

Content Distribution Networks

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CSE 124

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Content Distribution Networks: Why?

- Offload traffic from content providers
 - Allow sites to focus on core expertise rather than building scalable web services
 - Reduce operational costs for service providers
- Improve client perceived-latency
 - Move content closer to end clients
 - Performance often dominated by network latency

Not bandwidth!
- Problem: www.cnn.com (traditionally) maps to a single machine in the network
 - How to redirect client requests to closest/best replica?

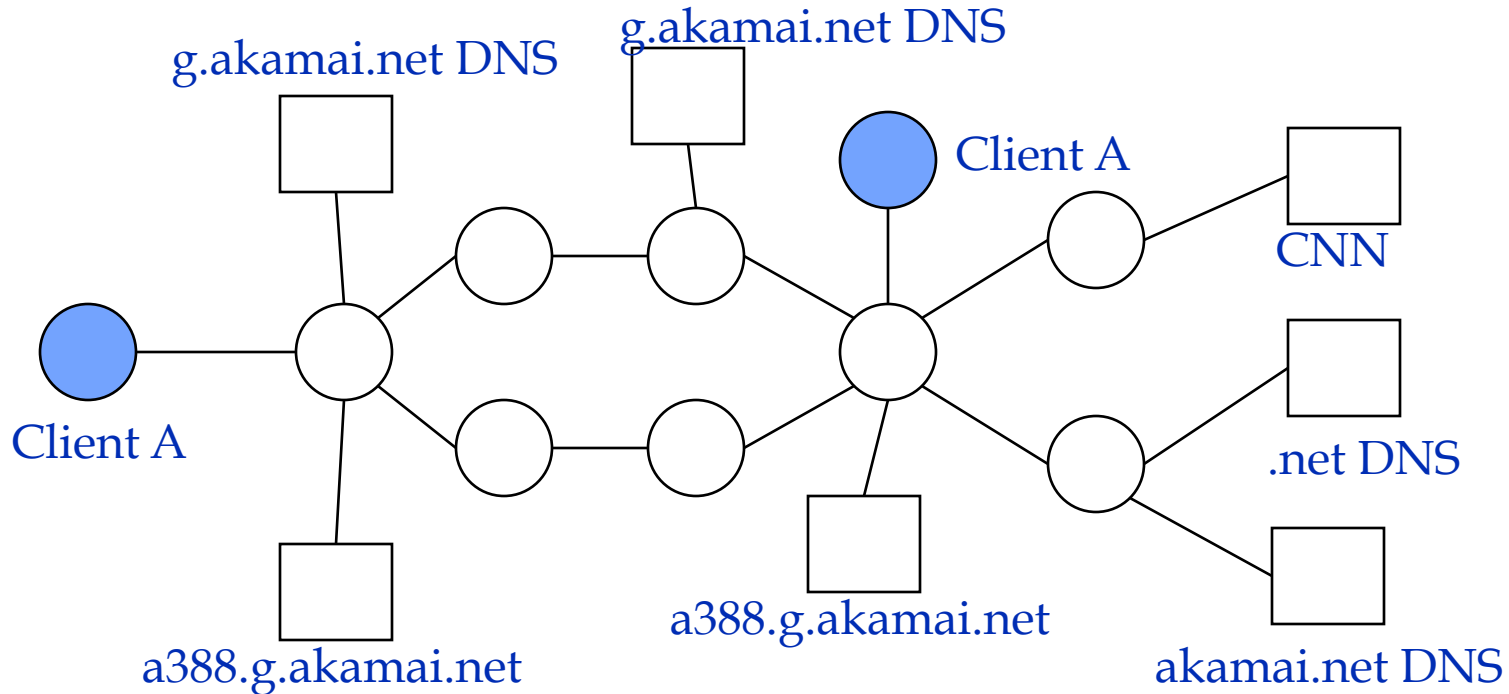
Edge-service advantages

- Fast
 - Content and applications are served from locations near to end users
- Reliable
 - No single point of failure
 - Automatic failover
- Scalable
 - Global capacity on demand
- Cost effective
 - No over-provisioning
 - No redundant datacenters
 - Simple to manage
- Secure
 - Traffic harder to steal
 - Defense in depth protects central infrastructure

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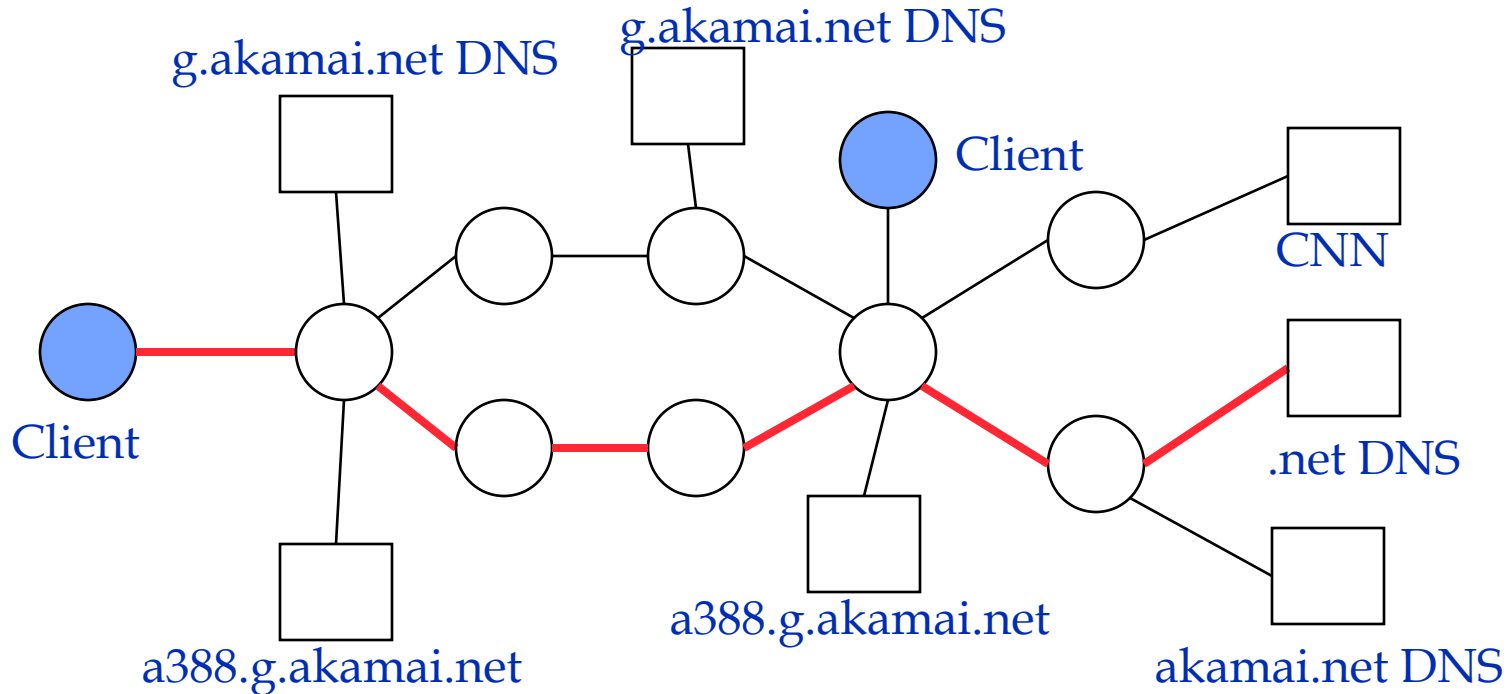
- CDN' s propose to host web site images/audio/video
 - Images often make up more than 90% of web traffic
- One problem with replication is *consistency*
 - How do you keep your cached copies up to date?
 - By focusing on multimedia, largely eliminate consistency problems
- The future
 - Web moving increasingly toward *dynamic content*
 - How will CDN' s support replication in this case? (ESI' s)
 - Consistency, centralized databases, authentication
 - Access logs

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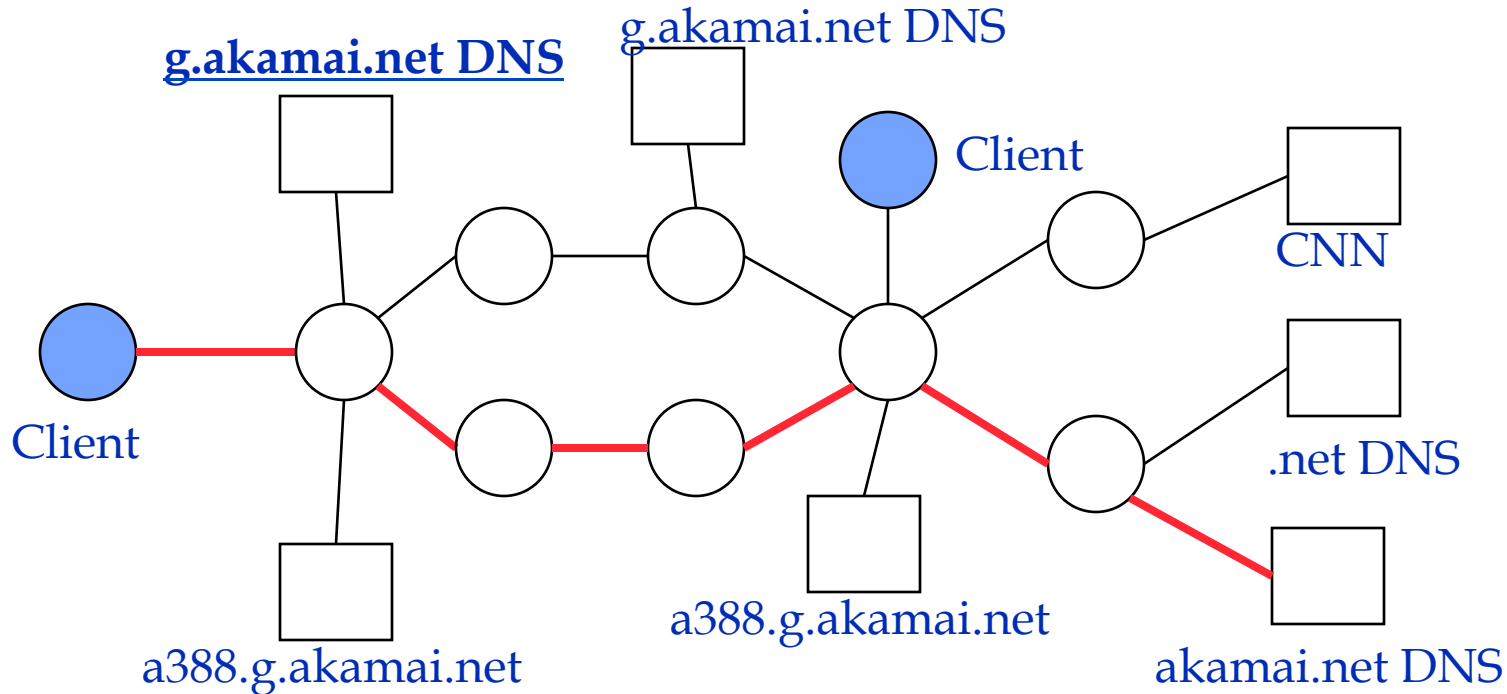
- Goal: quickly/efficiently deliver static content to clients
 - E.g., Akamai, Adero

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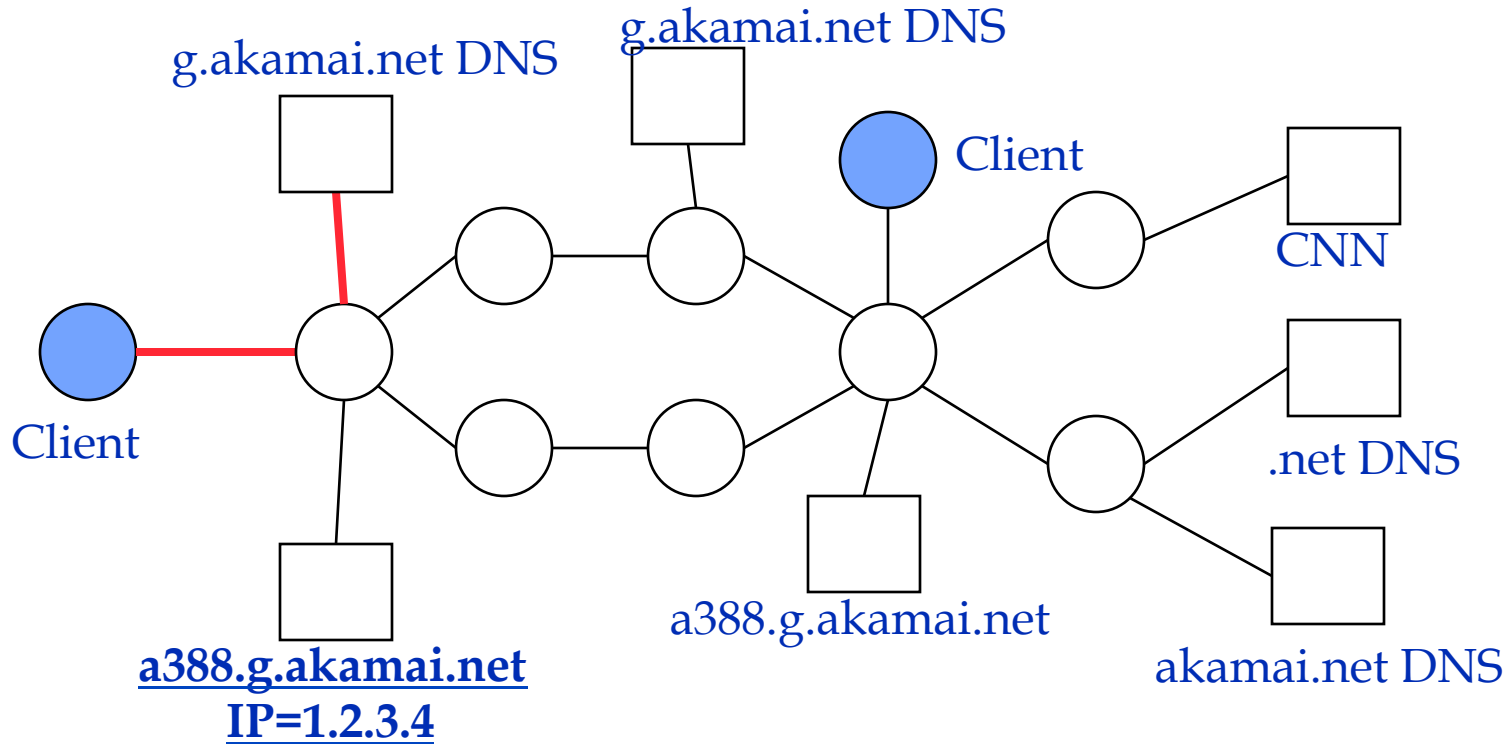
- Lookup akamai.net from .net DNS server
 - Cache reply (48 hour timeout)

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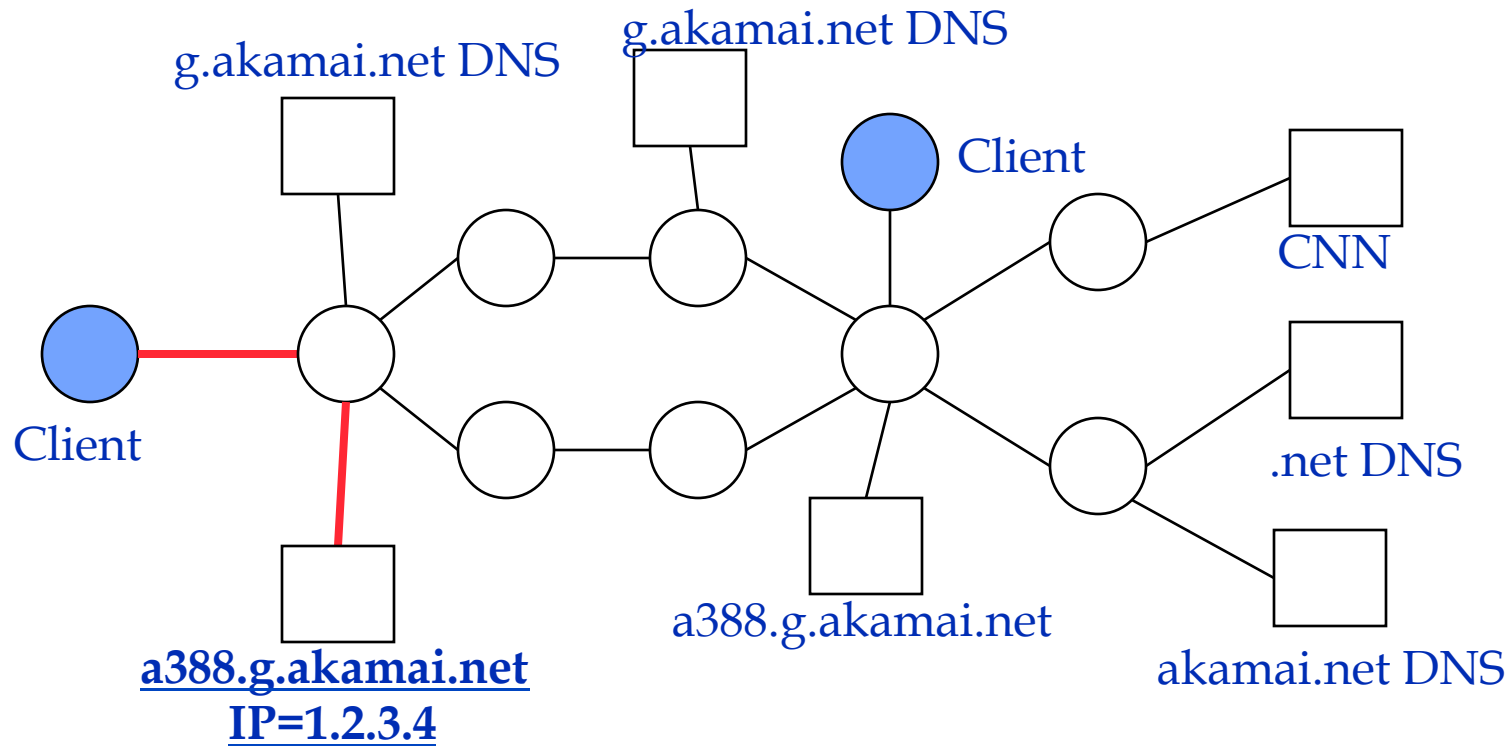
- Lookup `g.akamai.net` from `akamai.net` DNS server
 - Get nearby DNS server; Cache reply (30 minute timeout)
 - How do they know where nearby is?

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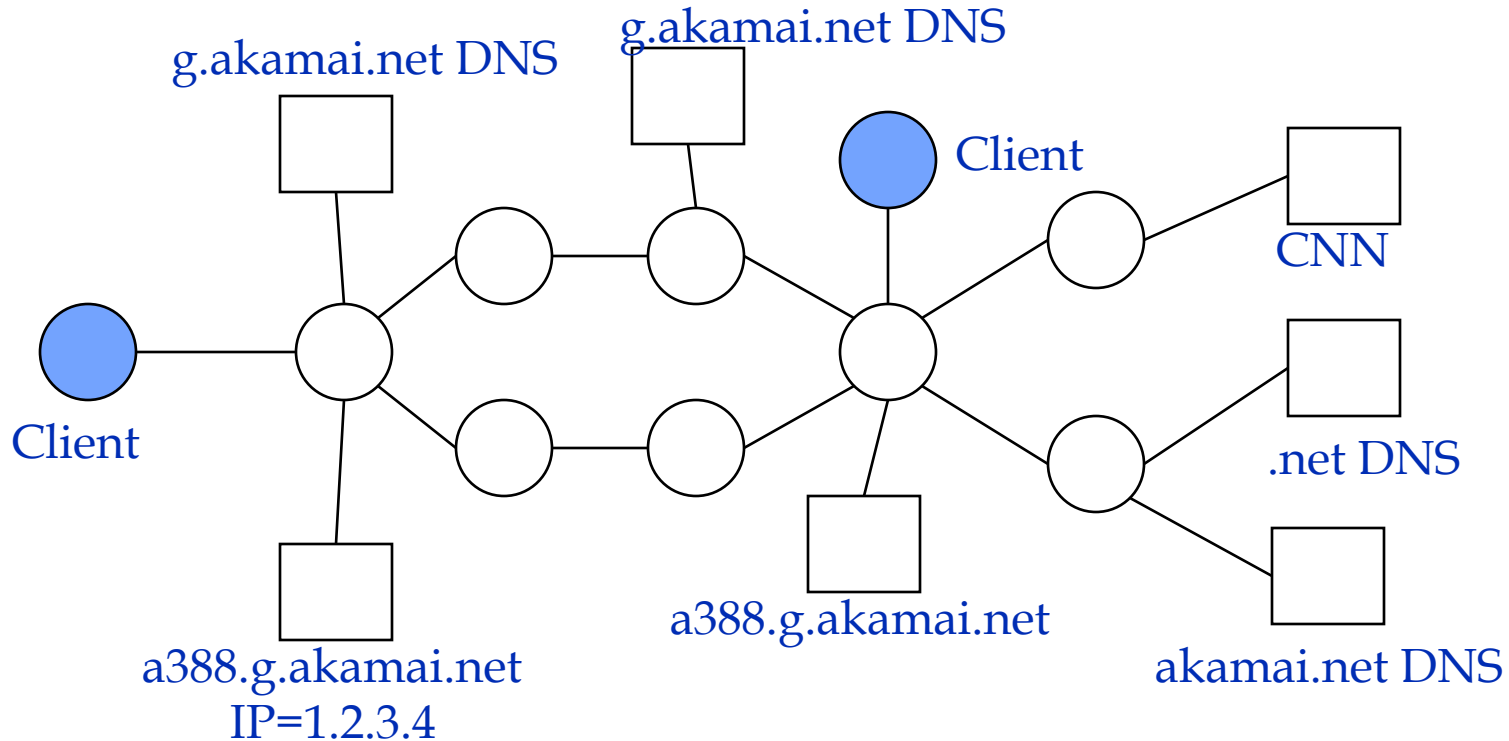
- Lookup a388.g.akamai.net from g.akamai.net DNS server
 - Get nearby replica location; cache reply (30 second timeout)

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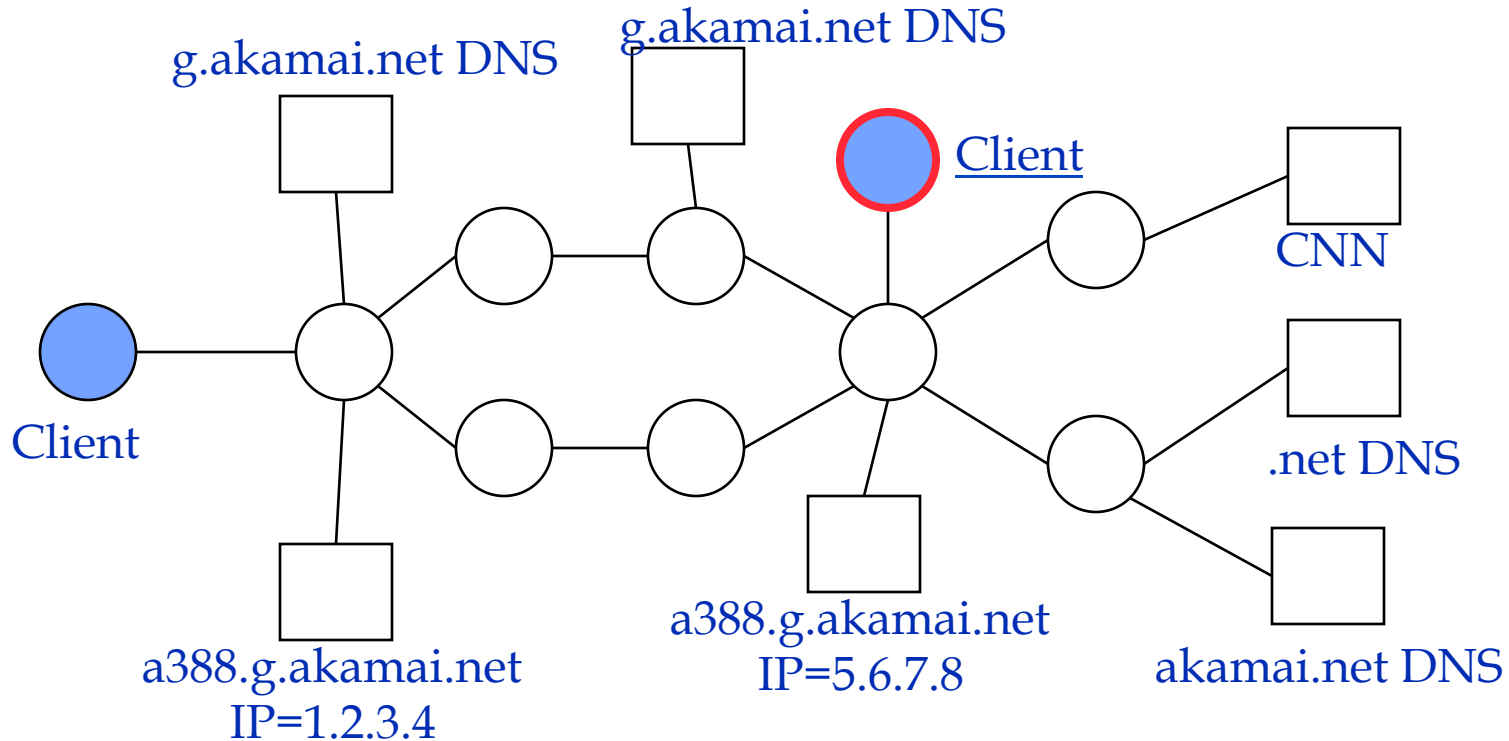
- Retrieve content from nearby server

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- A few minutes later, Client wishes to retrieve another page
 - What happens if IP 1.2.3.4 is overloaded?

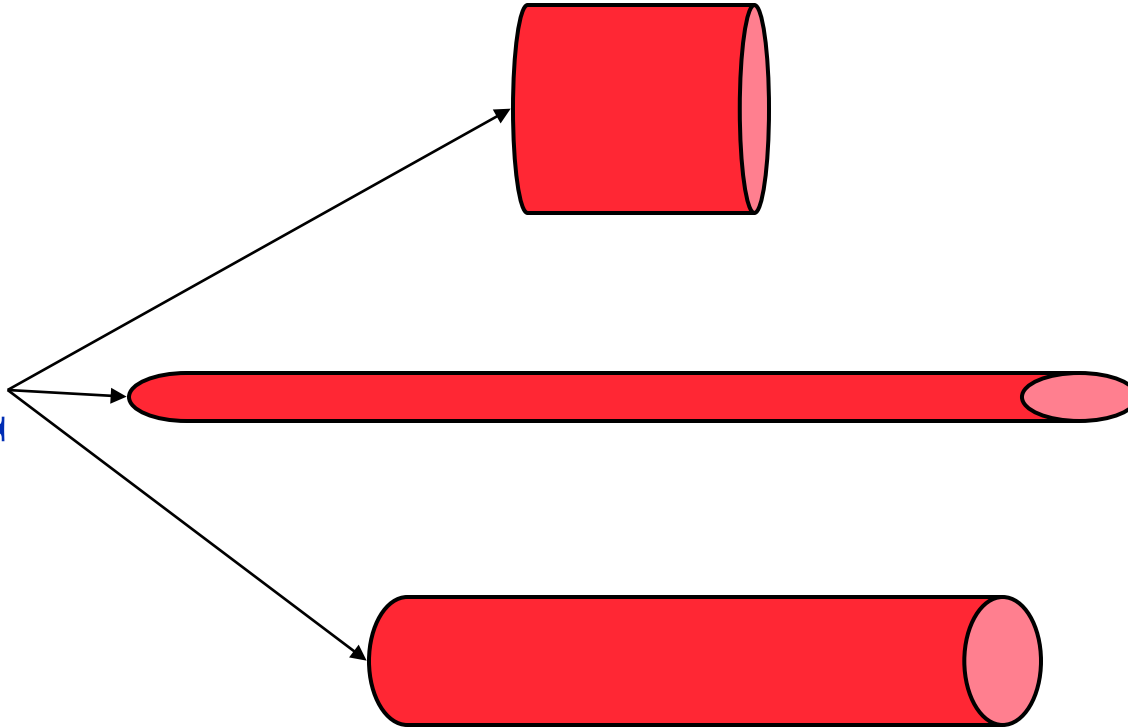
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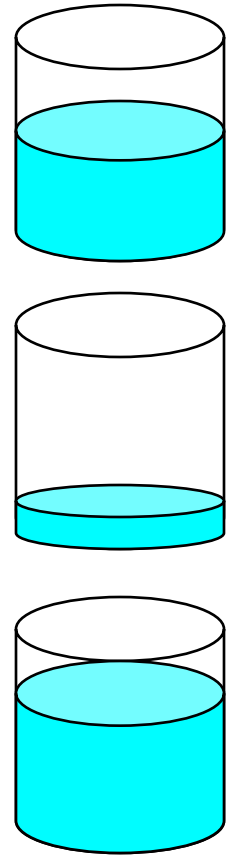
- What would happen if a client in another part of the network requested CNN content?

Request Routing

Requests



Network



Replicas

Architectural Discussion

- Typically cache DNS lookups for days
 - Akamai overloads DNS lookup for load balancing
 - Allows for fine-grained redirection of client requests to appropriate replicas
- Akamai turns one round trip request into two
 - But... the two round trips could be to closer sites
 - Relies upon retrieval of relatively large objects to amortize cost of first round trip (for DNS lookup)
- What is Akamai optimizing for?
 - Consumed bandwidth? Client-perceived latency?
 - Who is paying Akamai?

Content Distribution Networks: Motivation

- Four bottlenecks
 - The first mile
 - Peering points
 - Network backbones (bandwidth is not free)
 - The last mile
- Where is traffic coming from (2000)
 - How many ISP's make up 95% of network traffic?
 - What are the top ISP's as measured by traffic?

Content Distribution Networks: Motivation

- Four bottlenecks
 - The first mile
 - Peering points
 - Network backbones (bandwidth is not free)
 - The last mile
- Where is traffic coming from (2000)
 - 95% of traffic from 7000 ISP' s (Zipf distribution again)
 - Heavy tailed distribution (sum of top 10 is less than 20%)
 - UUNET (6%), at home (4%), AOL (3.6%)
 - Only 10 networks have more then 1%

Akamai Measurements (2000)

- Peak backbone bandwidth ~200 Gbps
 - Small cable channel with 100k subscribers would consume 30 Gbps
- Akamai Network deployment
 - 6200 servers, 400 networks, 54 countries

Akamai Measurements (2005)

- 15,000+ servers
- 2,400+ Locations
- 1,000+ networks
- 70 countries
- 80+ gigabits/sec of traffic
- 50+ billion hits per day
- 10-15% of the world's web traffic
- 18,000 web sites, 1,300 recurring revenue customers

Building out the Akamai Network (2000)

- Akamai goal: convince all 7000 ISP' s that make up 95% of traffic to deploy 1 or more Akamai servers
- Values for ISP' s
 - Increased QoS for subscribers
 - Decreased cost for transit
 - Easy revenue stream from delivery
 - Satellite transport (11 mb/s usenet feed)
 - Network monitoring tools
 - (free)

Performance (2000)

- Average speedup of 2-46 times
 - Median of 7x, 86% reduction in download time
 - Peak speedup is 3-136 with a median of 13
- Consistent performance
 - For all 94 sites, the CDN reduced the standard deviation of download by 30-92%
- Availability and Reliability
 - CDN reduced the error rate by 30-100% for all sites

Components of a CDN

- Network performance monitoring
 - What to measure? active/passive, how to measure?
 - More than 10 million data points a second
- Server performance monitoring (disks, CPU, network, processes, hardware)
 - Usage and capacity monitoring (usage by object, storage usage per server/region, network utilization)

Resource Management/Server Selection

- Takes as input data about system state and needs to connect users to servers
- Optimize performance while managing:
 - Traffic, server load, fault tolerance and reliability, storage, hit rate, load for multiple types of traffic, multiple server resources
- Must be truly distributed and fault tolerant (must tolerate failure of multiple components without ever disrupting service)
- Must work with imperfect information and in an unreliable environment
 - >150,000 requests/sec at peak

Log Collection and Processing

- Scale to handle 10s of billions of hits per day
- Distributed collection and filtering
- Scalable processing and data mining infrastructure
 - Needs to have short delay (cannot wait a day to deliver data to customers)
 - How many unique users? What are the paths through their web sites?
- Loading into server 300 GB/day

Akamai HTTP Server

- Event kernel for performance
- Native SSL, cookie support, authentication, DRM, dynamic content generation, XSLT processing
- Streaming Servers (streaming qt, real g2, windows media)
 - A few Gb' s traffic in each of the 3 streaming formats