On the Use of Anycast in DNS

Sandeep Sarat
Johns Hopkins University
Vasileios Pappas
UCLA
Andreas Terzis
Johns Hopkins University
http://hinrg.cs.jhu.edu/
Background

• What is Anycast?
  - Client transparent mechanism to route packet to one of multiple servers in anycast group
  - Implemented via announcements of the same address prefix from multiple origins (IGP+EGP)
  - Deployed in top-level DNS nameservers
    • Reduction in query latency
    • Scalability
    • Availability
    • Resistance to DDoS attacks
Goal

- Measure the impact of anycast on DNS
  - Response times
  - Availability in terms of number and duration of outages
  - Constancy of server selection
  - Effectiveness of localization
What we tested

- **Base Case: Unicast server**
  - Test-case: B-Root (local load balancing)

- **Anycast Configurations**
  - **Hierarchical**
    - Test-Cases: F-Root (26 servers), K-Root (7 servers)
      - Explore the effect of number and locations of servers
  - **Flat**
    - Test-Case: Ultra DNS (8 servers *)
Measurement Methodology

- **Measurements using PlanetLab**
- **Special DNS queries to the anycast address from each PL site every [25-35] seconds**
- **Period of study: 3 weeks from Sept 19, 2004 to Oct 8, 2004**
- **Definitions**
  - Outage: Period of time when queries are unanswered (multiple of meas. period)
  - Flip: Client switches from one server to another

<table>
<thead>
<tr>
<th>Continent</th>
<th>% of PL nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>South America</td>
<td>0.5</td>
</tr>
<tr>
<td>Australia</td>
<td>1.8</td>
</tr>
<tr>
<td>Asia</td>
<td>15.8</td>
</tr>
<tr>
<td>Europe</td>
<td>16.7</td>
</tr>
<tr>
<td>North America</td>
<td>65.2</td>
</tr>
</tbody>
</table>
Response Times

- Anycast servers have lower response times
- UltraDNS TLD1 has the lowest query latency
- Among the rest, F-Root is the best
  - Reason: high geographic diversity
- Response times have high deviations
  - Due to instability as we will see later

<table>
<thead>
<tr>
<th>Server</th>
<th>Mean (ms)</th>
<th>Median (ms)</th>
<th>Std. dev. (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypo. Unicast*</td>
<td>93</td>
<td>51</td>
<td>207</td>
</tr>
<tr>
<td>min{TLD1,TLD2}*</td>
<td>69</td>
<td>51</td>
<td>173</td>
</tr>
<tr>
<td>TLD1</td>
<td>96</td>
<td>54</td>
<td>207</td>
</tr>
<tr>
<td>F-Root</td>
<td>75</td>
<td>70</td>
<td>85</td>
</tr>
<tr>
<td>TLD2</td>
<td>104</td>
<td>85</td>
<td>237</td>
</tr>
<tr>
<td>B-Root</td>
<td>115</td>
<td>95</td>
<td>121</td>
</tr>
<tr>
<td>K-Root</td>
<td>140</td>
<td>121</td>
<td>104</td>
</tr>
</tbody>
</table>

* Hypothetical cases comparison
Availability

- Percentage of unanswered queries < 0.9%
- TLD1, TLD2 have the largest number of outages
- F-Root has the least
  - Reasons (speculation)
    - Ultra DNS is single-homed
    - Longer Internet paths
- Average inter-outage time for same client is in the order of days
Outage Duration

All schemes show roughly the same behavior.
Constancy

- Constancy measured by frequency of flips between servers
- TLD1, TLD2 have most flips
- F-Root, K-Root have higher percentage of flips after an outage
- Majority of flips for F-Root and K-Root are between the global nodes

5 orders of magnitude
Effectiveness of Localization

• Question: Does anycast lead clients to the closest server?
• Direct comparison flawed due to different routing paths for unicast and anycast addresses
• Solution:
  - Compare path used by anycast to paths to all last hop routers

60% to 80% of clients go to the closest anycast server
Comparison of Strategies

• Hierarchical schemes have higher stability and availability
• Flat schemes are more effective in directing queries to the “closest” anycast instance
• Possible idea:
  – Tune parameter to adaptively change properties anycast scheme – Radius of announcement at each anycast node
Summary

- Anycast improves availability
- Other properties depend on the scheme used
- Trade-off between availability, stability and effectiveness of localization
- Caveats:
  - Results apply to Planet Lab environment
  - Support arguments using BGP data
  - Skew due to load on the anycast server
- For more:
  - http://www.cs.jhu.edu/~sarath/Anycast-TR.pdf