

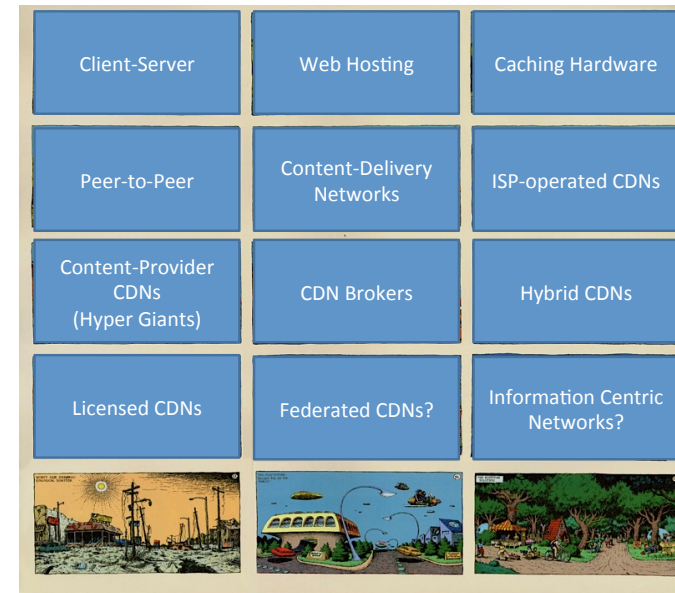
The Role of Content Delivery Networks in an Information Centric Network

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Duke University
Akamai Technologies

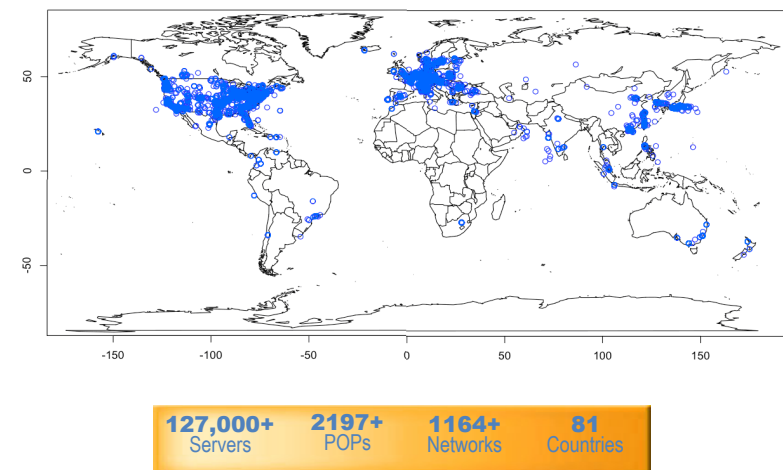
Trends

- Divergence of architectures
- Commoditization (e.g., video)
- Longer tail in object popularity distribution

A Short History of America by R. Crumb



Akamai Network Deployment



Akamai Statistics

- Peak bit rate: 13.1 Tbps on 3/13/2013
- Peak HTTP daily requests: 2.59 trillion on 9/23/12
- 560.1M unique IPv4 addresses connected to Akamai on 3/6/2012
- 683M in Q3 2012

How Big is the CDN Market?

2012 Data (Source: Bloomberg BusinessWeek)

	Revenues	Earnings
Akamai	1.374B	204M
Chinanet	46.6M	3.0M
Limelight	180.2M	(30M)
Level 3	6.376B	(422M)
Netflix	3.6B	17.2M

Content Provider Requirements

- Access control
- Accounting
- Verifiable reliability
- Invalidation

Embedded Image Delivery (e.g., Amazon)

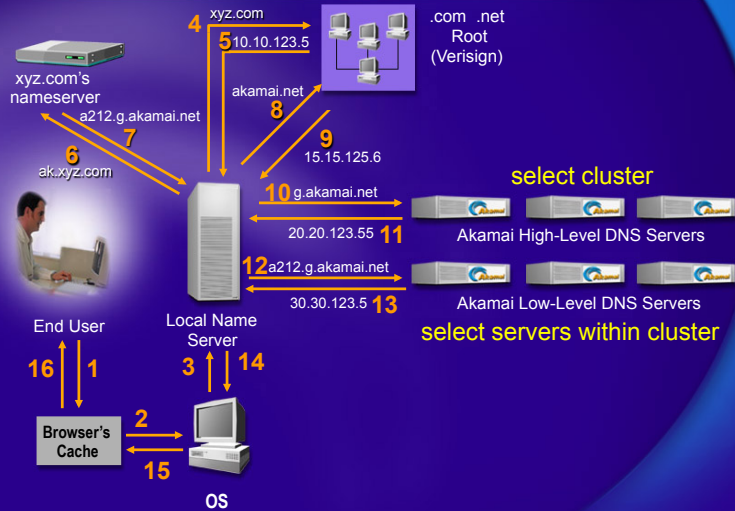
Embedded URLs are Converted to ARLs

```
<html>
<head>
<title>Welcome to xyz.com!</title>
</head>
<body>

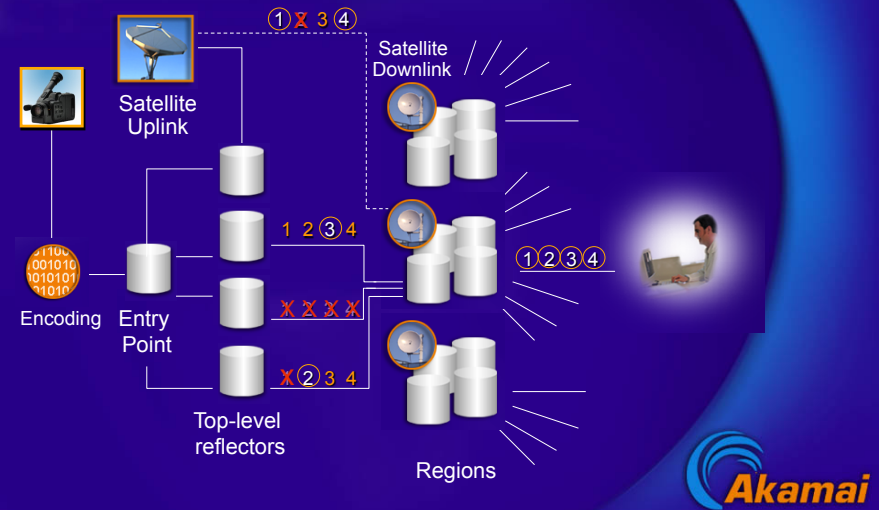

<h1>Welcome to our Web site!</h1>
<a href="page2.html">Click here to enter</a>
</body>
</html>
```

ak

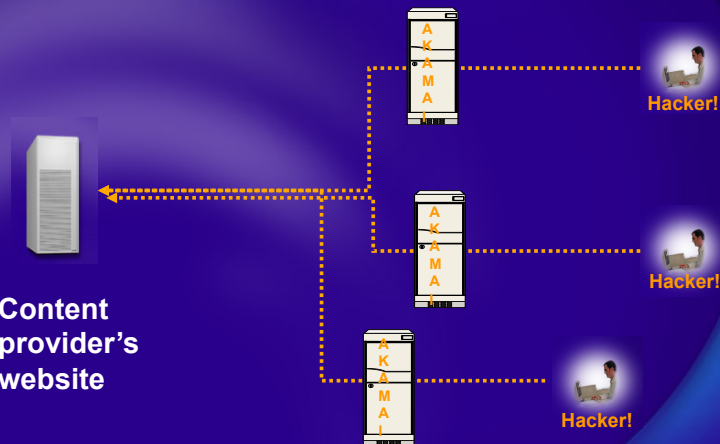
Akamai DNS Resolution



Live Streaming Architecture



SiteShield (www.fbi.gov)

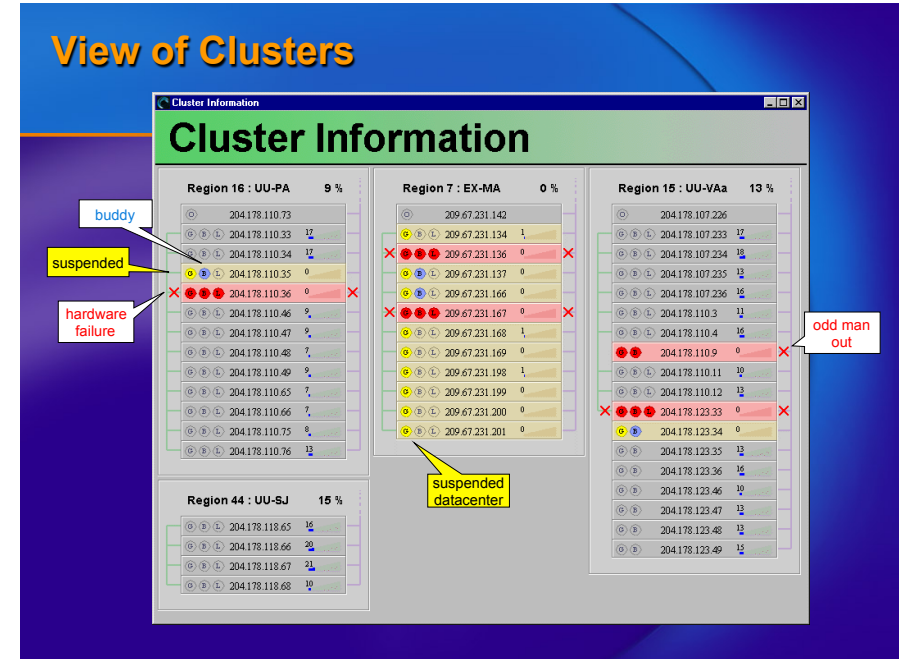


Akamai Cluster



Servers pool resources

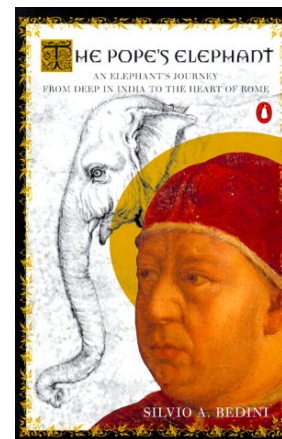
- RAM
- Disk
- Throughput



High-Margin Services

- Web site acceleration (latency reduction)
- “Intelligence” about end users
- Protection
- Bells and whistles – rapid software changes

Are CDNs and CCNs Mortal Enemies?



- CDN operates mainly at the application layer today
- CCN suggests moving some CDN functionality into the network, e.g., caching at routers

Principles and Benefits of ICN

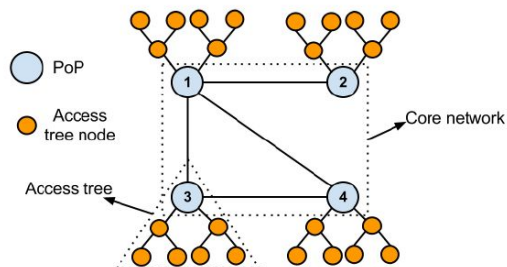
- Principles
 - Decouple names from locations
 - Pervasive caching
 - Nearest replica routing
 - Binding names to intent
- Benefits
 - Lower response latency
 - Simplified traffic engineering
 - Security
 - Support for Mobility
 - Ad hoc modes

Caching and Nearest Replica Routing Responsible for Several Benefits

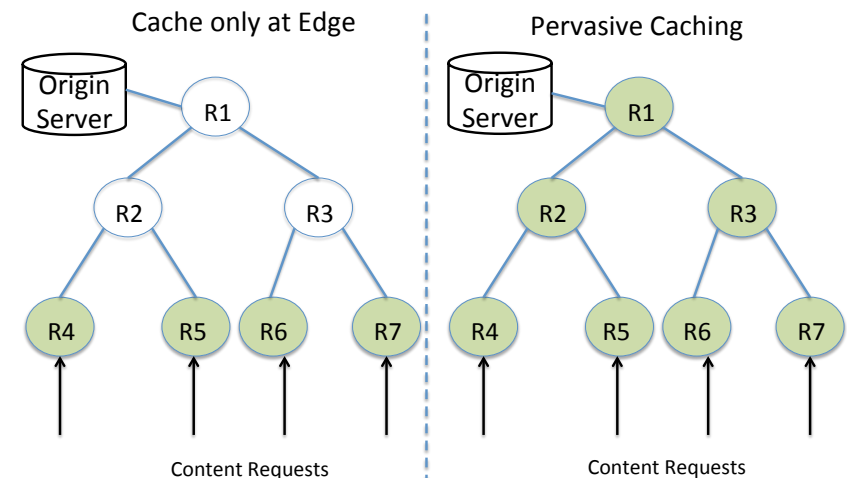
Benefit	Decoupling	Feature		
		Pervasive Caching	Nearest-replica routing	Binding
Latency		✓	✓	
Traffic Engg		✓	✓	
Mobility	✓		✓	
Ad hoc mode	✓		✓	
Security	✓			✓

Comparing CDN vs. ICN Caching and Routing

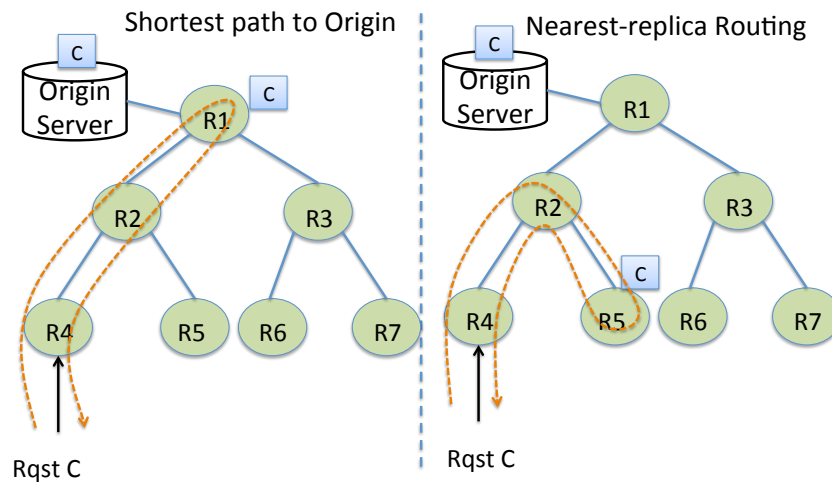
- How much benefit does pervasive caching provide over caching at the edge?
- How much benefit does nearest-replica routing provide?



Caching at Edge vs. Pervasively



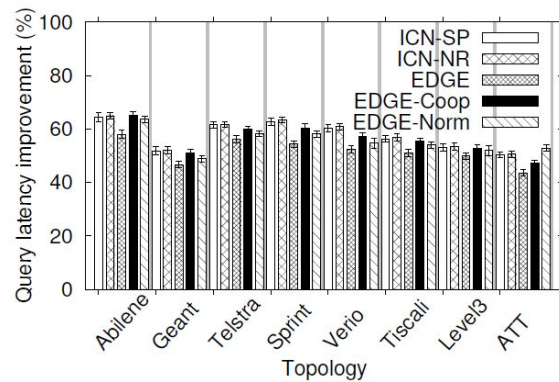
Shortest Path vs. Nearest-Replica Routing



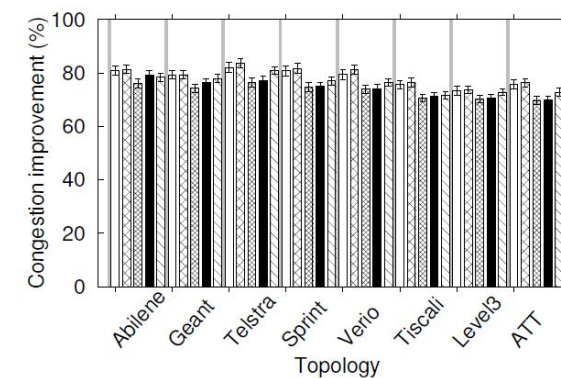
Trace-Drive Simulations

- Traces from one day's CDN logs from locations in U.S., Asia, Europe
- Backbone models from Rocketfuel
- POP cache budget capacity proportional to city population
- LRU replacement policy
- Evaluate average latency, maximum congestion, maximum origin server load

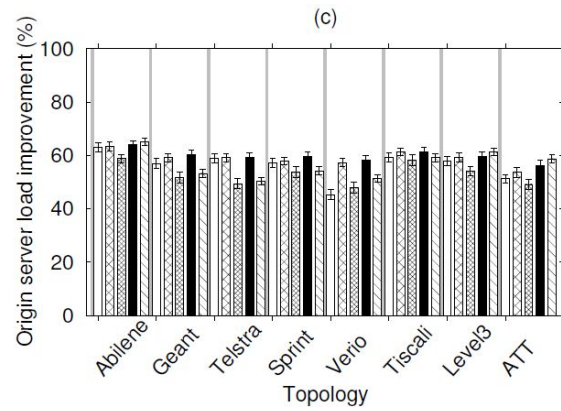
Average Latency (Hops)



Maximum Congestion



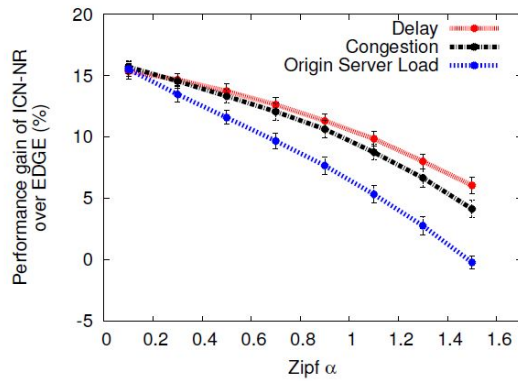
Maximum Origin Server Load



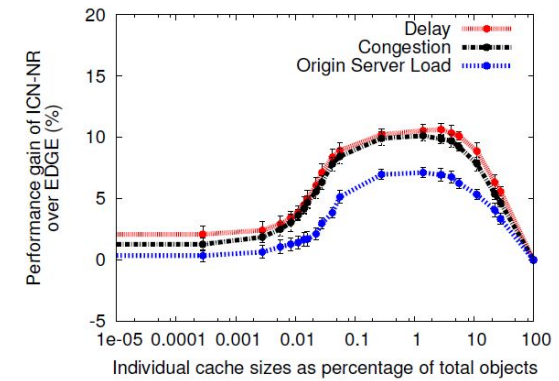
Observed Zipf Parameters from CDN

Location	Requests	Zipf parameter
Asia	480K	1.06
Europe	503K	0.98
USA	965K	0.91

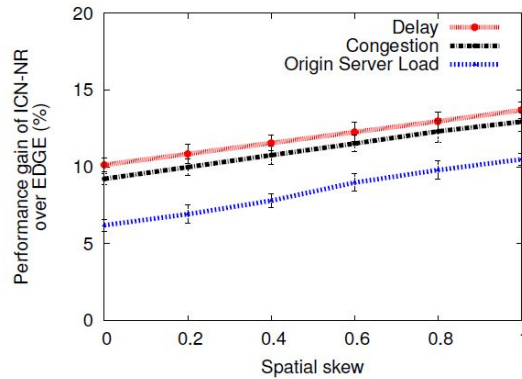
Sensitivity Analysis: Zipf α



Sensitivity Analysis: Cache Budget



Sensitivity: Spatial Skew



Key Points

- Caching pervasively doesn't provide large improvements versus caching only at the edge
- Nearest-replica routing doesn't provide large improvements versus shortest-path routing

Research Directions?

- How should a CDN be integrated into an ICN?
- How much ICN functionality can be implemented at the application layer?