DNS PERFORMANCE
Impact of Caching

Performance of Object References

client
Network
server

client
Network
server

client
cache manager
Network
server

VS
Cache Design Issues

- **Size**
  - influences “hit ratio” (though DNS caches are typically not size-limited)
  - \( T_{\text{avg.}} = \text{hit\_ratio} \times T_{\text{avg.-cache}} + (1 - \text{hit\_ratio}) \times T_{\text{avg.-remote}} \)

- **Replacement**
  - free space for new data when full
  - Usually not critical for DNS caches, since most are not size-limited

- **(in)Validation**
  - does the cache hold “current” information?

- **Location**
  - memory vs disk (speed vs size)

DNS Resolution with Cache

```
resolver  nslookup www.cs.cmu.edu

QUERY: www.cs.cmu.edu
REPLY: cmu.edu (NS)
QUERY: www.cs.cmu.edu
REPLY: cs.cmu.edu (NS)
QUERY: www.cs.cmu.edu
REPLY: 128.2.209.79 (A)
```

```
root.edu                  NS      A.ROOT-SERVERS.NET       198.41.0.1
cmu.edu           NS      LANCELOT.NET.CMU.EDU   128.2.232.1
cs.cmu.edu      NS      MANGO.SRV.CS.CMU.EDU    128.2.222.180
www.cs.cmu.edu  A    128.2.209.79
```
DNS Resolution with Cache

nslookup ftp.cs.cmu.edu

QUERY: ftp.cs.cmu.edu
REPLY: 128.2.242.152 (A)

QUERY: ftp.cs.cmu.edu
REPLY: 128.2.242.152

edu. NS A.ROOT-SERVERS.NET 198.41.0.1
cmu.edu NS LANCELOT.NET.CMU.EDU 128.2.232.1
cs.cmu.edu NS MANGO.SRV.CS.CMU.EDU 128.2.222.180
www.cs.cmu.edu A 128.2.209.79
ftp.cs.cmu.edu A 128.2.242.152

CDF of DNS Lookup Latency

J. Jung et al, DNS Performance and the Effectiveness of Caching, Proceedings of IMW 2001
**DNS Latency with n Referrals**

J. Jung et al., DNS Performance and the Effectiveness of Caching, Proceedings of IMW 2001

- 0 referral
- 1 referral
- 2 referrals
- overall

80% of lookups

Avg # of queries ~ 1

% Lookups with n referrals

<table>
<thead>
<tr>
<th>mit-jan00</th>
<th>mit-dec00</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>74.62%</td>
</tr>
<tr>
<td>1</td>
<td>24.05%</td>
</tr>
<tr>
<td>2</td>
<td>1.15%</td>
</tr>
<tr>
<td>3</td>
<td>0.11%</td>
</tr>
<tr>
<td>≥4</td>
<td>0.04%</td>
</tr>
</tbody>
</table>

**DNS Latency with Query to Root**

J. Jung et al., DNS Performance and the Effectiveness of Caching, Proceedings of IMW 2001

- Root Lookups: 401,231 (16%) 270,643 (6.4%)
- Root Errors: 59,363 (2.3%) 3,309 (0.4%)
- gTLD Lookups: 41,854 (1.6%) 3,295 (0.4%)
- gTLD Errors: 2,676 (0.1%) 6,341 (0.3%)

NS cache hit
NS cache miss
Most Popular Names vs % Requests

J. Jung et al, DNS Performance and the Effectiveness of Caching, Proceedings of IMW 2001

~ 46% names accessed only once. Implication?

TTL Distribution

J. Jung et al, DNS Performance and the Effectiveness of Caching, Proceedings of IMW 2001

How do large TTLs for NS records help?
Is Caching Effective: Using Trace-driven Simulation

- **Goal:** study effect of group size and TTLs on cache hit rates
- **Use traces to:**
  - Derive databases of:
    - IP-to-name mapping
    - largest-TTL values
  - Randomly divide TCP clients into groups of size $s$
- **Simulate a shared DNS cache for each group**
  - For each new TCP connection in the trace,
    - Use src IP addr to identify group
    - Use dest IP address to identify domain name client would have looked up
      - Since not all DNS queries would appear in the trace
    - Record hit/miss based on group's simulated cache; update cache on miss

Issues?
- Multiple domain names map to same IP address
- Clients belong to several caching groups (multiple local DNS servers)

A-record Cache Sharing vs Hit Ratio

J. Jung et al., DNS Performance and the Effectiveness of Caching, Proceedings of IMW 2001

Most benefits of sharing obtained with 10-20 clients per cache

With no sharing, avg hit rate is 60-70%!
Zipf-like distribution of name popularity
A-record TTL vs Hit Ratio

J. Jung et al, DNS Performance and the Effectiveness of Caching, Proceedings of IMW 2001

Using small TTLs not likely to affect hit rates much

Same TTL simulated for all names

Is Caching Effective: Using Trace-driven Simulation

- Per-client or per-application caching of A records can almost entirely handle the job of reducing client-latency
- Not a good idea to reduce TTL values on NS-records (or for A-records for name servers)
  - Would increase the load on root and gTLD servers by a factor of 5!
  - Local proxy-based caching helps significantly reduce load on root servers
Mean DNS Time for 15,000 Names (from 75 Sites)


% Total DNS Time for 15,000 Names (75 Sites)