M7024E Laboratory 1: Getting Started with a Public Cloud

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Lab Report

Question 1

How does CDNs work? What is a difference between a traditional CDN and a Cloud-based CDN? Provide an in-depth discussion with examples and figures.

a) How does CDNs work?

Content delivery networks (CDNs) are referred as geographically distributed network of servers at various locations across the globe that provides fast delivery of Internet content/services (e.g. HTML pages, JavaScript files, images, audios and videos etc) by caching the web content in proxy servers near to user physical location. [1] It distributes the content from an "origin" server throughout the world by caching content close to where each end user is accessing the internet via a web-enabled device. The content user requests is first stored on the origin server and is then replicated and stored elsewhere as needed. [2]

b) What is the difference between a traditional CDN and a Cloud-based CDN? Provide an in-depth discussion with examples and figures.

There are several differences between typical CDN and cloud-based CDN but few of them are listed below with an in-depth explanation. [1][2][3]

1. **System Design:**

   A traditional CDN consists of origin servers (including load balancing DNS server and source server) and point of presence (i.e. caching server) where the source server stores source content and pushes it to the caching server in order to serve the end users where as in CCDN the content provider puts content in the cloud and a master is responsible content distribution and allocates an appropriate location for the content and saves a fixed number of copies in other area.

2. **Bandwidth Utilization:**

   In a typical CDN system, when the request to content is made for the first time, the caching server needs to pull the specified content from the origin server that makes the bandwidth utilization rate of origin server to increase, where as CCDN supports the mechanism of: pipelining copy which allows replication of data on list of nodes. So in case a caching server lacks the requested content, and the edge of the server on the other position has the requested content, content can be obtained from this server which decreases the bandwidth utilization rate of origin server as well as its cost.

3. **Cost-Effective Scaling:**

   Based on the increasing number of users and growth of network traffic, a typical CDN system needs to increase its physical infrastructure to meet the user requirements. Whilst, CCDN provides cloud orchestration and offer its users to manage cloud resources and consume delivery content using pay-as-you-go model.

4. **Increased point of presence (caching servers):**

   CCDN system provides an ease of moving content closer to the user due to the omnipresence of the cloud than the typical CDN. CCDN can rent the operating resources from cloud

providers and apply global load balancing strategy which reduces the cloud congestion and user access delay to increase the reach and visibility of CDN on-demand.

5. **Data Fragment Caching:**

   CDN cloud provider uses a caching mechanism according to streaming media and user behavior features. For instance, most of the video users just watch a small part of the video so the content provider origin server only stores the prefix of audio/video media and the remainder of the content is cached when user is playing the content. Since cloud storage mechanism is based on blocks, the master splits the content into some data blocks (fragments) with fixed size to utilize the cache server more efficiently and reduce user's response time.

6. **Content Creation:**

   In typical CDNs, services to create and manage internet content sources are not provided to its end users; such as a creating a video using an existing internet content source and combining it with a new content source. On the other hand, CCDN provides this facility to its end users to act as both content creator and consumer.

7. **Cloud Storage:**

   Cloud-based CDN allow its users to store, manage and deliver a great amount of data (e.g. media, documents etc) in cloud storage and access it from anywhere around the world with high reliability, scalability and fast speed.

8. **Cloud Security:**

   CCDN provides its customers high performance and secure services by combining CDN security with the cloud based distributed infrastructure. Unlike CDN, it supports advanced standards and methods of security such as PCI compliance, secure socket layer and digital rights management to offer protection to its end users.

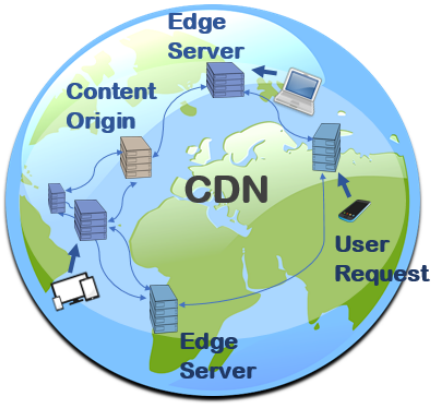

Figure 1: Typical CDN Architecture

Figure 2: CCDN Architecture [4]

Question 2

List major CDN providers in the CDN marketplace. Compare two CDN providers based on at least five characteristics. For example, number of edge locations.

Some of the major CDN providers are as following:

1. StackPath
2. Akamai
3. Cloudflare
4. KeyCDN
5. Microsoft Azure CDN
6. Google Cloud CDN
7. CacheFly
8. Amazon CloudFront
9. Leaseweb
10. Rackspace
11. Sucuri

Comparison between CDN providers

Key Features	CDN Provider	
	Cloudflare	Amazon CloudFront
Cities with Network	250	90+
Countries with Network	100+	47
DDoS Protection	Yes	via AWS Shield
Configuration Method	Nameserver	Special URLs
Live Video Stream	No	Yes
Image Optimization Support	Yes	No
Network Architecture	Reverse-proxy	Push-pull approach
Pricing	Flat charges	Pay as you go
WAF	Yes	Yes

Table 1: Cloudflare vs AWS CloudFront

Cloudflare has a much larger and widespread content delivery network as compared AWS CloudFront [5] [6]. Cloudflare makes use of reverse proxy network architecture to manage data and requests. Website is configured to use Cloudflare name servers which manages the incoming requests. While CloudFront makes use of push-pull approach such that copies of data called distributions are made which are served to the user using special URLs [7]. Cloudflare is suitable to use when the whole website or a sub domain needs to be optimized or protected, as Cloudflare as in built DDoS protections. Moreover, Cloudflare has a generous free tier plan and premium plans have a flat monthly fee. Whereas CloudFront is ideal to use when particular type of data or files needs to be optimized as it is based on pay as go model.

Question 3

Test your CDN distribution using a number of methods and explain the results.

To determine the effectiveness of using CDN distributions we created two S3 AWS Buckets one in Stockholm and the other in Sydney along with 2 AWS CloudFront distributions for CDN.

Experiment 1: Using Curl

In this experiment bash script was used to execute curl request to measure web page response time 100 times with a delay of 5 seconds between each request. Client requests were sent from the laptop located in Skellefteå, Sweden. Following results were obtained:

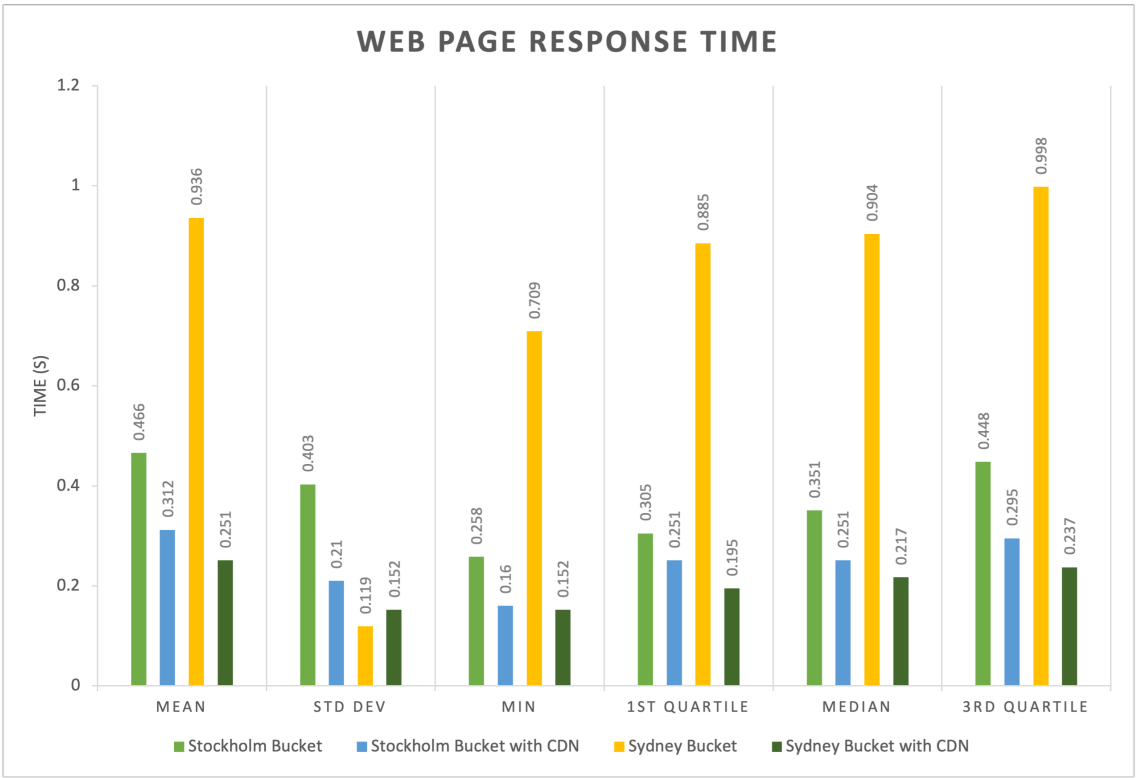

Figure 3: Measuring web page response time using curl

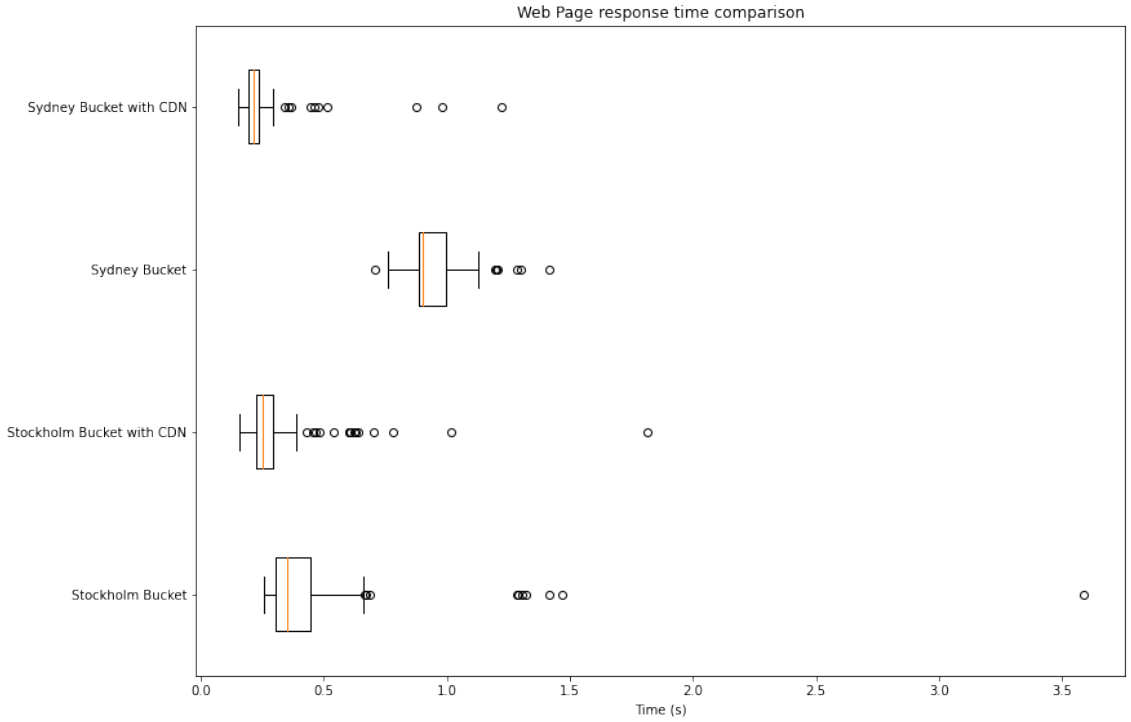

Figure 4: Box Plot

Figure 3 shows the comparison between CDN vs Non CDN distribution for web page response time

for Stockholm and Sydney. When no CDN distribution was used, mean response time for loading page from Sydney was 2x as compared to loading page from Stockholm. Since the requesting client is located in the Skellefteå, relative distance to Stockholm is relatively less compared to Sydney hence the response time is less. However, when CDN distribution was used to access web page response time significantly improved regardless of the location where the content is hosted. When a CDN distribution is used, it tries to deliver the content from the closes location to reduce the latency, and hence low response time as shown in figure 3 and 4.

Experiment 2: Using Grafana

In this experiment same buckets and CDNs were used as experiment 1. Grafana web tool was used to measure web page response latency. The clients (or the probes) were located in Amsterdam, Atlanta and Sydney. The figures below show how the latency varies with different locations and with the use CDN distribution.

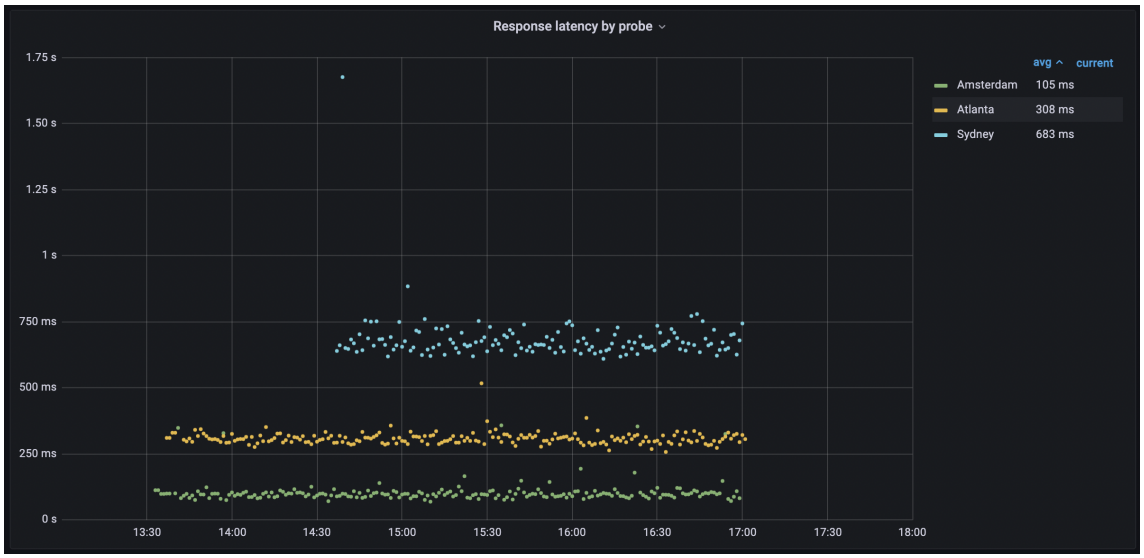

Figure 5: Stockholm Bucket

Figure 6: Stockholm Bucket with CDN

Figure 5 shows variation in the response time when page is accessed from Amsterdam, Atlanta and Sydney using non-CDN distribution. Since our bucket is hosted in Stockholm, Amsterdam has the least latency while Sydney has the highest.

Figure 6 shows when a CDN distribution is used to serve content, latency dramatically reduces and response time is not affected by the clients location

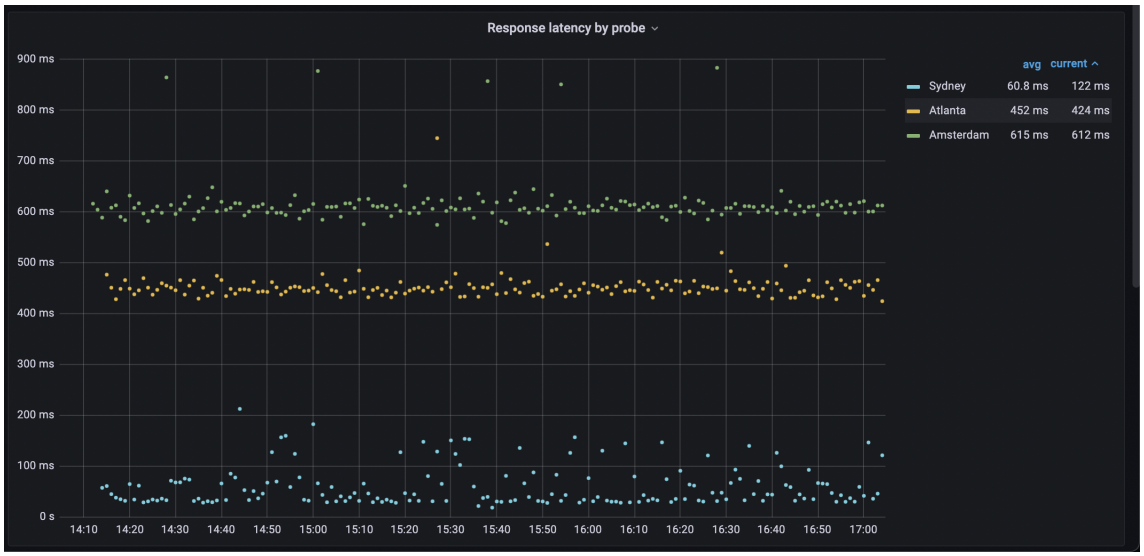

Figure 7: Sydney Bucket

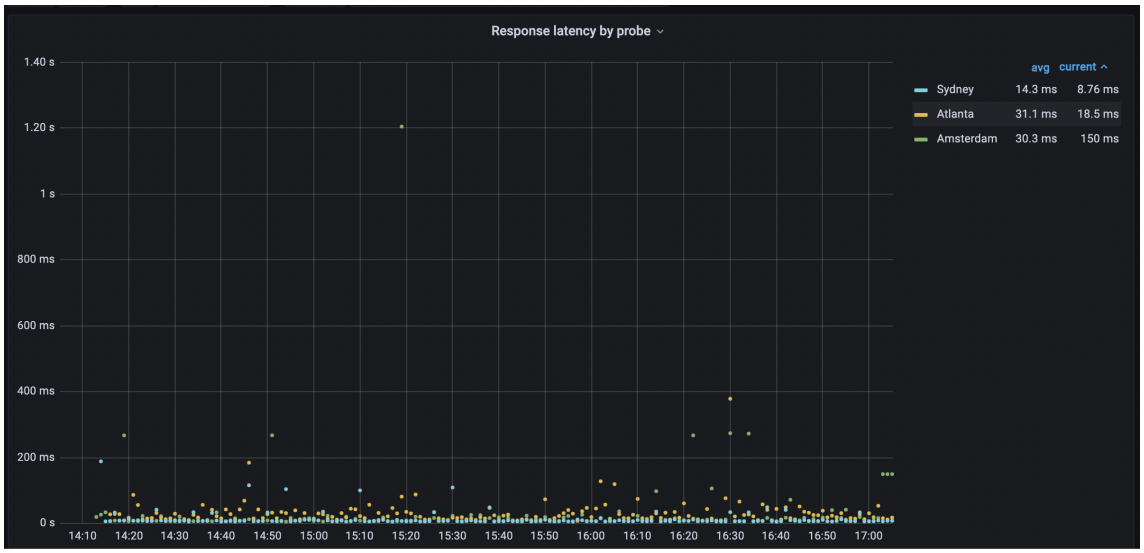

Figure 8: Sydney Bucket with CDN

Figure 7 and 8 show similar results as above. In this case content is served from a bucket in Sydney. When a non-CDN distribution is used latency is highest when content is accessed from Amsterdam and lowest from Sydney. Similarly, when a CDN distribution is used, response latency remains almost the same regardless of the clients location.

Above results show that by using CDNs website response time can significantly improve. This is especially beneficial for those businesses where response time is critical or to ensure smooth experience for the customers. Moreover, since a website expects visitors from all across the globe by using CDNs a similar experience can be ensured for all the users (depending on CDN network).

References

[1] M. Wang, P. P. Jayaraman, R. Ranjan, K. Mitra, M. Zhang, E. Li, S. Khan, M. Pathan, and D. Georgeakopoulos, *An Overview of Cloud Based Content Delivery Networks: Research Dimensions and State-of-the-Art*. Springer Berlin Heidelberg, 2015, vol. 9070, p. 131–158. [Online]. Available: http://link.springer.com/10.1007/978-3-662-46703-9_6

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