



# Behavior analysis of DNS Anycast in 2008

-- Annual Report of Gulliver Project --

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# Introduction

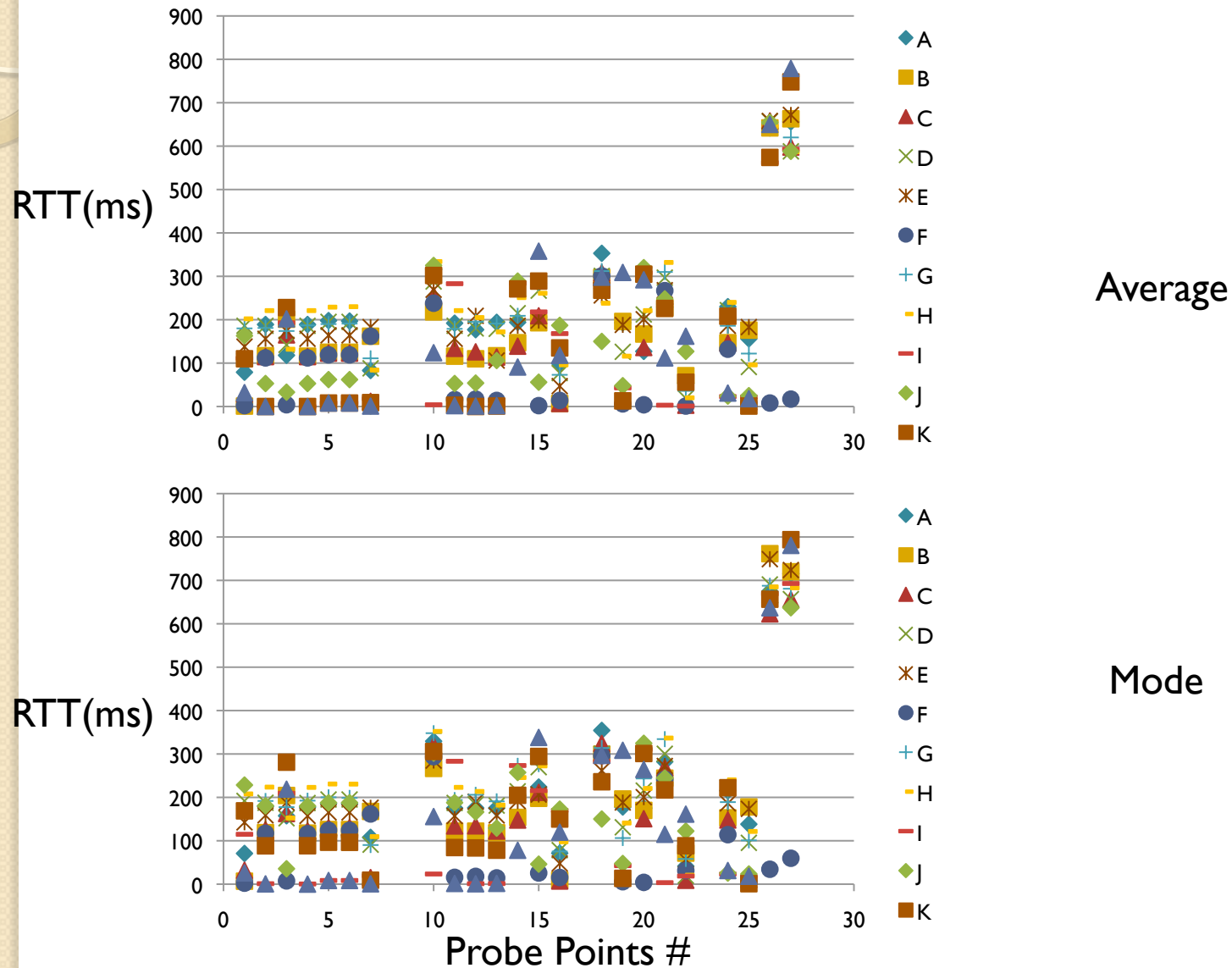
- Gulliver Project
  - DNS Active Measurement Project
  - **<http://gulliver.wide.ad.jp/>**
- Probes DNS reachability from worldwide locations
  - RTT, Query Timeout, Anycast ID
- 27 Probe Locations as of Mar. 2009
- Targets
  - Root DNS Servers
  - ccTLD DNS Servers
  - in-addr.arpa DNS Servers



# Analysis

- Measurement Span
  - From Jan. 2008 to Mar. 2009
- Targets
  - Root DNS Servers
- RTT distribution
  - “Average” and “Mode” are nearly equal
  - RTT values are not distributed largely

# Average v.s. Mode RTT Values



# Categorize Root DNS by Anycasting

- Root DNS Servers be categorized by its operation policy

Type-1 : Non Anycasted

- A, B, D, E, G, H

Type-2 : Anycasted

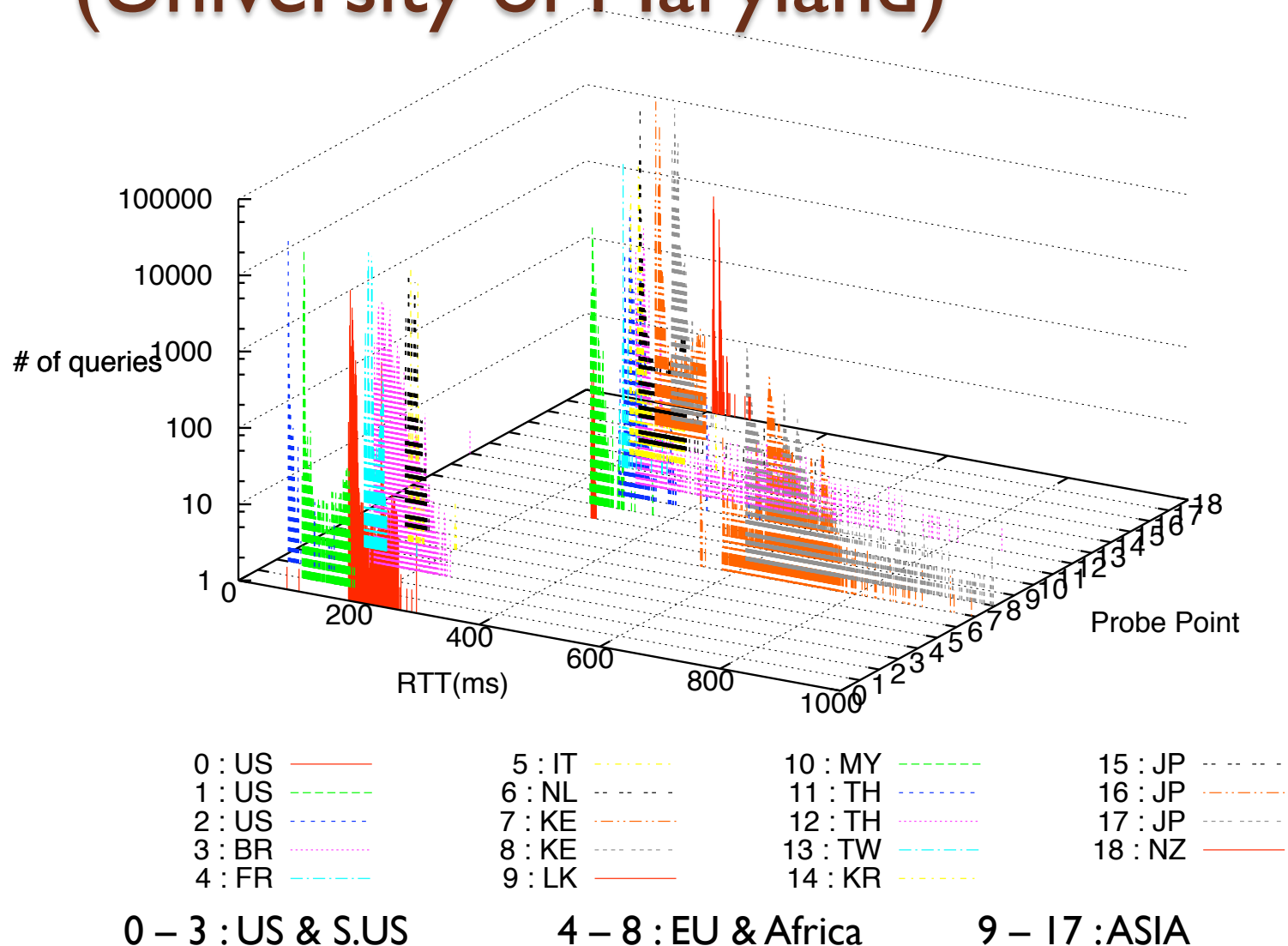
- C, M, L

Type-3 : Heavily Anycasted

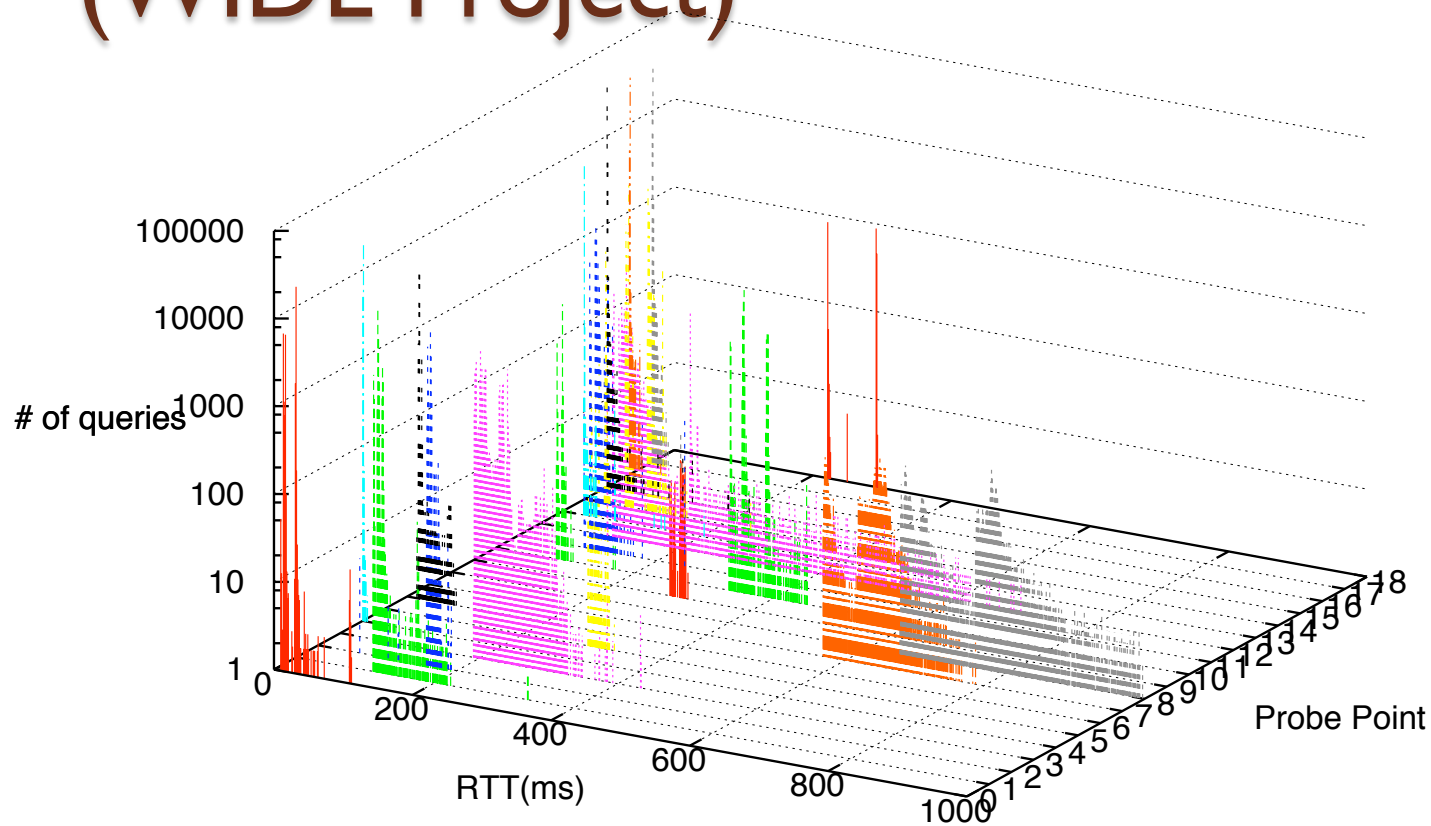
- F, I, J, K

- Is there any relation ???
  - Anycast Changes
  - RTT
  - Query Timeout

# RTT distribution of D-ROOT (University of Maryland)



# RTT distribution of M-ROOT (WIDE Project)



0 : US  
1 : US  
2 : US  
3 : BR  
4 : FR

5 : IT  
6 : NL  
7 : KE  
8 : KE  
9 : LK

10 : MY  
11 : TH  
12 : TH  
13 : TW  
14 : KR

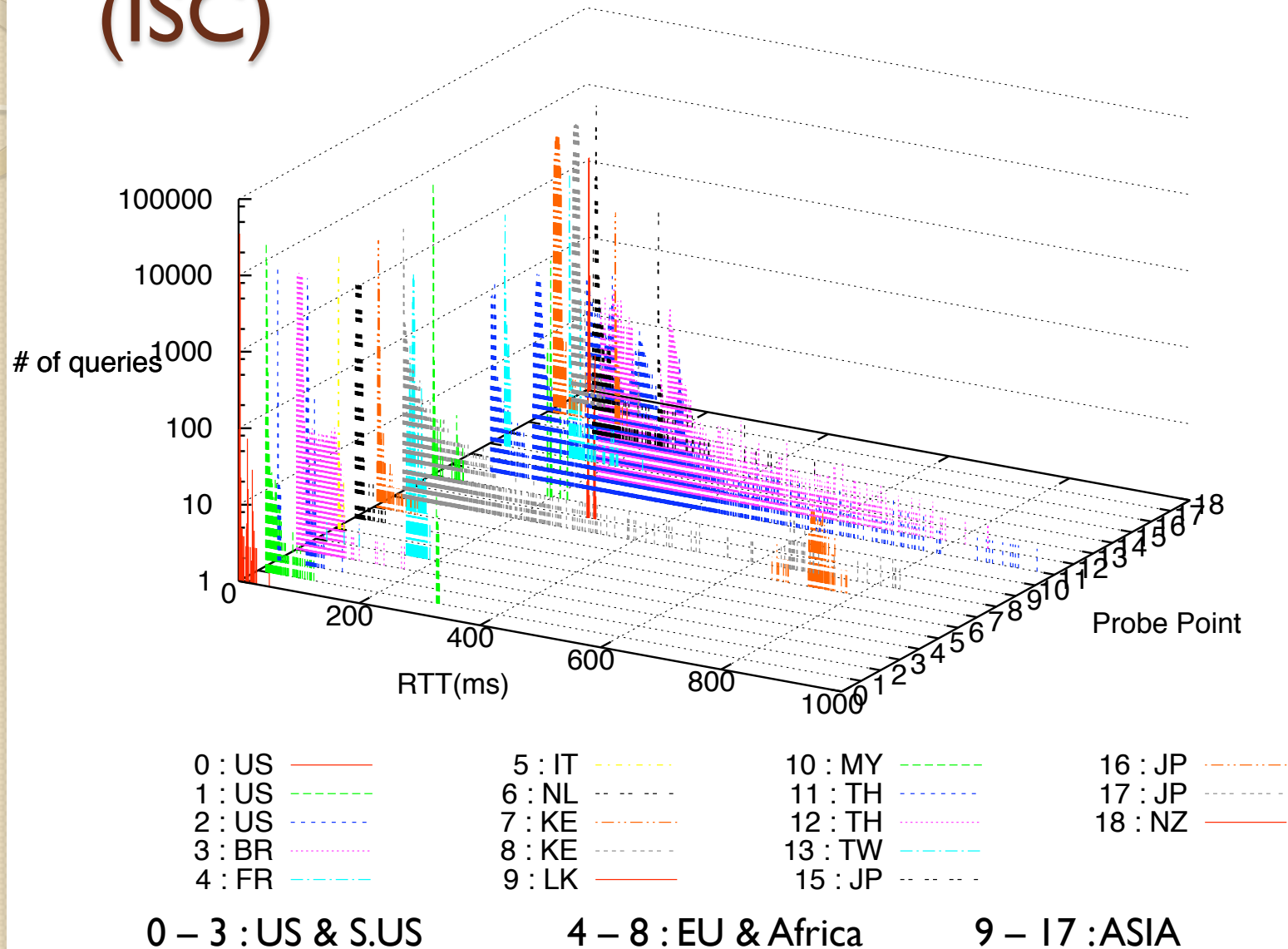
15 : JP  
16 : JP  
17 : JP  
18 : NZ

0 – 3 : US & S.US

4 – 8 : EU & Africa

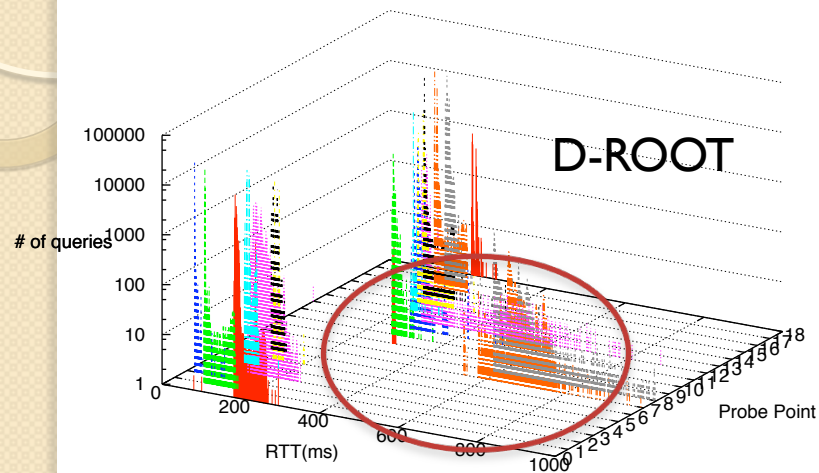
9 – 17 : ASIA

# RTT distribution of F-ROOT (ISC)

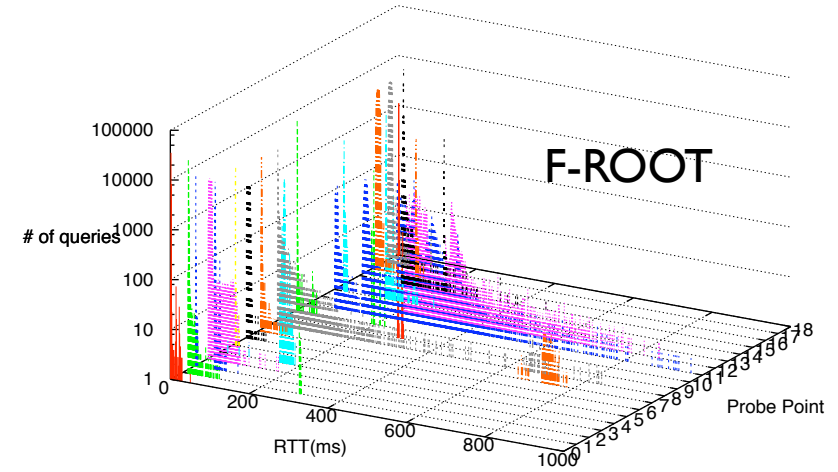




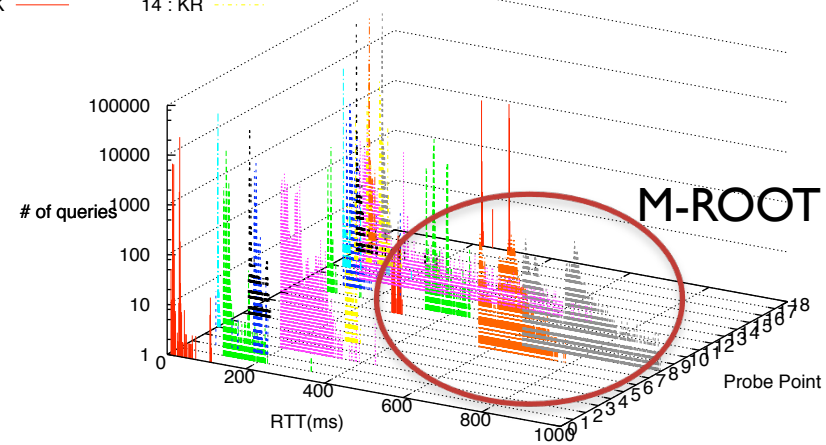
# Distributions



|        |        |         |         |
|--------|--------|---------|---------|
| 0 : US | 5 : IT | 10 : MY | 15 : JP |
| 1 : US | 6 : NL | 11 : TH | 16 : JP |
| 2 : US | 7 : KE | 12 : TH | 17 : JP |
| 3 : BR | 8 : KE | 13 : TW | 18 : NZ |
| 4 : FR | 9 : LK | 14 : KR |         |

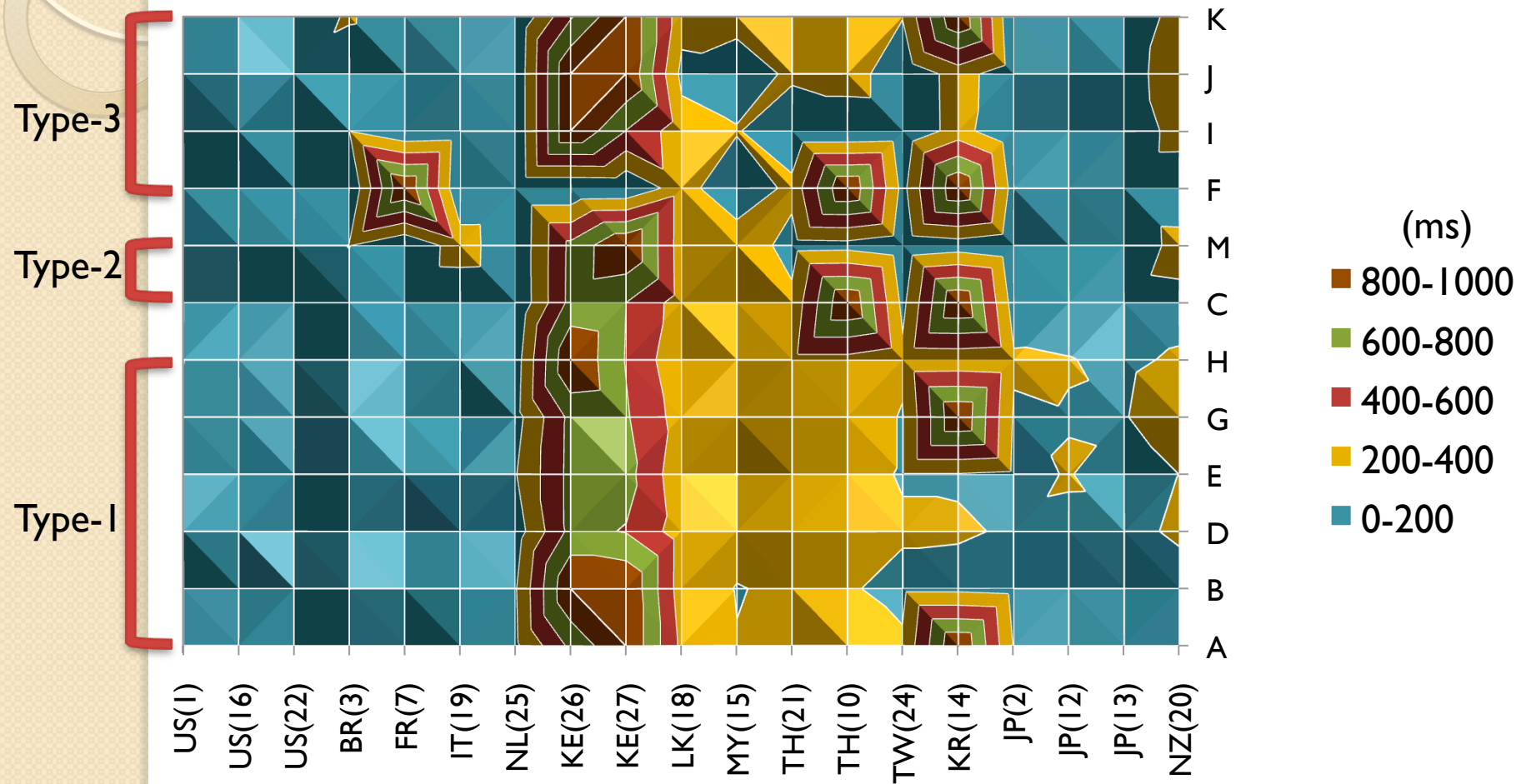


|        |        |         |         |
|--------|--------|---------|---------|
| 0 : US | 5 : IT | 10 : MY | 16 : JP |
| 1 : US | 6 : NL | 11 : TH | 17 : JP |
| 2 : US | 7 : KE | 12 : TH | 18 : NZ |
| 3 : BR | 8 : KE | 13 : TW |         |
| 4 : FR | 9 : LK | 15 : JP |         |

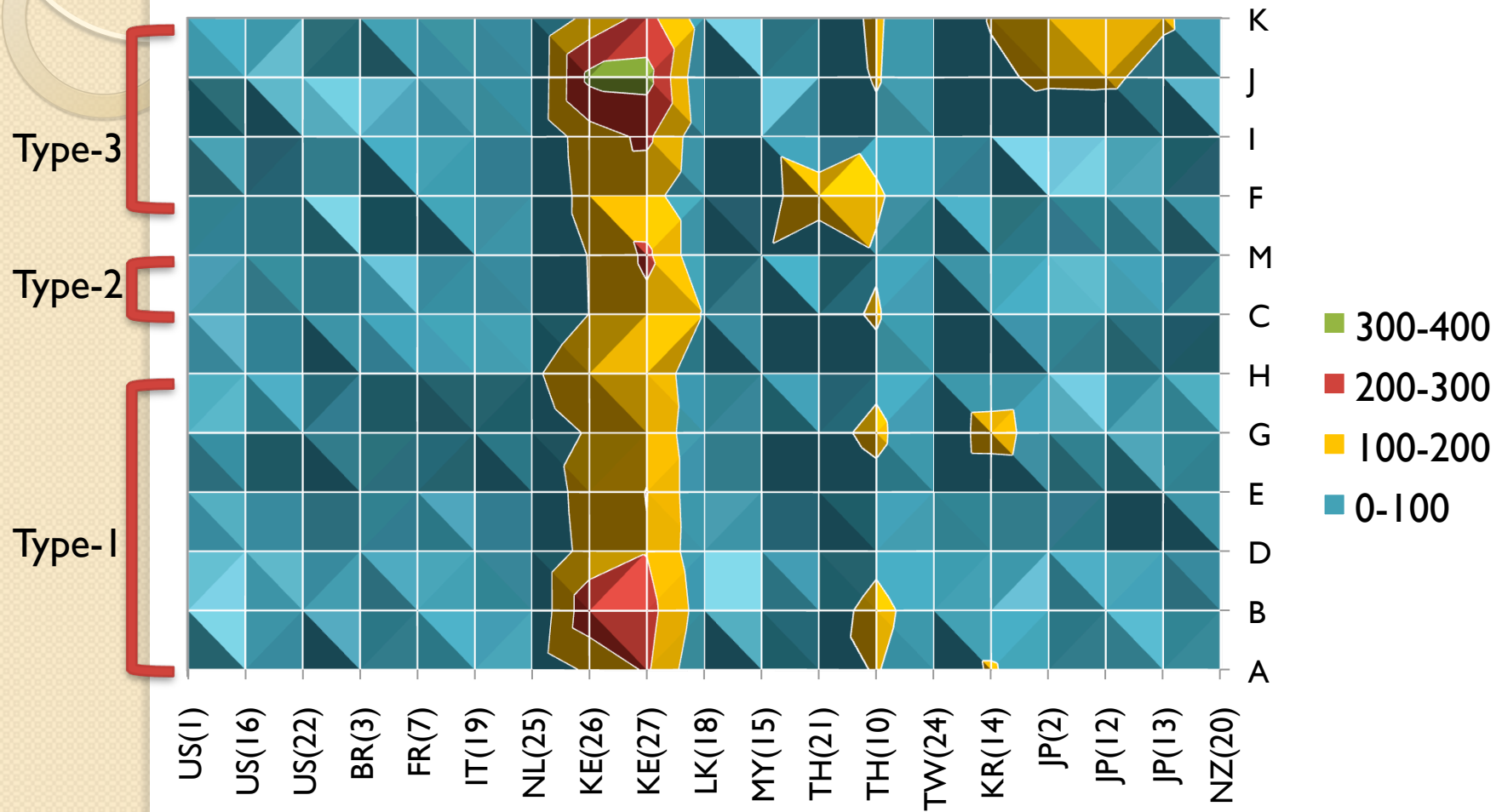


|        |        |         |         |
|--------|--------|---------|---------|
| 0 : US | 5 : IT | 10 : MY | 15 : JP |
| 1 : US | 6 : NL | 11 : TH | 16 : JP |
| 2 : US | 7 : KE | 12 : TH | 17 : JP |
| 3 : BR | 8 : KE | 13 : TW | 18 : NZ |
| 4 : FR | 9 : LK | 14 : KR |         |

# Matrix of RTT (mode)



# Matrix of StdDev

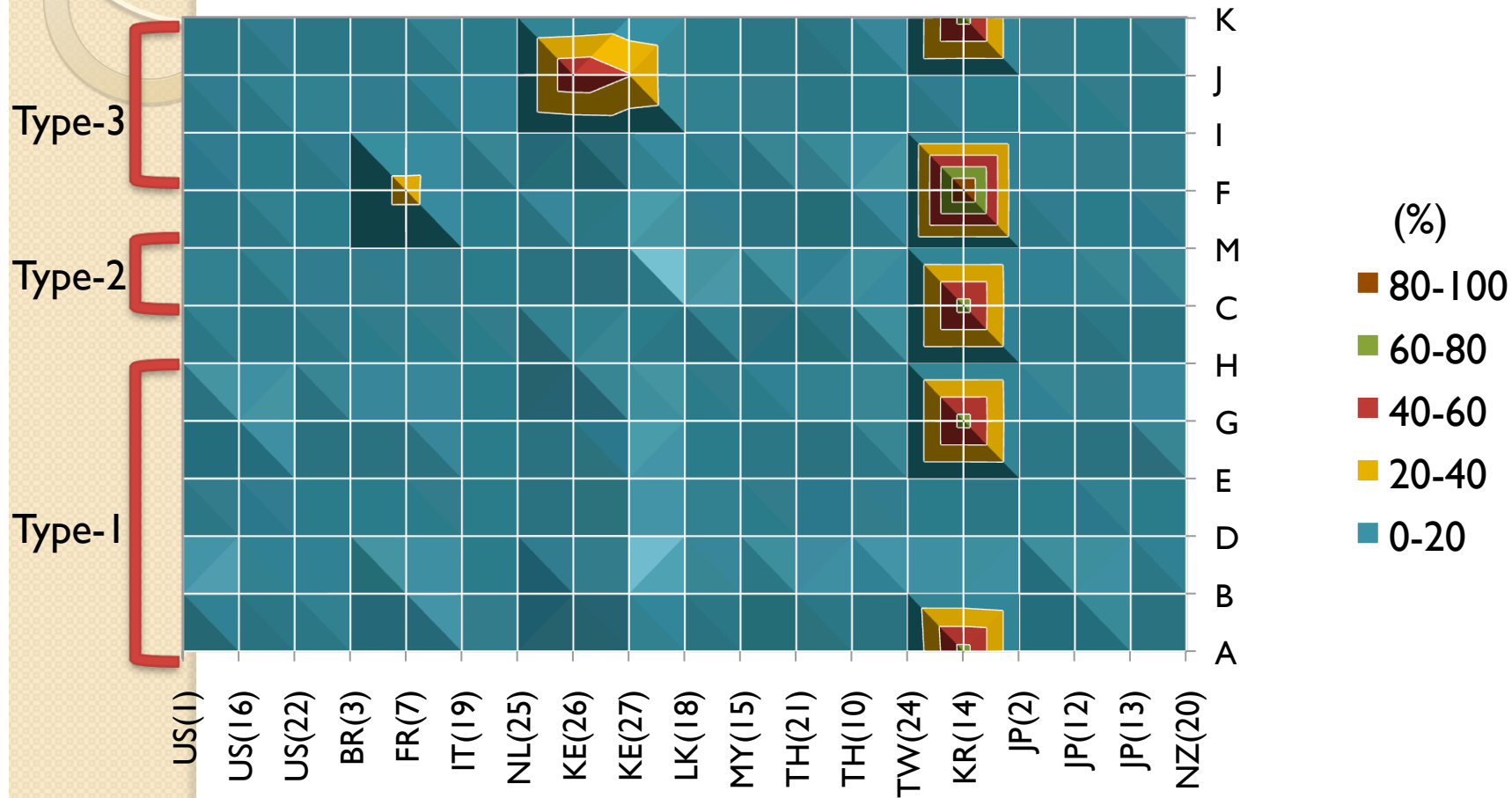




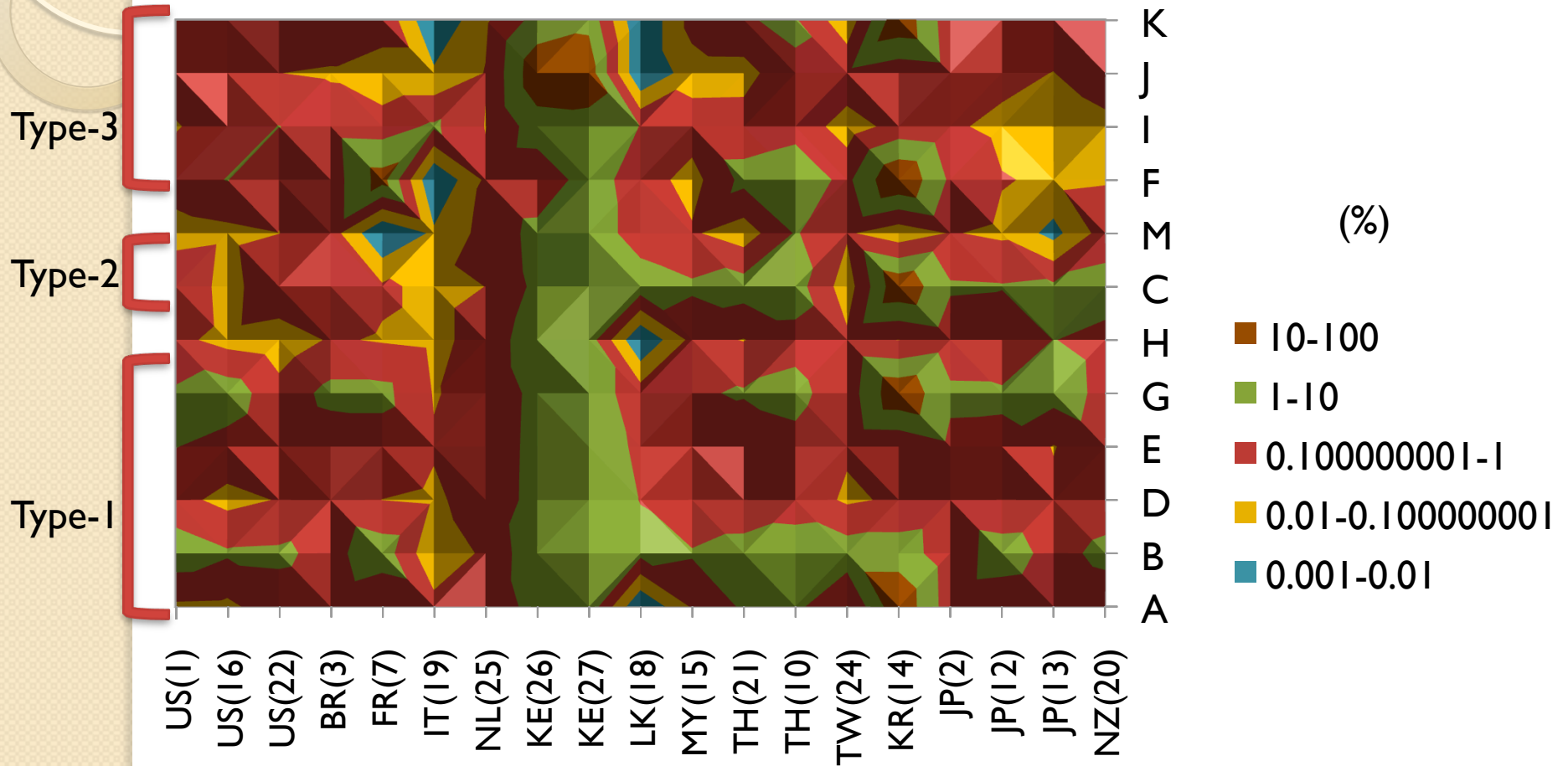
## RTT & StdDev

- Africa (Kenya) and Asian probes show larger RTT values
- StdDev of Asian probes are not so large
- Kenya probes show large StdDev values

# Matrix of Query Timeout



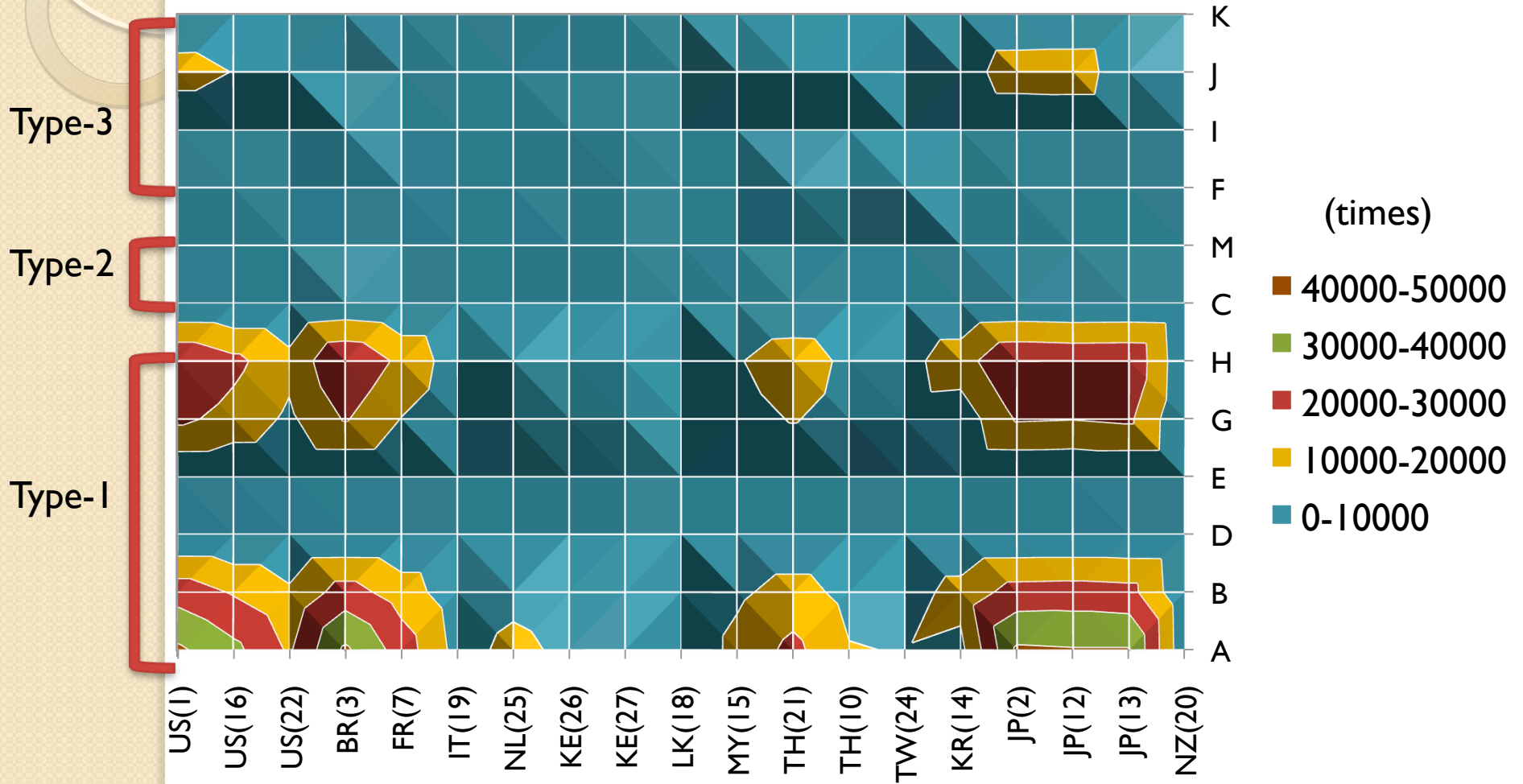
# Matrix of Query Timeout (Scale Changed)



# DNS Query Timeout

- Kenya and several Asian probes show over 1 % timeout rate
- Probes which show over 10% timeout rate
  - KR, KE, FR
  - FR -> F : Problem ?
  - KE : High Timeout Rate
  - KR : Only A, C, F, G, K show problem

# Matrix of Anycast ID Changes

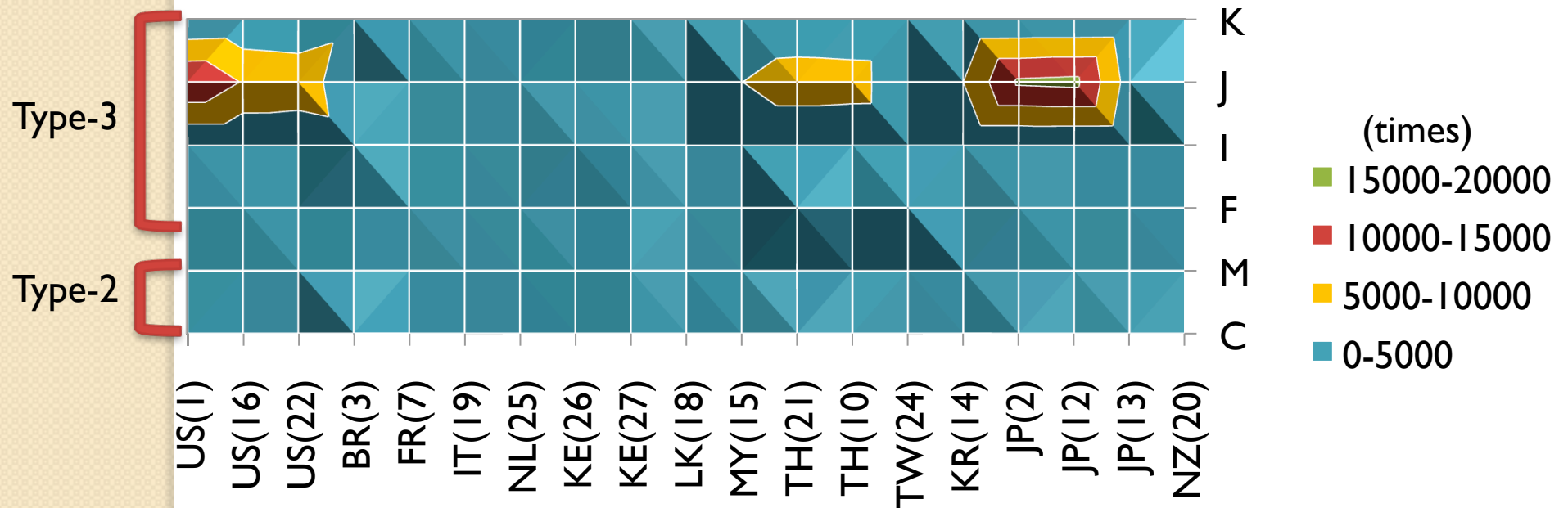




# Type-I Anycast ID

- Inside Sites
  - Load Balancing ...
- B
  - bl.isi.edu
  - b2
  - b3
- H
  - H1
  - H2
  - H3
- G
  - g.root-servers.net
  - g.root-servers2.net
- A
  - ns10-aroot
  - ns11-aroot
  - ns12-aroot
  - ns13-aroot
  - ns14-aroot
  - ns15-aroot .....

# Anycast Changes (Only Anycast Root)



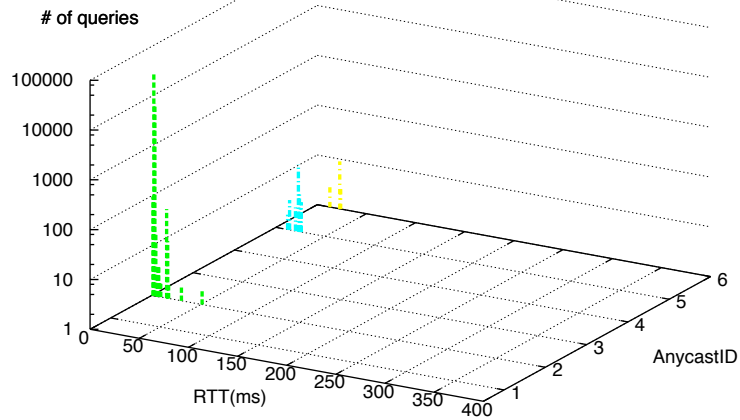
# Anycasting Operation

- A, B, G, H show load balancing of Hosts
- F/J ROOT has a lot of of Anycast sites.
  - F(46), J(52) locations as of Feb. 2009
- 2 Types of Anycast
  - Global Anycast
    - Announce Prefixes globally by BGP
    - J uses global anycast at many sites
  - Local Anycast
    - Announce Prefixes locally by BGP(NO-EXPORT)
    - F uses local anycast at many sites

# F-ROOT Anycast 1,4,16,22

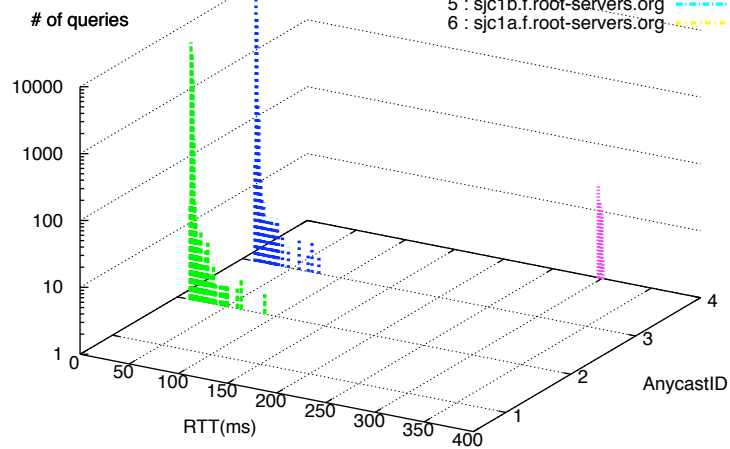
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Total Query TIMEOUT Rate = 0.322%



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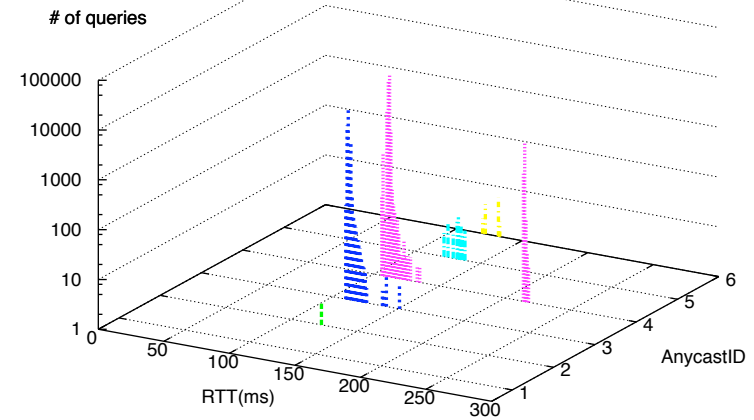
Total Query TIMEOUT Rate = 1.237%



2 : pao1a.f.root-servers.org  
3 : pao1b.f.root-servers.org  
4 : khi1a.f.root-servers.org

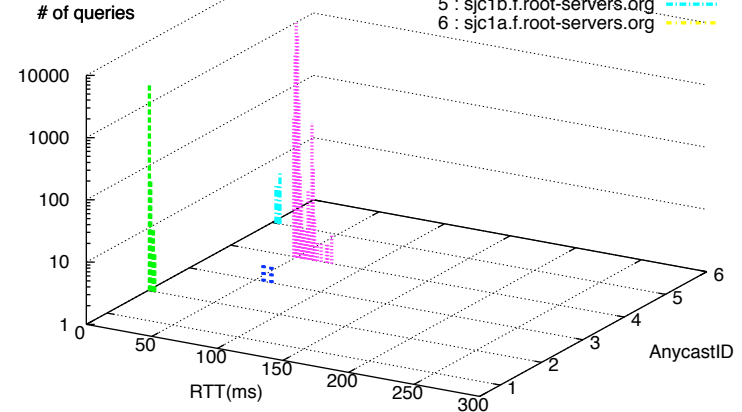
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Total Query TIMEOUT Rate = 0.500%



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Total Query TIMEOUT Rate = 0.197%



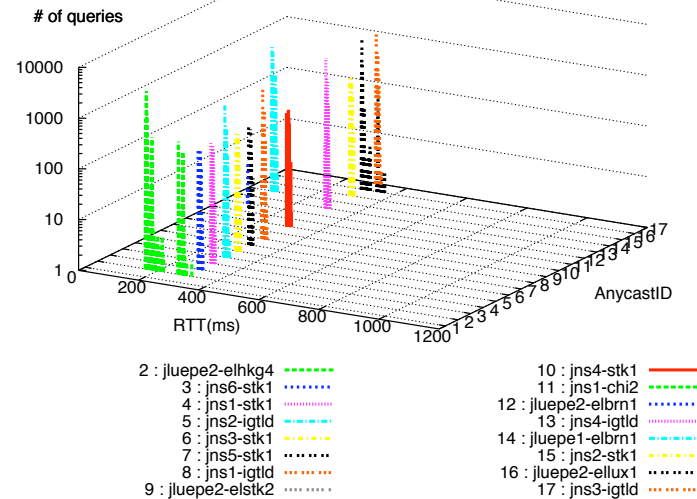
2 : ord1a.f.root-servers.org  
3 : pao1b.f.root-servers.org  
4 : sfo2a.f.root-servers.org  
5 : ord1b.f.root-servers.org  
6 : khi1a.f.root-servers.org

# J-ROOT Anycast

1,4,16,22

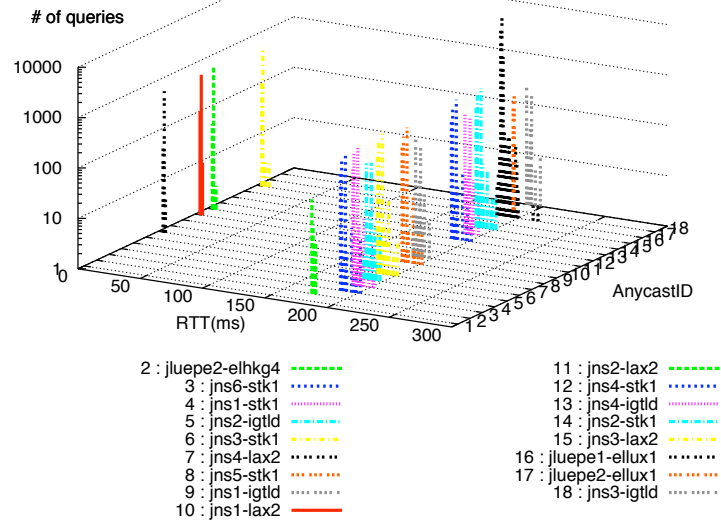
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Total Query TIMEOUT Rate = 0.405%



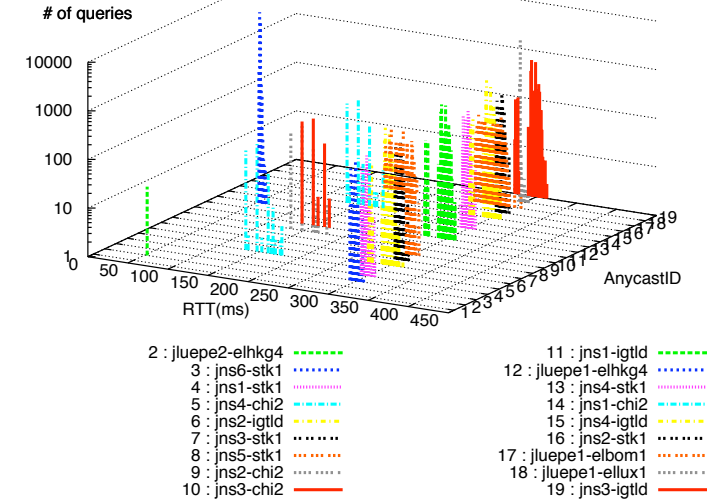
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Total Query TIMEOUT Rate = 0.216%



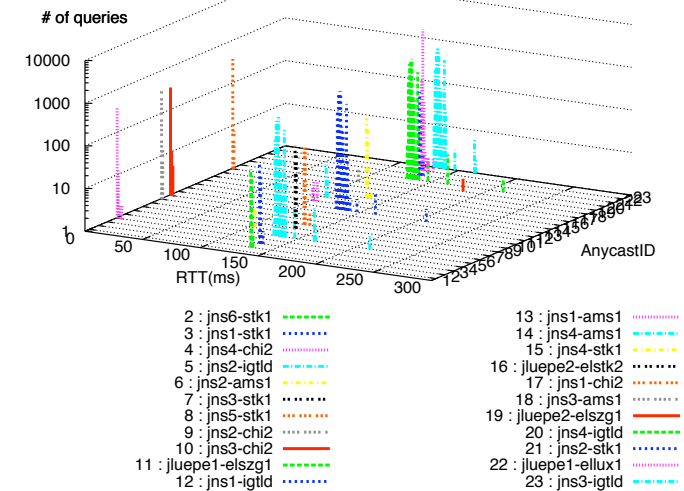
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Total Query TIMEOUT Rate = 0.147%



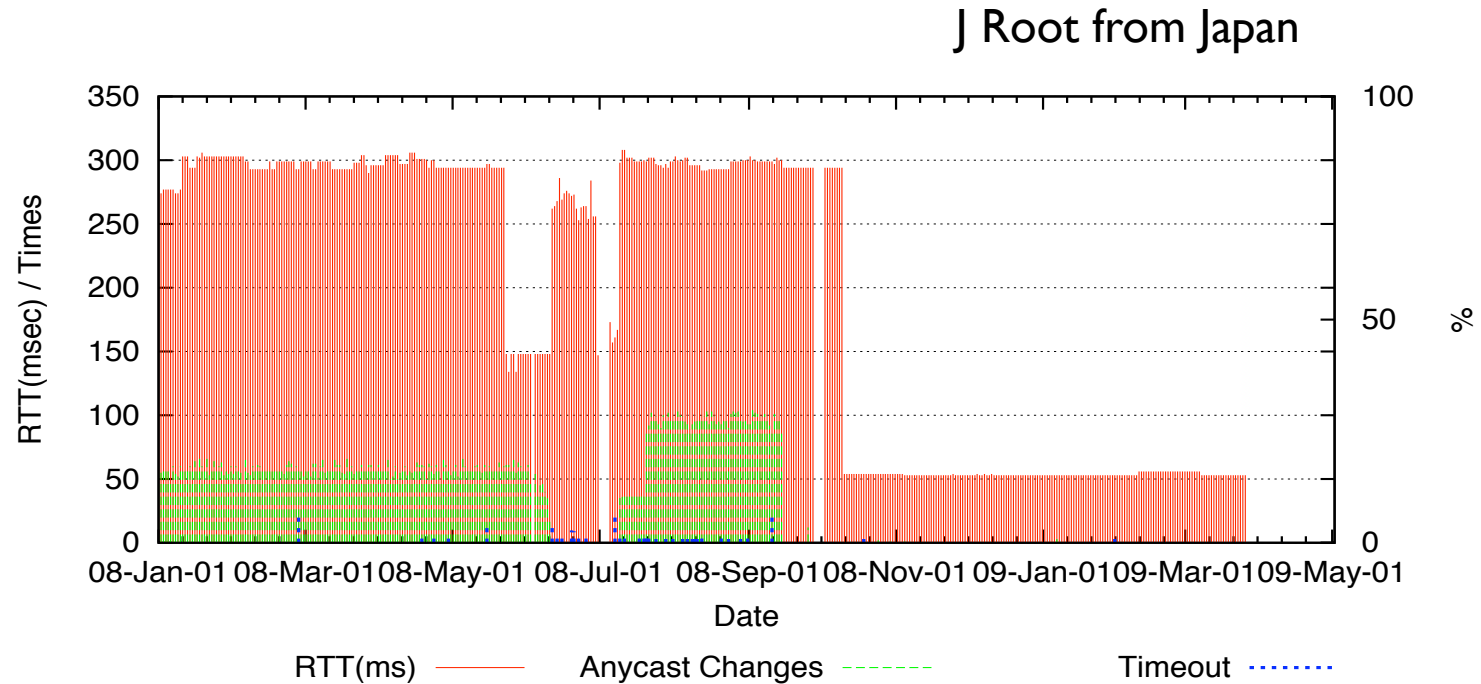
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Total Query TIMEOUT Rate = 0.127%

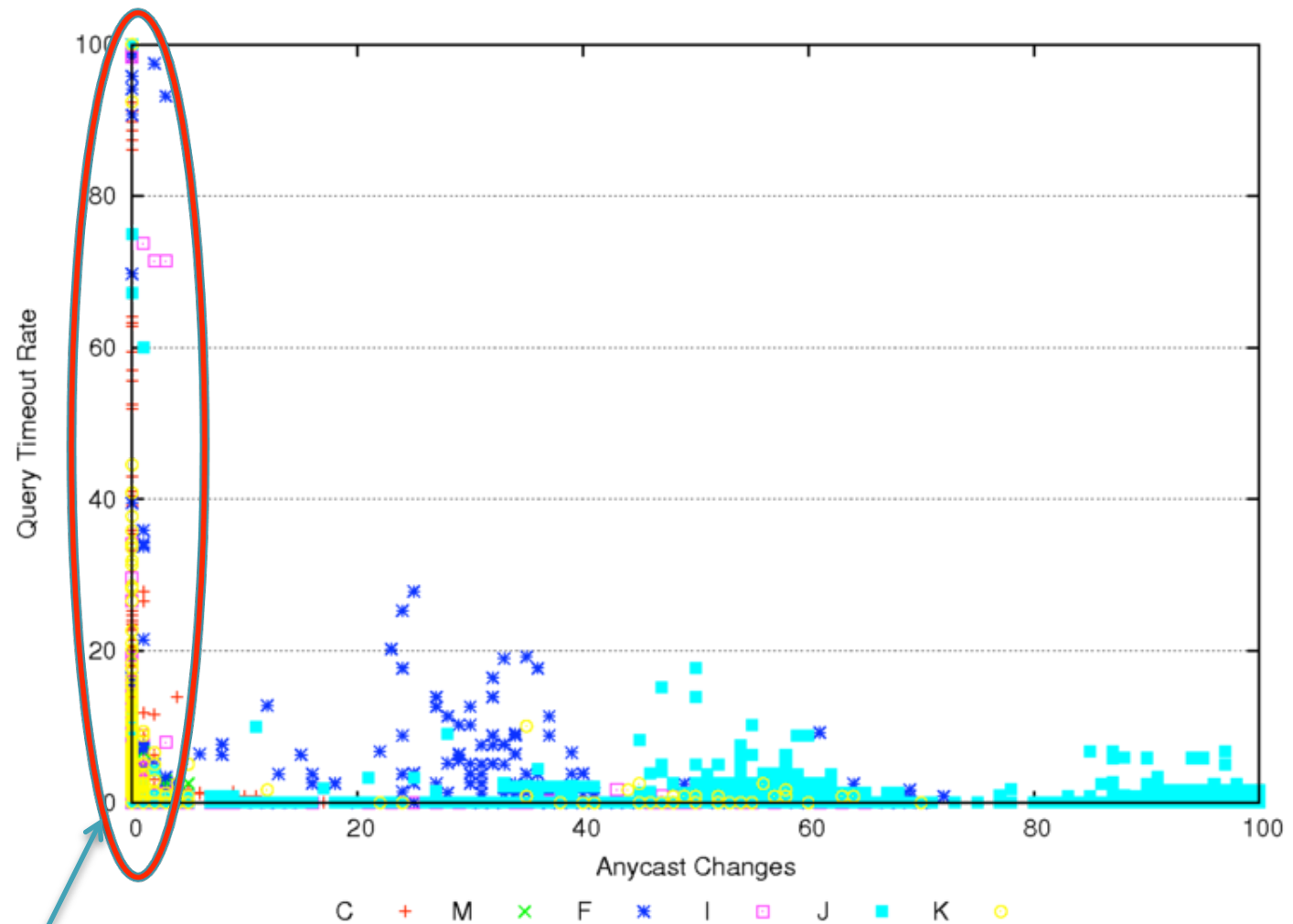


# Relation ?

- Anycast Changes
- RTT
- Query Timeout

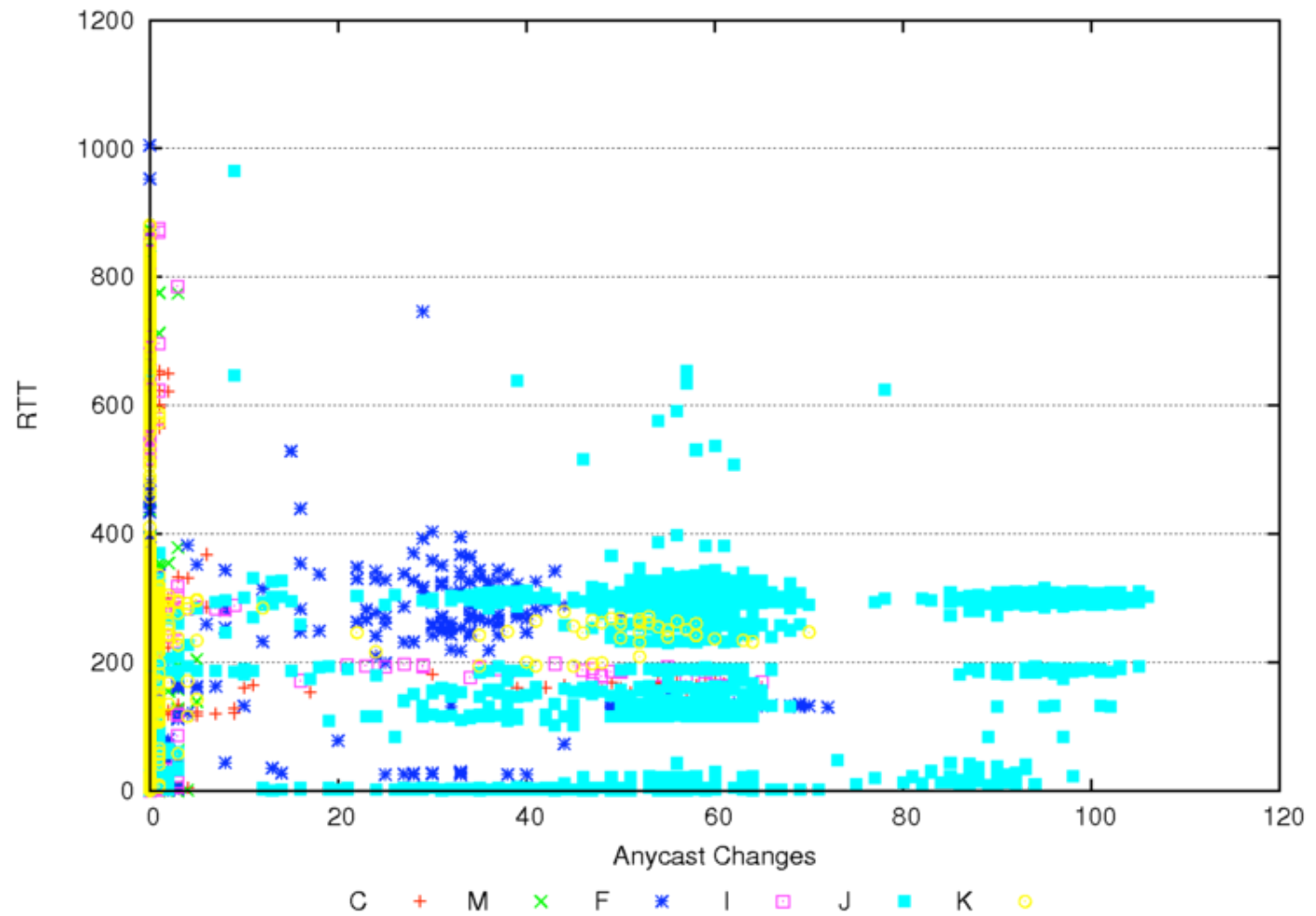


# Anycast v.s. Timeout



Probes at a few anycast changes show HIGH Timeout Rate ?

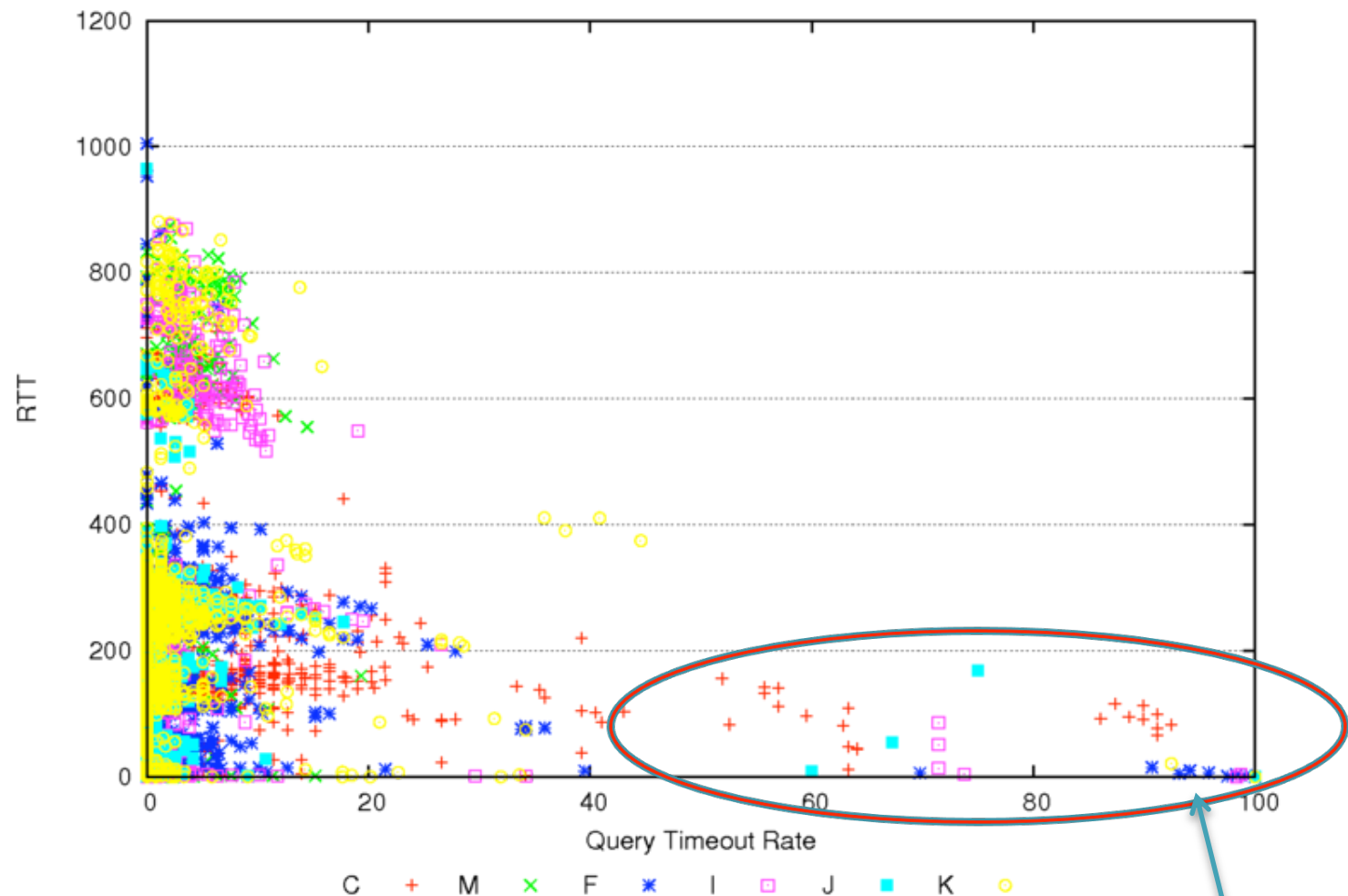
# RTT v.s. Anycast



RTT : Daily Average



# RTT v.s. Timeout



Probes at Smaller RTT show HIGH Timeout Rate ??

RTT : Daily Average



# Continuous Works

- Anycast v.s. Timeout
  - No direct relation
  - Need more analysis
- More Analysis
  - ccTLD and in-addr.arpa
- More Server
  - gTLD
- <http://gulliver.wide.ad.jp/>



# Need Partners

- Could you accommodate our measurement box ?
- One global IPv4 (IPv6) address is required.
- If you accommodate, we will issue login account on our member page. You can get a lot of measurement data from the page.