Computer Networks

Assignment-5

Code - CSA0735

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Scenario :- An ISP wants to optimize DNS lookup using caching.

Questions :-

a.) How does TTL affect DNS caching?

In DNS caching, the Time to live (TTL) value determines how long a DNS resolver (like an ISP's server) can cache a DNS record before it needs to be refreshed from the authoritative name server. A higher TTL means the resolver holds the record longer, reducing the number of DNS lookups and improving performance, but updates to the record take longer to propagate. Conversely, a lower TTL means more frequent lookups but faster updates.

In essence, TTL represents a trade-off between caching efficiency and responsiveness to DNS changes. A longer TTL is suitable for records that change infrequently, while a shorter TTL is

better for records that change more frequently

For example :- a website with a static homepage might use a longer TTL, while a website with a frequently updated blog might use a shorter TTL

b.) Estimate average saving in latency if cached queries save 200ms for 10,000 users

Given :-

Latency saved per cached query = 200ms

Number of users = 10,000

Total Latency saved :-

Total latency Saved = 200ms X 10,000 = 2000000ms

Convert to seconds :-

$$2000000\text{ms} = \frac{2000000}{1000} = 2000 \text{ seconds}$$

Convert to minutes :-

$$\frac{2000}{60} \simeq 33.33 \text{ min}$$

If cached DNS queries Save 200ms per user then across 10,000 users, the total latency Saving is 2000 seconds and 33.33 min in total

This means the ISP saves about 33 min of total user waiting time just from one round of DNS lookup optimization. If each user performs multiple queries per day, the cumulative savings are much higher.

C.) Compare local Vs public DNS resolvers.

Feature	Local DNS Resolver (ISP, Internal)	Public DNS Resolver (Google, Cloudflare, OpenDNS, etc)
Ownership	Maintained by ISP or private organization (eg. university)	Provided by third-party public DNS services
Examples	ISP DNS, Enterprise DNS (using BIND)	Google (8.8.8.8) Cloudflare (1.1.1.1) OpenDNS (208.67.222.222)
Proximity	Typically geographically close to the user	May be farther, but optimized using global CDNs
Performance	Faster for local or ISP-cached domains	Often faster for global domains due to better caching

Caching Efficiency	Good for repeated requests within a local network	High-efficiency caching with anycast and global load balancing
Configuration	Default in most ISP setups or enterprise network	Manually set by the user on their devices / routers
Privacy	May log user activity Subject to ISP's privacy policy	Varies by provider (eg. cloudflare claims no logging of ISP.)
Security Features	Limited, unless custom DNSSEC or filtering is added	Many public resolvers offer DNSSEC, phishing protection and DOH / DOT
Reliability	Dependent on local infrastructure	Highly reliable with distributed global infrastructure
Customization	High (admins can set rules, filters blacklists)	Limited customization per user.
use cases	Internal Company networks, ISPs Controlled environment	General public usage, faster access to global content, Privacy.

d.) Suggest prefetching stategies.

Prefetching stategies aim to improve performance by loading data into the cache before it's needed, reducing latency when the data is actually accessed. These strategies can be broadly categorized into hardware prefetching, software prefetching, and hybrid approaches.