Content Distribution

Today
- Challenges of content delivery
- Content distribution networks
- CDN through an example
Trends and application need

- Some clear trends
  - Growing number of and faster networks
  - Growing availability and demand for content

- For applications, higher demand on performance and reliability
  - Small degradation are expensive in lost revenue ($2.8m/hour in 2009)
  - … damage reputation
  - … reduced productivity
Internet delivery challenges

- Peering point congestion
- Inefficient routing protocols
- Unreliable networks
- Inefficient communication protocols
  - TCP can be a serious bottleneck to video delivery
- Scalability – under and overprovisioning costs
- Application limitation and slow rate of change adoption
  - IE6 still in use (<1%)

<table>
<thead>
<tr>
<th>Distance (server to user)</th>
<th>Network RTT</th>
<th>Typical packet loss</th>
<th>Throughput</th>
<th>4GB DVD download time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local &lt;100mi</td>
<td>1.6ms</td>
<td>0.6%</td>
<td>44 Mbps (high quality HDTV)</td>
<td>12min</td>
</tr>
<tr>
<td>Regional 500-1,000mi</td>
<td>16ms</td>
<td>0.7%</td>
<td>4 Mbs (basic HDTV)</td>
<td>2.2hrs</td>
</tr>
<tr>
<td>Cross-continent</td>
<td>48ms</td>
<td>1.0%</td>
<td>1 Mbps (SD TV)</td>
<td>8.2hrs</td>
</tr>
<tr>
<td>Multi-continent ~6,000mi</td>
<td>96ms</td>
<td>1.4%</td>
<td>0.4 Mbps (poor)</td>
<td>20hrs</td>
</tr>
</tbody>
</table>
Content delivery

- The common answer
  - Replicate content around the world, closer to users
  - Bring users to the closest content

- A few ways to do this
  - Content distribution networks, “deep into ISPs” or “bring ISPs to home”
  - Peer-to-peer
  - Hybrid peer-assisted CDNs
Distributing content through CDNs

- Content provider determines which of its objects it wants the CDN to distribute
- Content provider tags and pushes content to CDN, which replicates and pushes the content to its servers
- A CDN provides a mechanism for
  - Replicating content on multiple servers in the Internet
  - Providing clients with a means to determine the servers that can deliver the content fastest
- An example with Akamai, a “deep into ISPs” CDN
  - Placing replica servers at ISP’s POPS
  - Closeness to end users for performance and reliability
  - Costly to maintain that many servers, control, replicate content, etc
Components of a delivery network

- End users
- Edge servers
- Transport system
- Origin
- Customers
- Communication and control system
- Mapping
- Data collection and analysis
- Management portal
When a browser is asked to get www.cnn.com, how does it know it should go to the CDN or from CNN?

- Users get an html document from www.cnn.com; this could be index.html
- index.html uses a modified URL for replicated content
- Example: If the jpeg files are what has been replicated then
  - `<img src="http://cnn.com/af/foo.jpg">
    may be modified as follows:
  - `<img src=http://a73.g.akamai.net/7/23/cnn.com/af/foo.jpg>`
CDN through an example

- What does this mean?
  
  `<img src=http://a73.g.akamai.net/7/23/cnn.com/af/foo.jpg>`
  
  - host part: a73.g.akamai.net
  - Akamai control part: /7/23
  - Content URL: /af/foo.jpg
CDN redirection

- The browser needs to resolve a73.g.akamai.net hostname for replicated content.
- All DNS queries for g.akamai.net are sent to an authoritative DNS server for g.akamai.net.
- Based on the IP address and information that it has about the Internet (called a map), the IP address of an Akamai regional server is returned to the requesting browser based on policy.
CDN through an example

Client requests translation for cnn.com

Client gets CNAME entry with domain name in Akamai

Multiple redirections to find nearby edge servers

End user

Client is given 2 web replica servers (fault tolerance)
CDN redirection

- Akamai IPs are cached at local DNS server
  - Not always necessary to go to the root DNS server
  - TTL associated with the IP address of an Akamai edge server is relatively small

- If content is not there
  - Edge server gets it from others
  - Or eventually from origin

- One tricky part, selecting the right edge server
  - Want to spread load evenly
  - Want minimal impact if server is added or removed
Edge server selection

- Selection based on network proximity and server load
  - CDNs leverage DNS for dynamic routing
- Edge server sends measurement results to the CSS
  - Include number of active TCP connections, HTTP request arrival rate, bandwidth availability, etc
Accounting

- Accounting mechanisms collect and track information related to request routing, distribution and delivery.
- Information is gathered in real time and put into log files for each CDN component.
- Also sent to CCS
CDNs – models and markets

Much more than Akamai

- Over 30 commercial CDNs: Amazon CludFront, BitGravity, CacheFly, CDNetworks, ChinaCache, CloudFare, Cotendo, Distil Networks, EdgeCast, Limelight, MaxCDN, Speedera, …
- A few non-commercial ones: BootstrapCDN, CloudFare, Coral, Incapsula
- Some from Telcos: AT&T, Bell, DT, Telecom, Telefonica, Level 3, …
Ubiquity of CDNs

Visit cnn.com...

34 DNS lookups

204 HTTP requests

520 KB of data downloaded
Ubiquity of Content Delivery Networks

56% of domains resolve to a CDN
Ubiquity of CDNs

- And it’s not just cnn.com...

74% of the top 1000 web sites use CDNs

74% of the top 1000 web sites use CDNs
Summary

- CDNs are conceptually a virtual network
  - Higher performance, reliability, security …
  - Works on the existing Internet as-is

- Alternatively, a clean slate re-design of the Internet could address the challenges
  - Sunk investment and entrenched adoption means the architecture will change slowly