CSE 486/586 Distributed Systems
Content Distribution Networks

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Understanding Your Workload

• Engineering principle
  – Make the common case fast, and rare cases correct
  – (From Patterson & Hennessy books)
  – This principle cuts through generations of systems.

• Example?
  – CPU Cache

• Knowing common cases == understanding your workload
  – *E.g.*, read dominated? Write dominated? Mixed?
Content Distribution Problem

- **Power law** (Zipf distribution)
  - Models a lot of natural phenomena
  - Social graphs, media popularity, wealth distribution, etc.
  - Happens in the Web too.
Content Distribution Workload

• What are the most frequent things you do on Facebook?
  – Read/write wall posts/comments/likes
  – View/upload photos
  – Very different in their characteristics

• Read/write wall posts/comments/likes
  – Mix of reads and writes so more care is necessary in terms of consistency
  – But small in size so probably less performance sensitive

• Photos
  – Write-once, read-many so less care is necessary in terms of consistency
  – But large in size so more performance sensitive
Facebook’s Photo Distribution Problem

- “Hot” vs. “very warm” vs. “warm” photos
  - Hot: Popular, a lot of views
  - Very warm: Somewhat popular, still a lot of views
  - Warm: Unpopular, but still a lot of views in aggregate
“Hot” Photos

• How would you serve these photos?
  • Caching should work well.
    − Many views for popular photos
• Where should you cache?
  − Close to users
• What’s commonly used these days?
  − CDN
    − CDN mostly relies on DNS
• “Very warm” and “warm” will be covered later
Content Distribution Networks (CDNs)

Content replication
• CDN company installs thousands of servers throughout the Internet
  − In large datacenters
  − Or close to users
• CDN replicates customers’ content
• When provider updates content, CDN updates servers
Content Distribution Networks

- Replicate content on many servers
- Challenges
  - How to replicate content
  - Where to replicate content
  - How to find replicated content
  - How to choose among replicas
  - How to direct clients towards a replica
How Akamai Works

cnn.com (content provider) ➔ DNS root server


HTTP

1 2

End-user

Akamai global DNS server

Akamai regional DNS server

Nearby Akamai cluster

Akamai cluster
How Akamai Works

cnn.com (content provider) → DNS root server → cache.cnn.com → DNS lookup → ALIAS: g.akamai.net → End-user
How Akamai Works

cnn.com (content provider) → DNS root server

1. End-user
2. DNS lookup
3. g.akamai.net
4. ALIAS
5. a73.g.akamai.net
6. DNS server

Akamai global DNS server

Nearby Akamai cluster

Akamai regional DNS server

Akamai cluster
How Akamai Works

cnn.com (content provider) DNS root server

End-user

DNS a73.g.akamai.net

Address 1.2.3.4

Akamai global DNS server

Akamai regional DNS server

Nearby Akamai cluster

Akamai cluster
How Akamai Works

cnn.com (content provider) → DNS root server

End-user

GET /foo.jpg
Host: cache.cnn.com
How Akamai Works

cnn.com (content provider) → DNS root server

End-user

GET /foo.jpg

Host: cache.cnn.com
How Akamai Works

cnn.com (content provider) → DNS root server

1. DNS query from end-user
2. Forwarded to Akamai global DNS server
3. Redirected to Akamai regional DNS server
4. Forwarded to nearby Akamai cluster
5. DNS query resolved
6. Content requested
7. Content delivered to end-user
8. Acknowledgment sent to DNS server
9. DNS server updates DNS cache
10. Future requests redirected to nearby Akamai cluster
11. Akamai cluster responds to DNS server
12. DNS query completes
Summary

- **Content Distribution Networks**
  - Deliver *popular content* for content providers
  - Improve performance by *moving content closer to users*
  - Improve reliability by *duplicating content*
  - Use DNS to redirect traffic to local mirrors
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