Assignment 2: A Case Study on CDNs, Streaming Services and DNS Traffic Management

In this assignment, you will explore how Content Delivery Networks (CDNs), DNS traffic management, and reverse proxies are utilized to enhance global content delivery in general and also for steaming services. The assignment will focus on platforms such as Google Cloud CDN, Google Media CDN, Cloudflare CDN, Akamai CDN, technologies like anycast, reverse proxy, load balancer and streaming services like Netflix and JioCinema. You will also perform a detailed analysis of DNS Resource Records (RRs) of popular websites across different networks.

Part 1: DNS Resource Record Analysis over two networks (40% of the marks)
1. DNS Resource Record (RR) Analysis:
   • Task: Use tools like dig or nslookup (or online tools, refer to References in slide deck posted on GC) to analyze DNS Resource Records (A, AAAA, MX, CNAME, etc.) for google.com, facebook.com, and netflix.com.
   • Do the above experiment on two different networks:
      • Network 1: A campus network (e.g., IITH LAN or Wi-Fi).
      • Network 2: A mobile network provided by a cellular carrier (e.g., 4G/5G).
   • Submission Requirement:
      • Record the DNS responses (with all RR types) for each network, providing the resolved IP addresses, TTL values, and other relevant data.
      • Analyze and compare the results between the two networks. Explain any differences in the TTL values, time taken for resolution, IP addresses, or resolver behavior.
      • Explain how DNS caching might influence the results based on your observations.
      • Include screenshots of your dig or nslookup results for each network.
   • Analysis: Compare the DNS records across networks. Discuss whether different CDNs are being used or if DNS responses are optimized for particular geographic regions. Hypothesise how Anycast routing or Geo-DNS impacts these results.

Part 2: CDN Architecture Analysis

1. CDN and Multi-CDN Optimization: (30% of the marks)
   • Task: Based on your DNS observations and research on CDNs (e.g., Google Cloud CDN, Akamai, Cloudflare), describe how a multi-CDN strategy could be employed to optimize content delivery for a global streaming service of yours like that of Netflix or JioCinema.
   • Submission Requirement:

   • For Google Media CDN or Netflix's Open Connect, discuss how it optimises video streaming and adaptive bitrate streaming to deliver high-quality content even under fluctuating network conditions using technologies like anycast routing, load balancers, reverse proxies, etc.

      • Create a network diagram showing how CDNs and reverse proxies can be used in your global streaming service to improve content delivery and security. Your diagram must illustrate how DNS plays a role in directing users to the nearest edge server.
      • Justify your CDN selection and explain why a multi-CDN setup would be effective. Consider geography, traffic patterns, latency, and failover strategies for the multi-CDN optimiser.

   • Comparison:
      • Compare your proposed architecture to Netflix Open Connect or Google Media CDN and explain how your design mitigates potential bottlenecks and handles spikes in user demand (e.g., during live events).

2. Reverse Proxy and Security: (30% of the marks)
   • Task: Many organizations use reverse proxies to protect their origin servers and enhance content delivery. Explain how Cloudflare acts as a reverse proxy for websites, and how it improves both performance and security.
   • Submission Requirement:
      • Explain the interaction between reverse proxies, DNS, and CDNs in the delivery of web content. Highlight the importance of SSL termination, DDoS protection, and content caching at the proxy level.
   • Analysis:
      • Explore how Google Global Load Balancer and Cloudflare use reverse proxies differently. Discuss which solution you would choose for your platform and why.

- Report Structure:
  - The report should include the following sections:
    - Introduction
    - Data and Observations (from dig, traceroute, etc.)
    - Analysis (based on CDN architecture, reverse proxy use cases)
    - References (cite all external resources, diagrams, articles, blogs, videos). Cite at least 3 technical blogs or industry articles or youtube videos (refer to the section on suggested reading below), 1-2 research papers, and official documentation (e.g., from Akamai, Google, Cloudflare, JioCinema, Netflix) in your report.

- Word Count: 3000–5000 words.
- Format: Submit as a google doc
- Tools to Use: dig, nslookup, traceroute, online tools, Wireshark (optional).

Suggested Resources for research:

1. Akamai: Visit [Akamai CDN](#) for whitepapers and technical documents on their CDN and DNS infrastructure.
2. Google Cloud CDN: [Google Cloud CDN Documentation](#) provides insights into CDN architecture and caching techniques.
3. Netflix Open Connect: [Netflix Open Connect](#) offers an overview of their custom CDN.
4. Cloudflare: [Cloudflare Learning Center](#) explains CDN, reverse proxy, and DNS optimization strategies.
5. Google Public DNS: Explore [Google Public DNS](#) to understand how DNS caching and resolver networks enhance global performance.

☐ **Additional Reading and viewing Material:**
   1. https://www.akamai.com/glossary/what-is-a-cdn
   2. https://www.cloudflare.com/en-gb/learning/
   3. https://cloud.google.com/blog/products/networking/media-cdn-origin-offload-does-trick-for-warner-bros-discovery
   4. https://cloud.google.com/cdn?hl=en
   5. https://cloud.google.com/load-balancing/docs/https

6. https://cloud.google.com/load-balancing/docs/application-load-balancer#use-cases
7. https://blog.jiocinema.com/tag/cdn/
8. Cloud CDN: Delighting Users with Low Latency, Intelligent Media and Web Delivery (Cloud Next '18)
9. FAST '21 - Keynote Address: Netflix: Streaming Entertainment to 200 Million Members Around the World
10. Akamai Tech Talks: DNS protocol
11. Cloud OnAir: Networking 104 - Everything You Need to Know About Load Balancers on GCP
12. CDNs 101: An Introduction to Content Delivery Networks - Jake Ginnivan - NDC Oslo 2023

Anti-Plagiarism Statement:

By submitting this assignment, I certify that the work presented here is my own, based on my personal research, observations, and understanding. I affirm that:
•   All data, diagrams, and content used from external sources (e.g., blogs, articles, papers, videos, podcasts) have been appropriately cited and acknowledged in the report.
•   Diagrams or visuals borrowed from online sources have been clearly credited, and I have provided my own explanations or insights for all included visuals.
•   This assignment has not been copied in part or whole from any other student or individual, and I have not used pre-written solutions or responses generated by LLMs (e.g., ChatGPT) without significant personalization, verification, and adaptation.
•   If I used any AI-based tools, I have appropriately acknowledged their usage and ensured that the work has been refined through my own understanding and knowledge.
•   I understand that failure to adhere to these guidelines may result in penalties for academic misconduct, as outlined by the institution's policies.

I also pledge to uphold the principles of honesty and integrity during this course and report any violations of the academic code of conduct if I become aware of them.