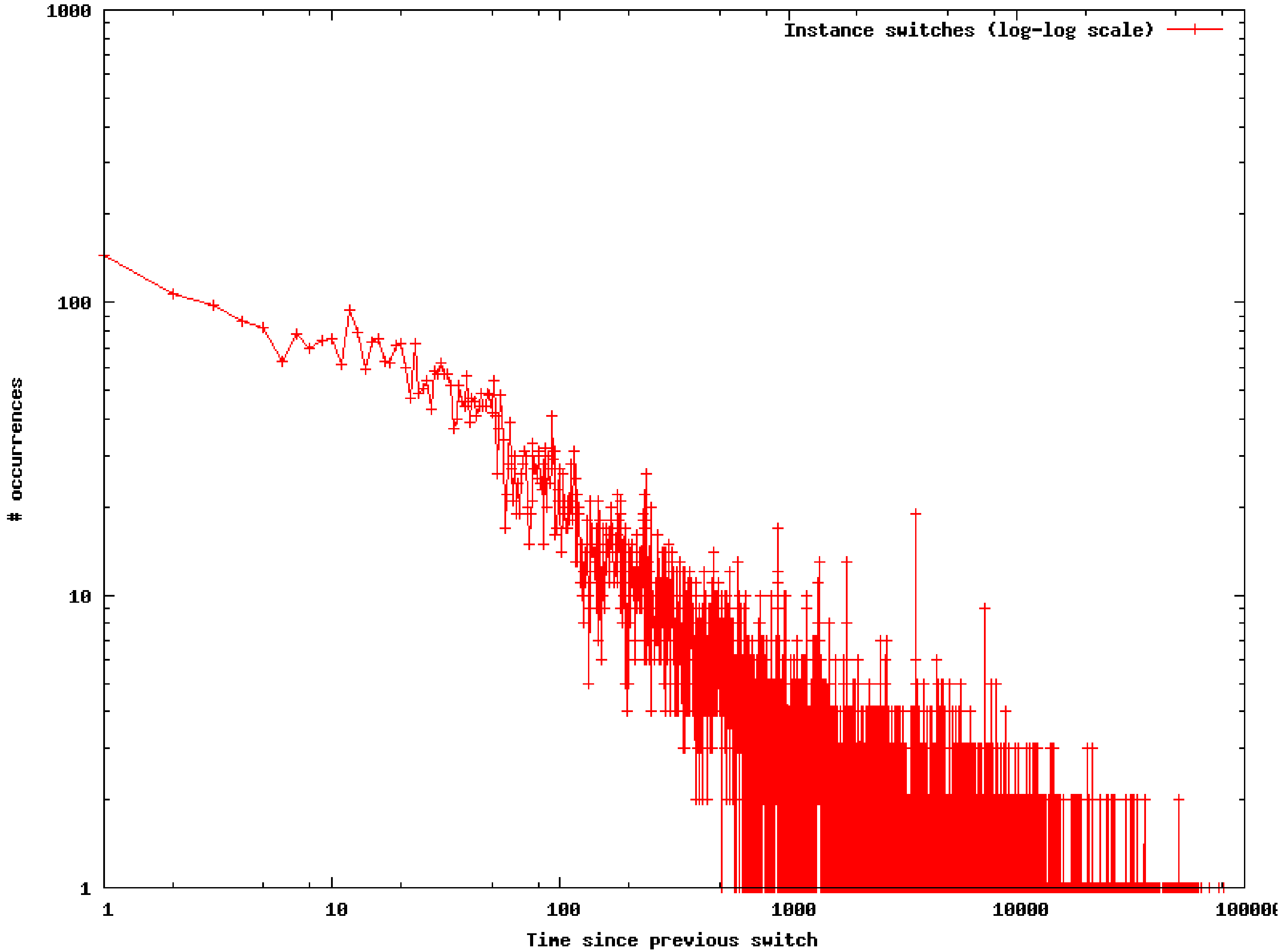
- 24 hours of data:
  - 527,376,619 queries
  - 30,993 node switches (~0.006%)

  - 884,010 IP's seen
  - 10,557 switching IPs (~1.1%)
- What do the switches look like?

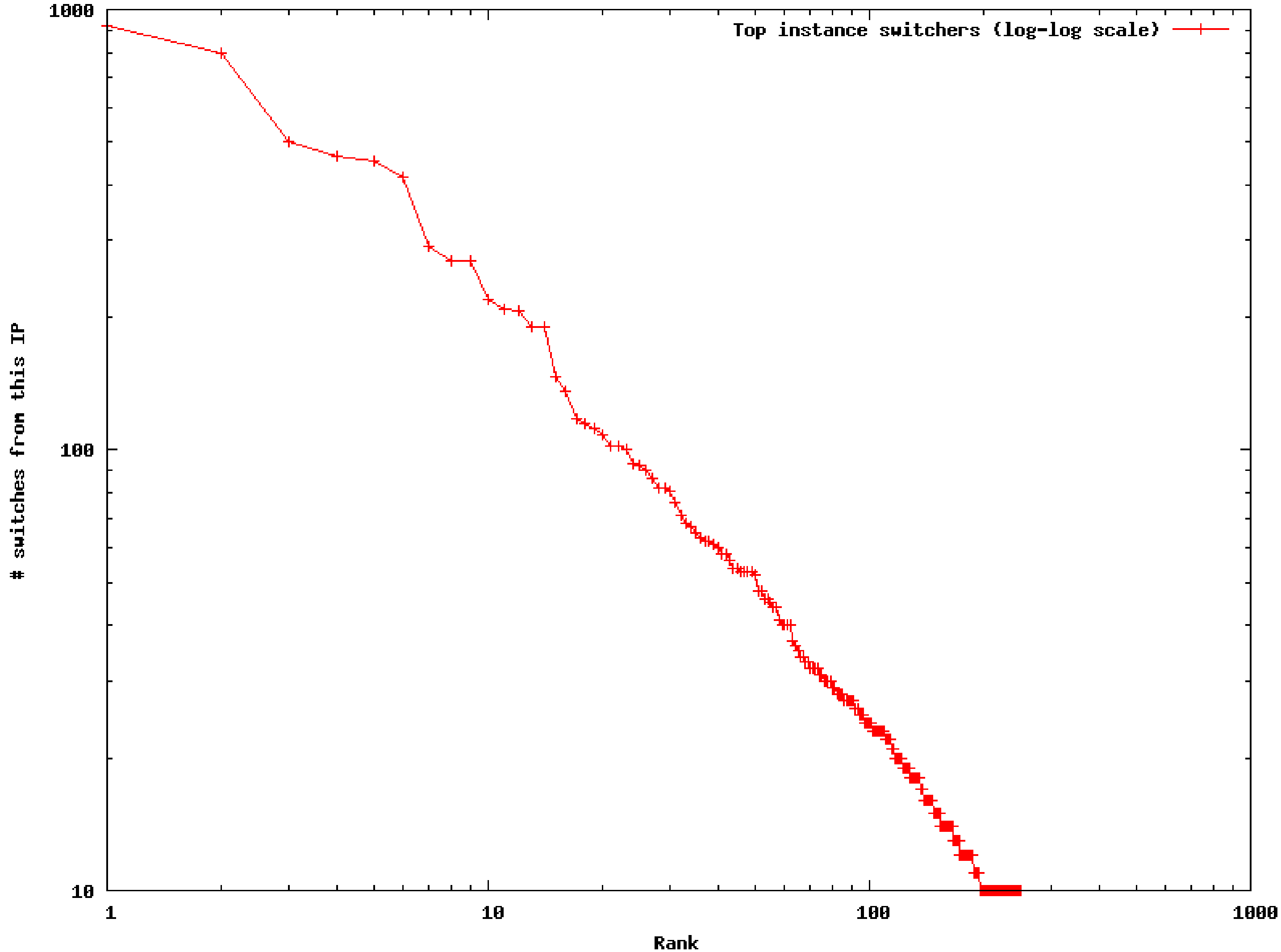
Time since last switch



Time since last switch, log-log



Top switching IPs



Stability: conclusions

- Node switches are rare
- But some IPs switch a lot
  - Load balancing?
  - Need to look into this
- What do the switch profiles mean?
  - We don't know yet
  - Further analysis needed

To sum it up...

- Anycast works very well for clients
  - Latency is very good
    - But local nodes can make things worse instead of better
  - Affinity does not seem to be a problem
    - 99.994% of queries hit same server as last query
    - 98.9% of IPs never switched in one a day

- Anycast works well for operators
  - Location for new nodes must be carefully considered
  - Local nodes don't take much load off global nodes
  - When a new node is deployed, traffic mostly comes from the other roots

Next steps

- Detailed writeup of results in progress
- Short term:
  - Look at effects of new global nodes
    - Does anycast still work so well?
  - Look at traffic distribution between global nodes
- Longer term:
  - Look at “pathological” node switchers
  - Develop methodology to choose location for new nodes
- Suggestions?

Questions?