

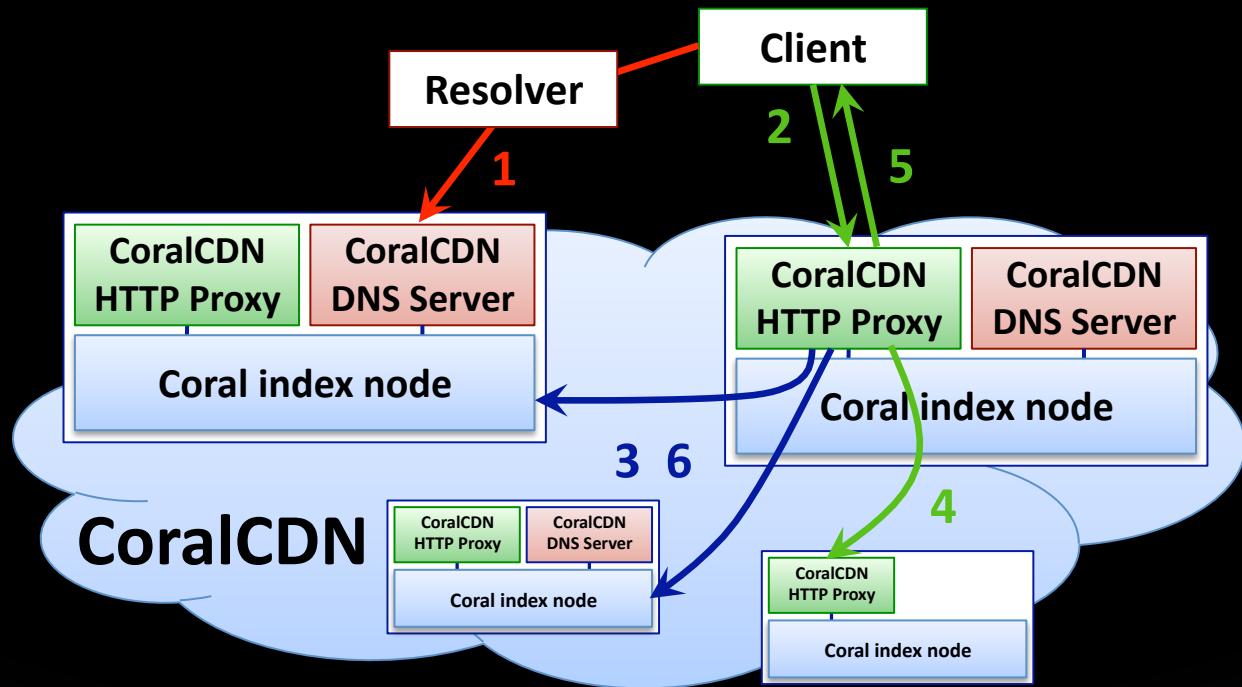
# Experiences with CoralCDN

## A Five-Year Operational View

Michael J. Freedman  
Princeton University

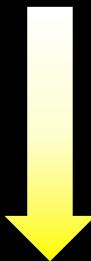
[www.coralcdn.org](http://www.coralcdn.org)

# A Cooperative, Self-Organizing CDN



**Goal:** To make desired content widely available regardless of publisher's own resources, by organizing and utilizing any cooperative resources

`http://example.com/path`



`http://example.com.nyud.net/path`

Adopted by:

Clients

Servers

Third-parties

# Many of you have used CoralCDN

The screenshot shows a Firefox browser window with an error message. On the left, there's a yellow warning icon with a red exclamation mark. To its right, the text "Server not found" is displayed in bold. Below this, a message reads: "Firefox can't find the server at [www.deadpagetoresurrect.com.](http://www.deadpagetoresurrect.com.)". At the bottom of the main content area, there's a bulleted list: "Check the address for typing errors such as [ww.example.com](http://ww.example.com) instead of [www.example.com](http://www.example.com)". On the right side of the window, there's a sidebar titled "Resurrect this page...". This sidebar contains five options, each with a small logo and text: "CoralCDN" (highlighted with a red oval), "Google", "Google (text only)", "Yahoo!", and "The Internet Archive".

Server not found

Firefox can't find the server at [www.deadpagetoresurrect.com.](http://www.deadpagetoresurrect.com.)

- Check the address for typing errors such as [ww.example.com](http://ww.example.com) instead of [www.example.com](http://www.example.com)

Resurrect this page...

CoralCDN

Google

Google (text only)

Yahoo!

The Internet Archive

# Many of you have used CoralCDN

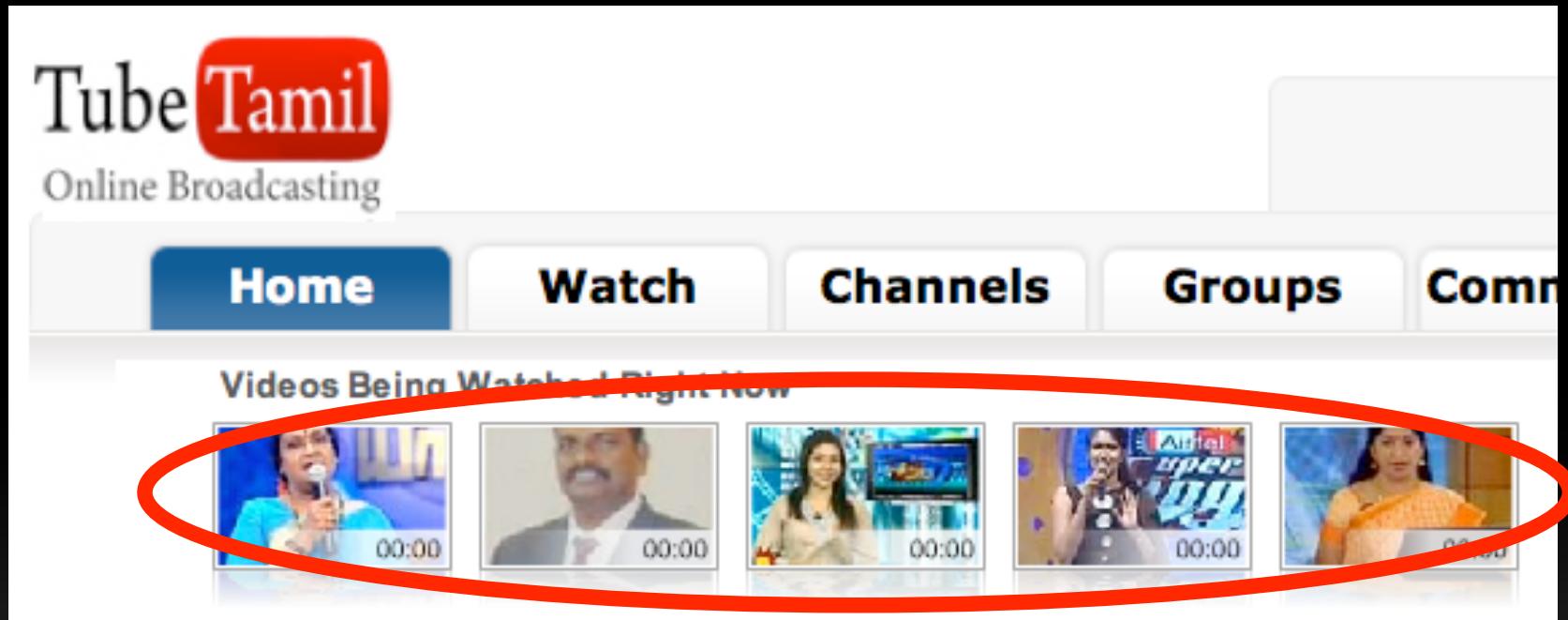
The screenshot shows a news article from Slashdot. The header reads "NEWS FOR NERDS. STUFF THAT MATTERS." Below it, the main title is "10Gbit to the Home by 2010". The post was "Posted by CmdrTaco on Sunday August 29, @12:08PM" and is categorized under "from the not-bloody-likely dept.". The text of the post discusses a report from the Japanese newspaper *Nihon Keizai Shinbun* stating that NTT, Fujitsu, and the Japanese Government are forming a working group to develop internet technologies aiming for completion by 2010. It includes a link to a complete translation and a reference to the "Coral Cache Link". A red oval highlights the link to the "Coral Cache Link".

**10Gbit to the Home by 2010**

Posted by [CmdrTaco](#) on Sunday August 29, @12:08PM  
from the not-bloody-likely dept.

womby writes "[Nihon Keizai Shinbun report](#) (Japanese) that NTT, Fujitsu and the Japanese Government are forming a working group to develop internet technologies aiming for completion by 2010.' [A complete Translation is here](#), if my blog gets beaten the [Coral Cache Link](#)."

# Many of you have used CoralCDN



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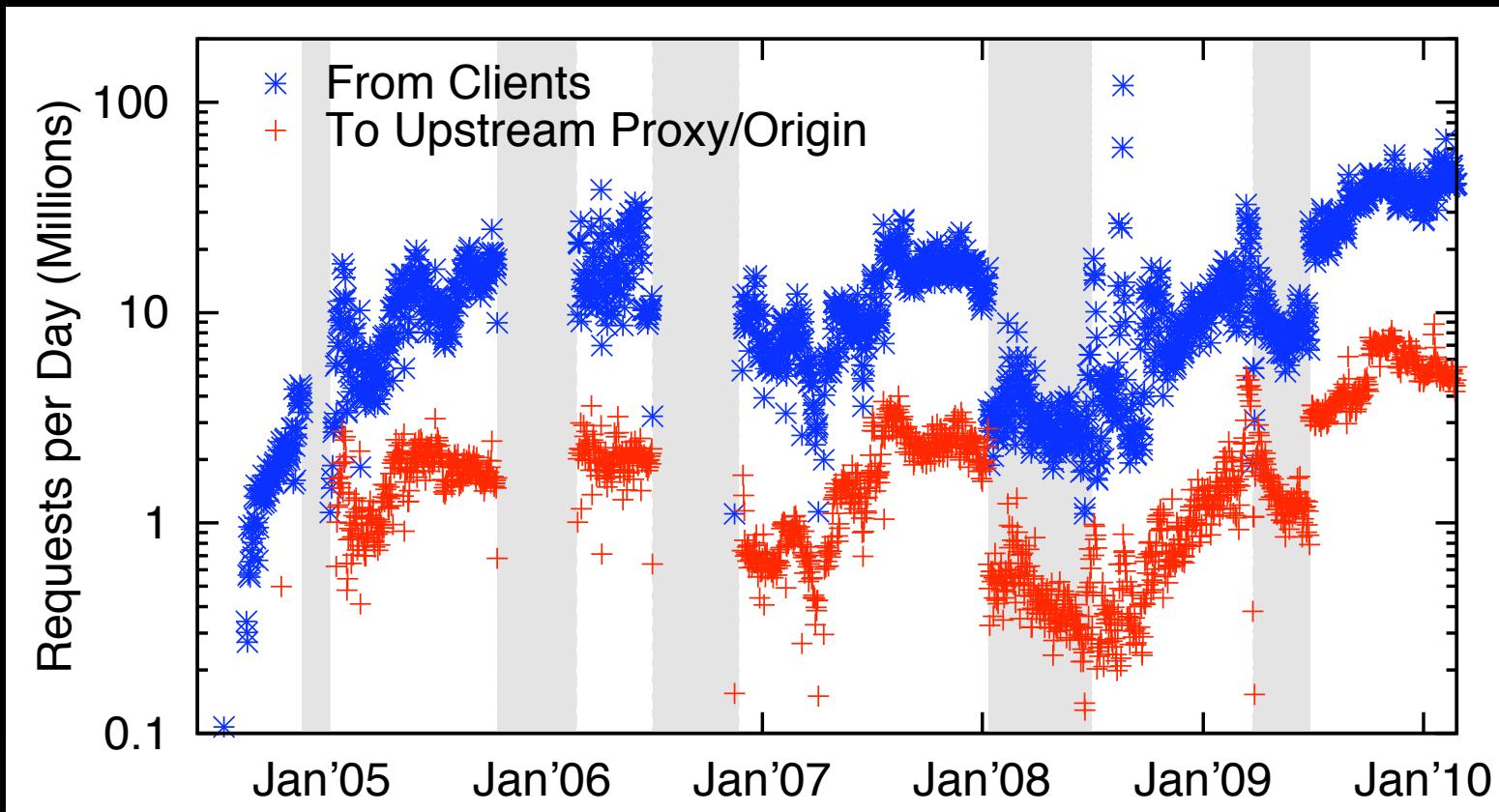


Many of you have used CoralCDN



electric sheep

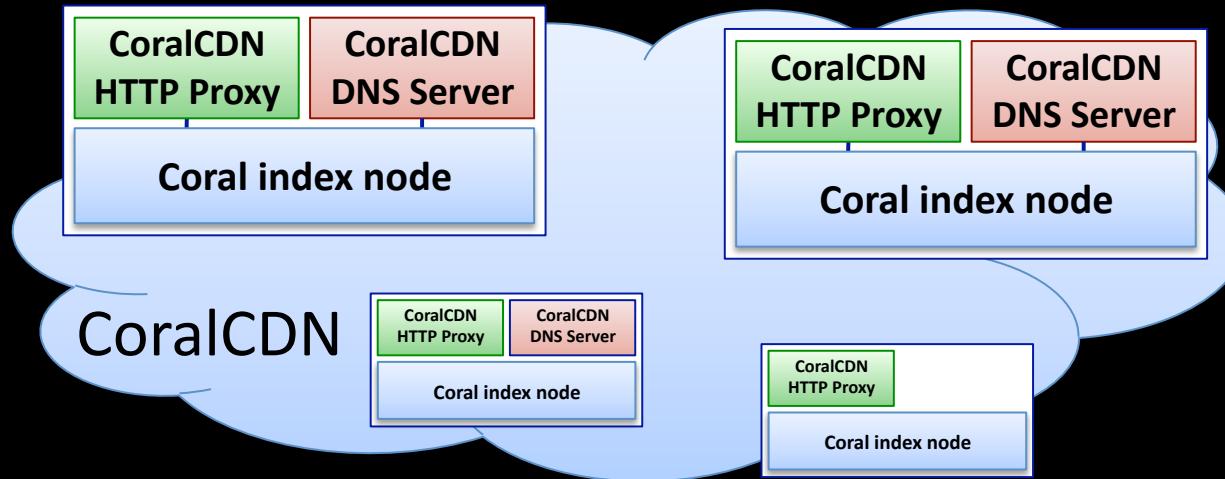




## Daily Request Volume

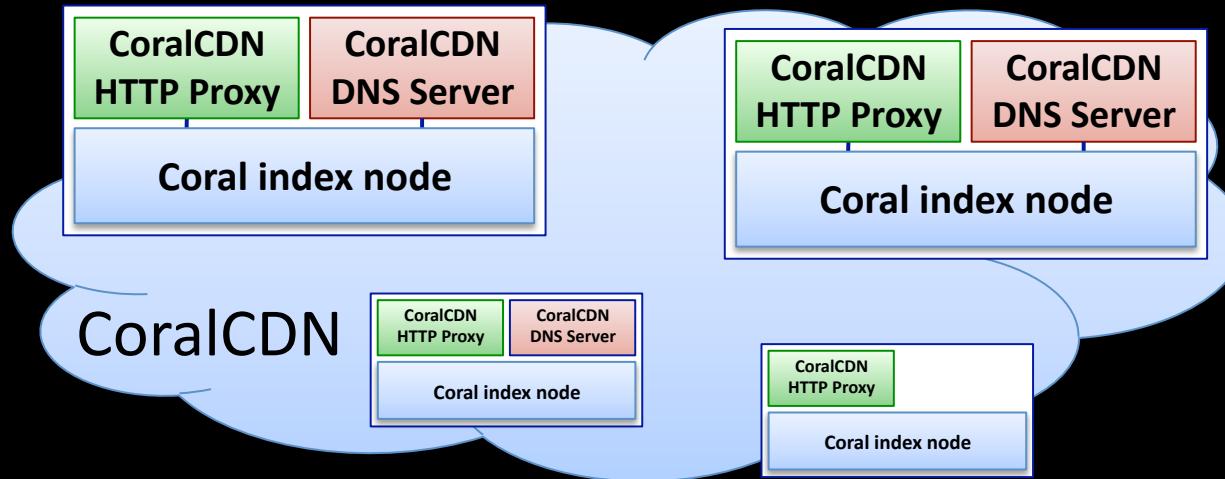
2M clients – 2 TB content – 20K origin domains

From 300-400 PlanetLab servers



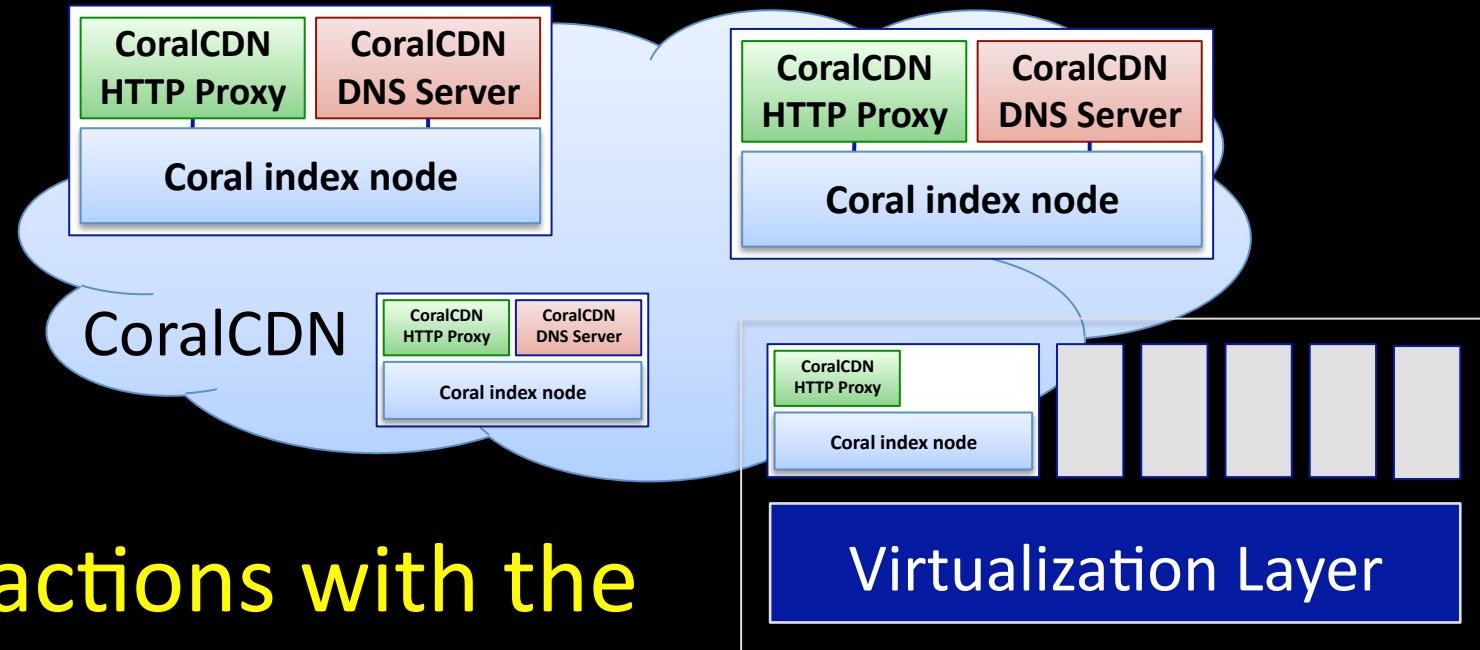
## Based on peer-to-peer DHT

1. Weakened consistency + algorithms that prevent tree saturation during lookup
2. Decentralized clustering for locality and hierarchical lookup
3. Cooperative HTTP / DNS that leverages locality



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## Interactions with the External Environment



Clients



Origin Domains

## 1. Experiences

- Naming
- Fault Tolerance
- Resource management

## 2. Revisit CoralCDN's design

# Naming



Flexible, open API



Mismatch with domain-based  
access control policies

# CoralCDN's Platform-as-a-Service API

## Rewrite rules in origin web servers

```
RewriteEngine on  
RewriteCond %{HTTP_USER_AGENT} !^CoralWebPrx  
RewriteCond %{QUERY_STRING} !(^|&)coral-no-serve$  
RewriteRule ^(.*)$ http:// %{HTTP_HOST}.nyud.net%{REQUEST_URI} [R,L]
```

# CoralCDN's Platform-as-a-Service API

## Rewrite rules in origin web servers

```
RewriteEngine on  
RewriteCond %{HTTP_USER_AGENT} !^CoralWebPrx  
RewriteCond %{QUERY_STRING} !(^|&)coral-no-serve$  
RewriteCond %{HTTP_REFERER} slashdot\.org [NC]  
RewriteCond %{HTTP_REFERER} digg\.com [NC,OR]  
RewriteCond %{HTTP_REFERER} blogspot\.com [NC,OR]  
RewriteRule ^(.*)$ http://%{HTTP_HOST}.nyud.net%  
{REQUEST_URI} [R,L]
```

Sites integrate with load/bandwidth monitoring

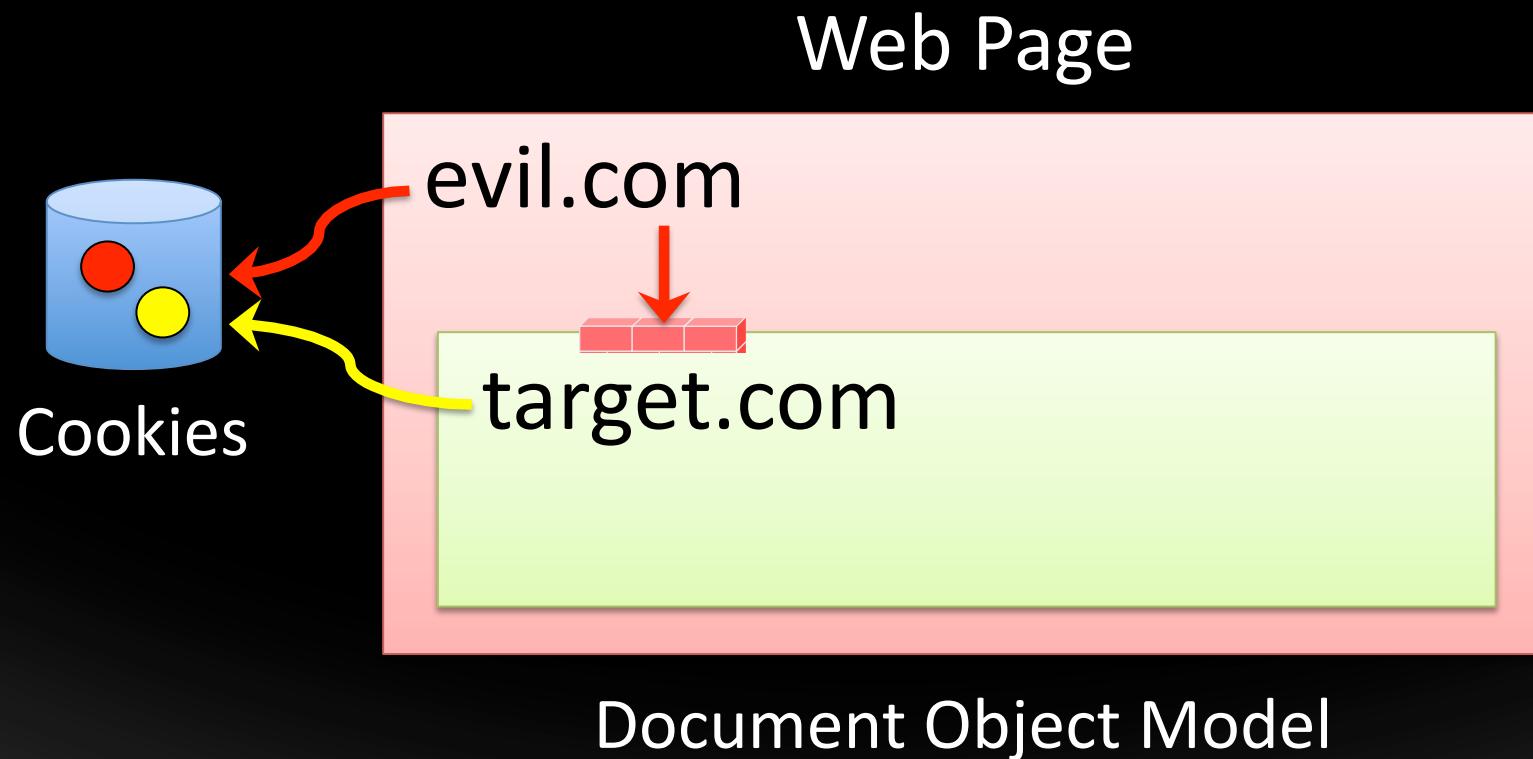
 Elastic Provisioning 

# Naming Conflation

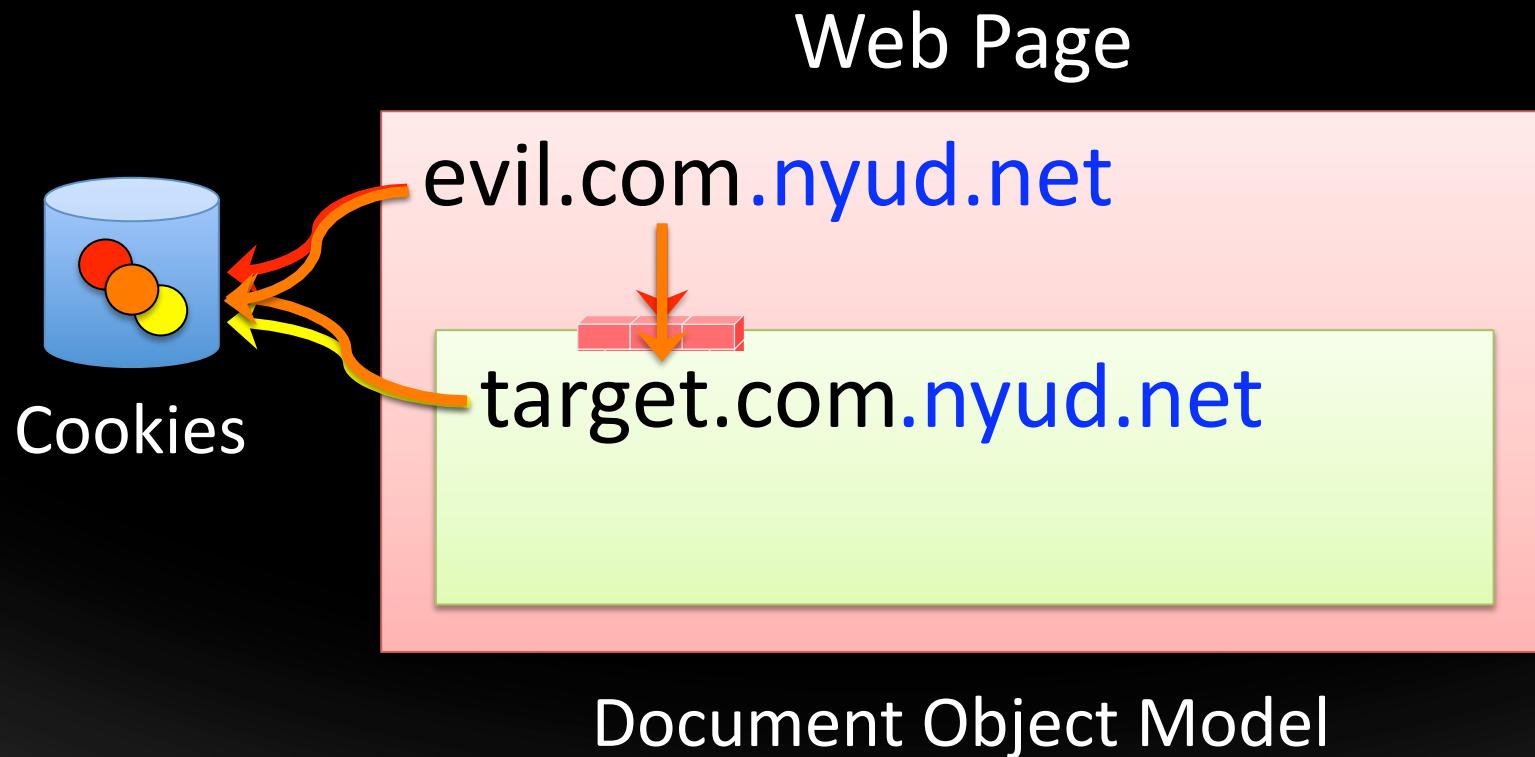
`http://domain.service1.service2/path`

- ✓ 1. Location to retrieve content
- ✗ 2. Human-readable name for administrative entity
- ✗ 3. Security policies to govern objects' interactions

# Domain-based Security Policies



# Domain-based Security Policies



Defaults violate least privilege

# Fault Tolerance: Failure Decoupling



## Internal failures:

- DHT nodes
- DNS servers, HTTP proxies
- Management service



## External failures:

- Decouple IPs from hosts
- Interactions with origin sites

# **Slashdot** happens!

## **Origin Status**

1. Unresponsive
2. Returns error code
3. Reply truncated



## **CoralCDN Reaction**

- Cache negative results
- Serve stale content
- Use whole-file overwrites

# **Slashdot** happens!

## **Origin Status**

1. Unresponsive

2. Returns error code

3. Reply truncated

## **CoralCDN Reaction**

- Cache negative results

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- Use whole-file overwrites



Maintain status quo unless improvements are possible

# What is “failure”?



The image shows a screenshot of a Twister application error page. At the top, there's a logo for "twister" with a yellow star and a small bird icon, followed by the word "Alpha". Below the logo, a blue horizontal bar contains the text "App Engine Error". The main content area has a light blue background. It features a large, bold, dark blue heading "Getting Over Quota". Underneath the heading, there is a message in English: "We apologize for your continuing inconvenience in accessing Twister. We are now getting over the Google App Engine serving quota by moving into a new environment. Please try again later." To the right of the text, there is a small, stylized illustration of a yellow bird perched on a blue base, with a small trail behind it. At the bottom of the page, there is some Japanese text: "Twisterにアクセスできない状況が続き、申し訳ございません。この問題を解決するために、新しい環境への移行準備を行っています。"

Return values should have fail-safe defaults

# Resource Management

✓ Control over bandwidth consumption

✗ Control and visibility into environment's resources

# Some timeline...



Mar 2004  
CoralCDN  
released on  
PlanetLab

# Some timeline...

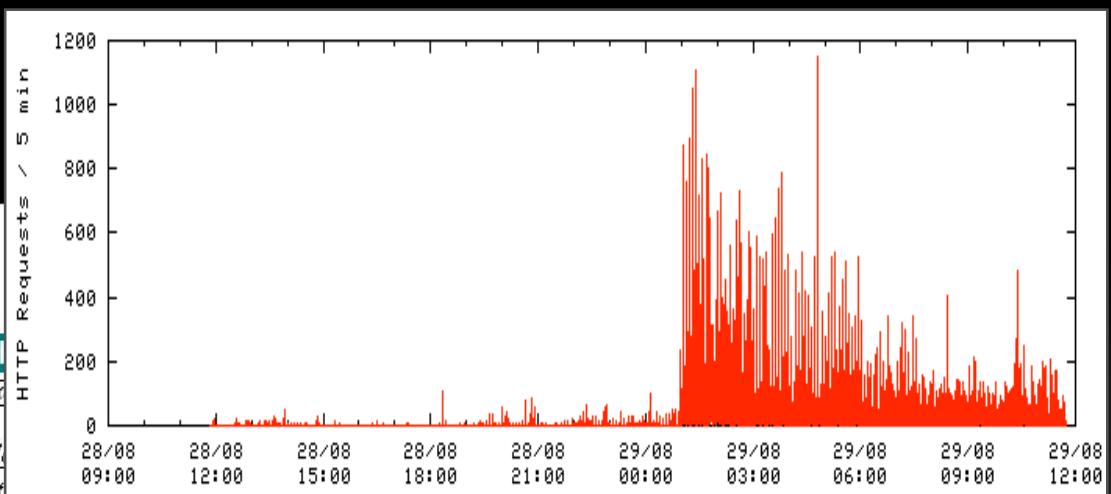


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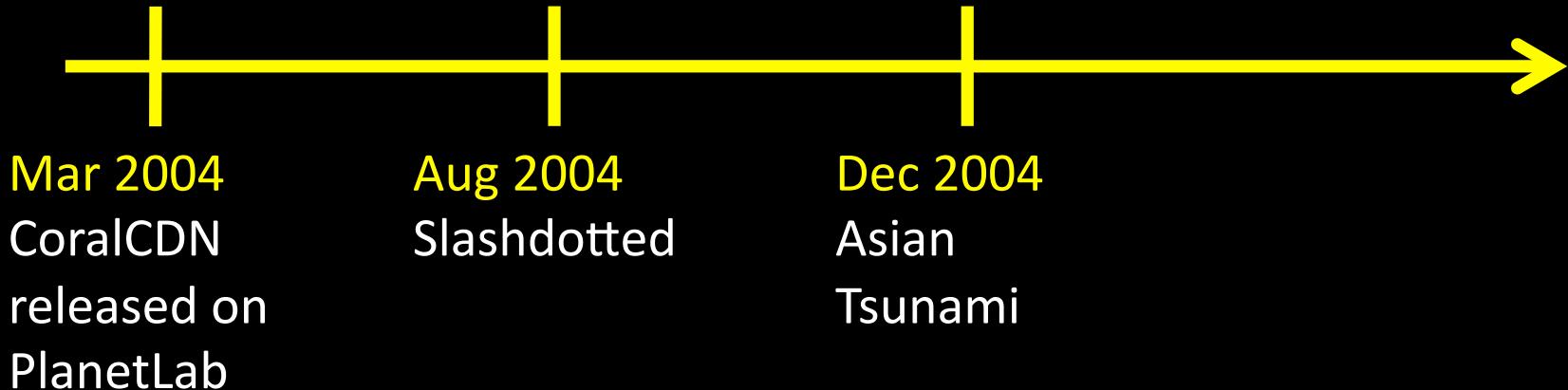
Aug 2004  
Slashdotted

The screenshot shows the Slashdot homepage with a news article titled "IT: Coral P2P Cache Enters Public Beta". The article was posted by timothy on Saturday August 28, 2004. The text discusses the entry of Coral into public beta, mentioning its use on Planet-Lab and its potential impact on the Slashdot effect.

**Slashdot**  
News for Nerds. Stuff that matters.  
Login | IT: Coral P2P Cache Enters Public Beta  
Why Login? Posted by [timothy](#) on Saturday August 28, 2004 @ 09:00 from the [will-it-scale](#) dept.  
Why Subscribe?  
Sections | Main  
Apache | Apple | 2 more | AskSlashdot | 2 more  
[Read More...](#) | 45 of 60 comments | [it.slashdot.org](http://it.slashdot.org)



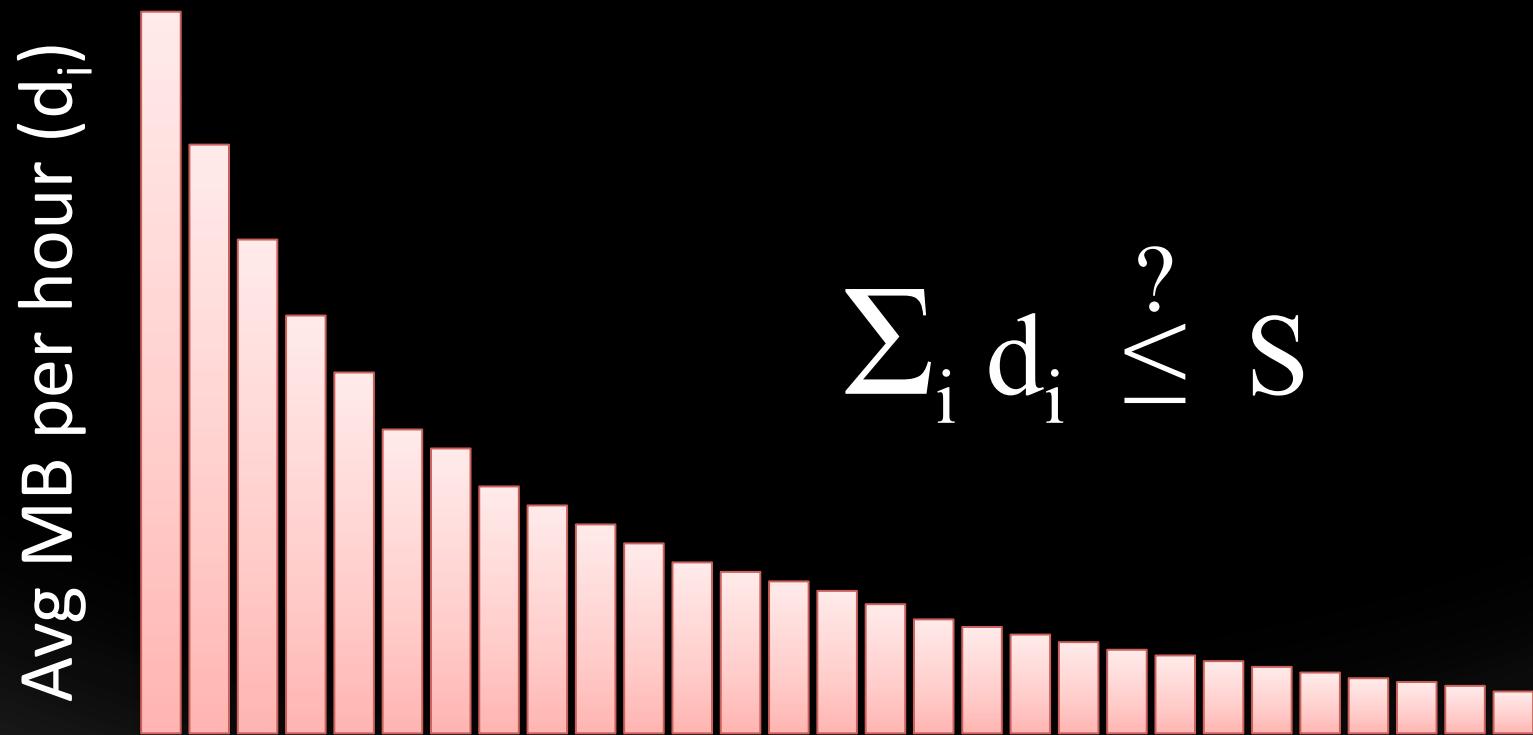
# Some timeline...



1. PlanetLab traffic jumps
2. Site threatens to yank PL
3. PL admin kills slice
4. Slice restored next day
5. Initiates discussion of resource limits for slices

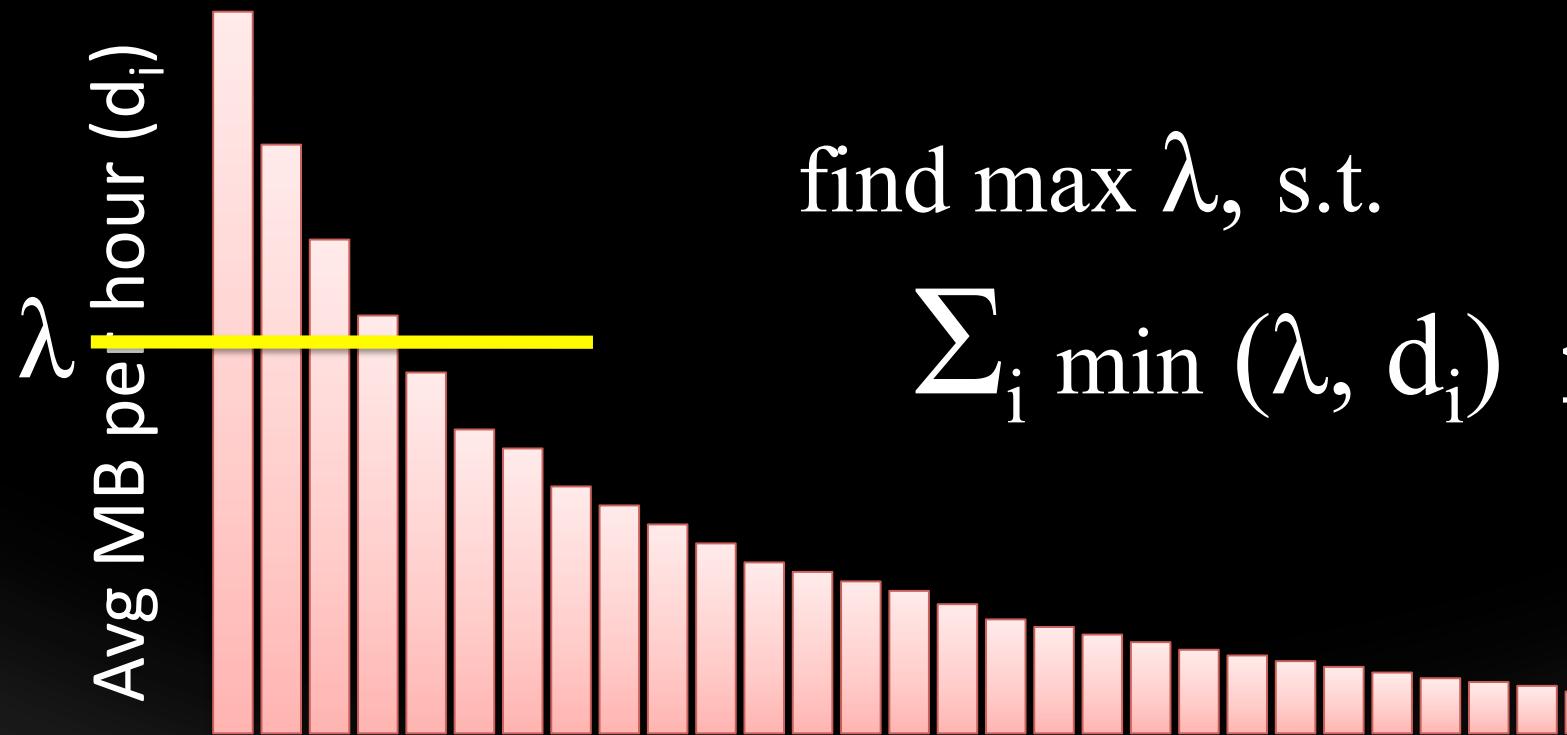


# Demand >> Supply: Enter Fair-Sharing Algorithms



Domains with heaviest consumption

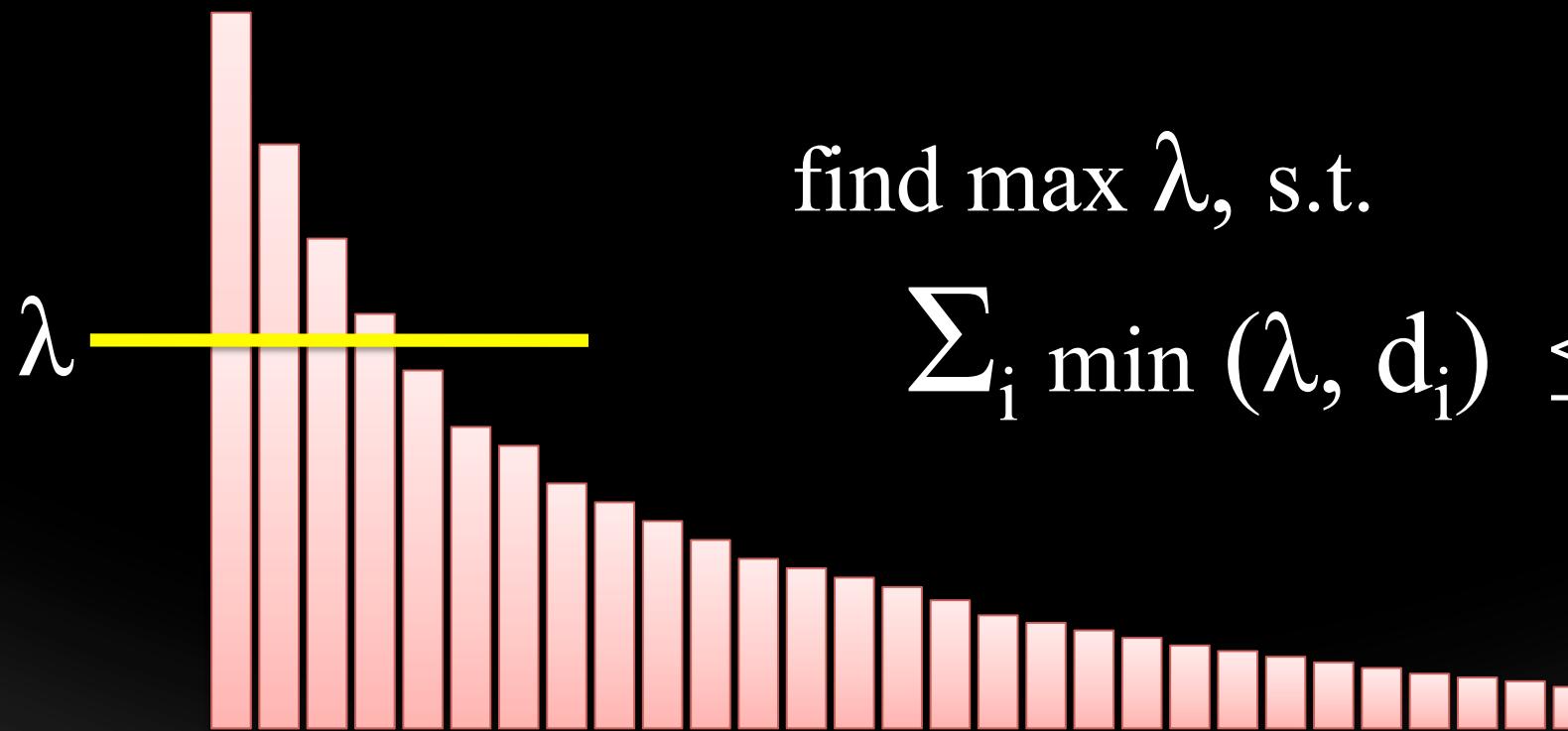
# Demand >> Supply: Enter Fair-Sharing Algorithms



find  $\max \lambda$ , s.t.

$$\sum_i \min(\lambda, d_i) \leq S$$

# Demand >> Supply: Enter Fair-Sharing Algorithms

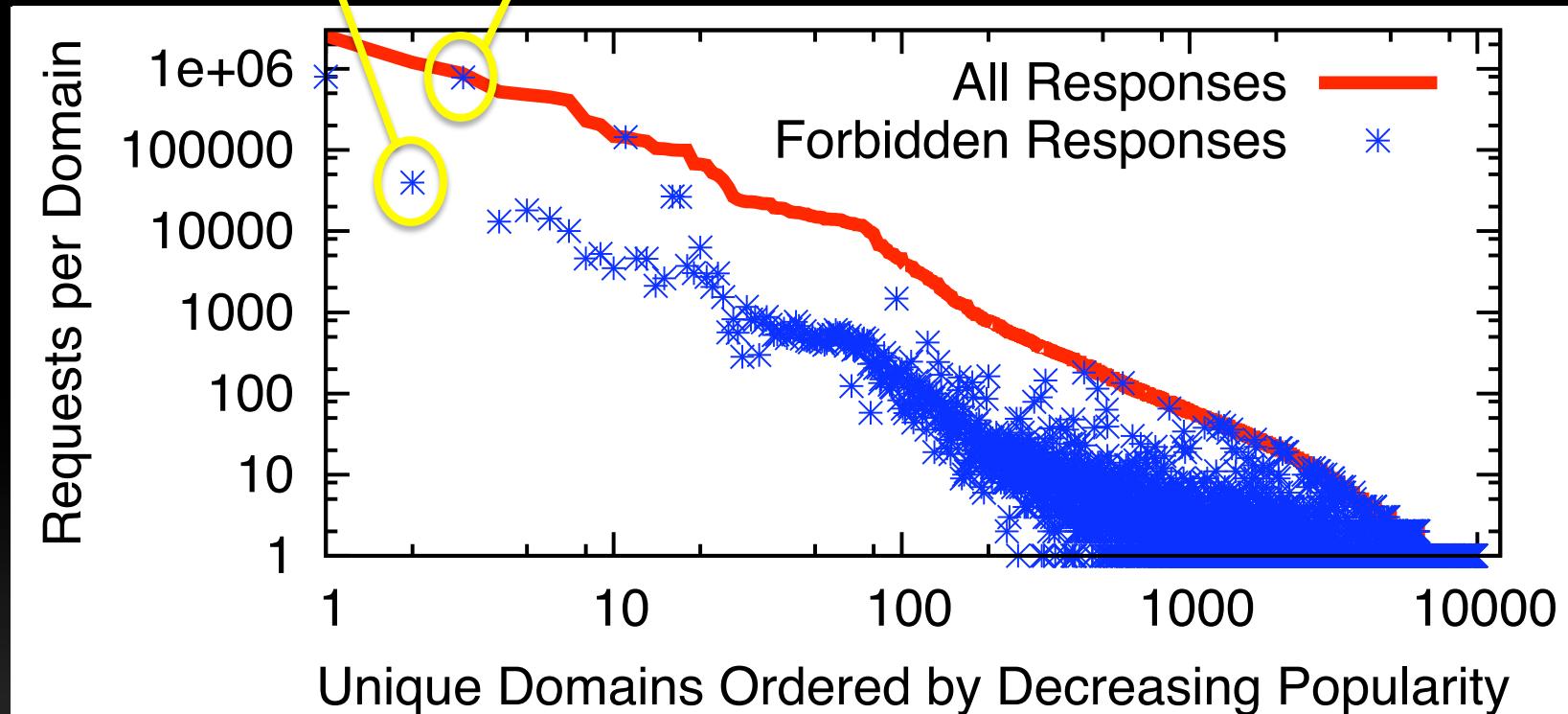


Domains with heaviest consumption

# Admission Control under Fair-Sharing

~10 kB imgs  
3.3% rejected

~5 MB videos  
89% rejected



Demand > 10 TB

Supply ≤ 2 TB

# Some timeline...

|                                      |             |                  |                                       |
|--------------------------------------|-------------|------------------|---------------------------------------|
| Mar 2004                             | Aug 2004    | Dec 2004         | Mar 2006                              |
| CoralCDN<br>released on<br>PlanetLab | Slashdotted | Asian<br>Tsunami | PL deploys<br>bandwidth<br>throttling |

1. PlanetLab traffic jumps
2. Site threatens to yank PL
3. PL admin kills slice
4. Slice restored next day
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# Resource Management: Us vs. Them

## Application Hammer

- Track HTTP traffic
- If site > fair share rate, reject via HTTP 403
- If total > peak rate, close server socket

## Platform Hammer

- Track all network traffic
- If total > 80% daily rate, BW shaping in kernel



# Resource Management: Us vs. Them

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## Platform Hammer

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**Result:** HTTP traffic is 1/2 - 2/3 of all traffic

Lower layers should expose greater visibility and control over resources

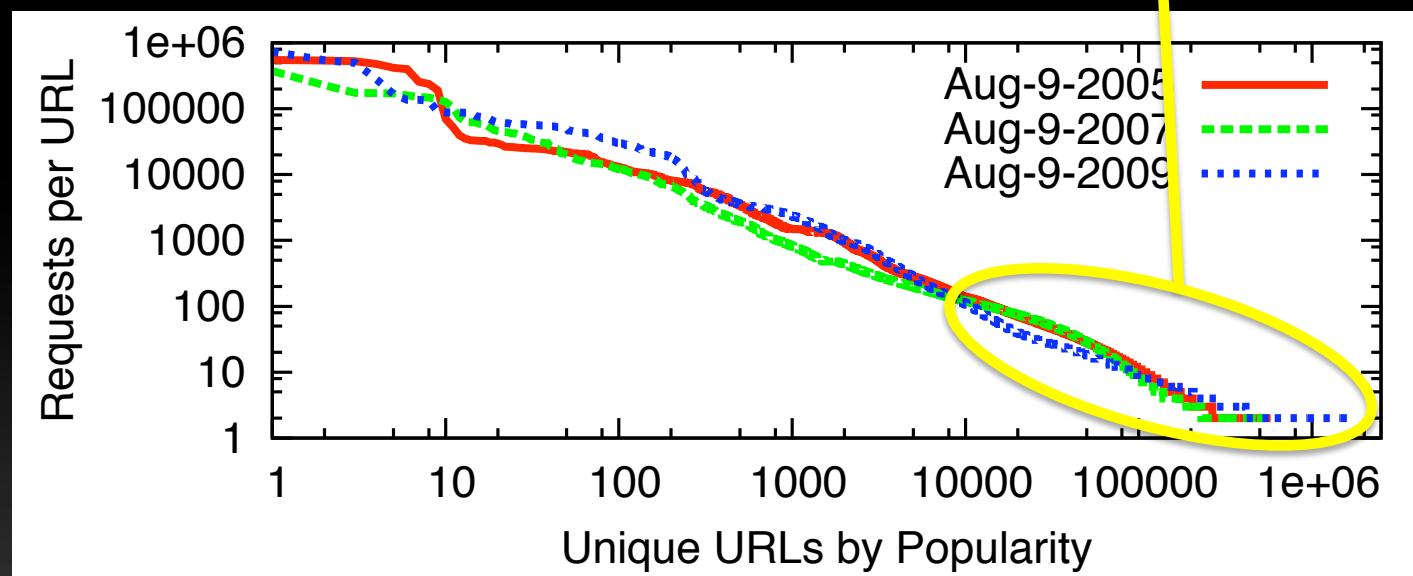
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## 2. Revisit CoralCDN's design

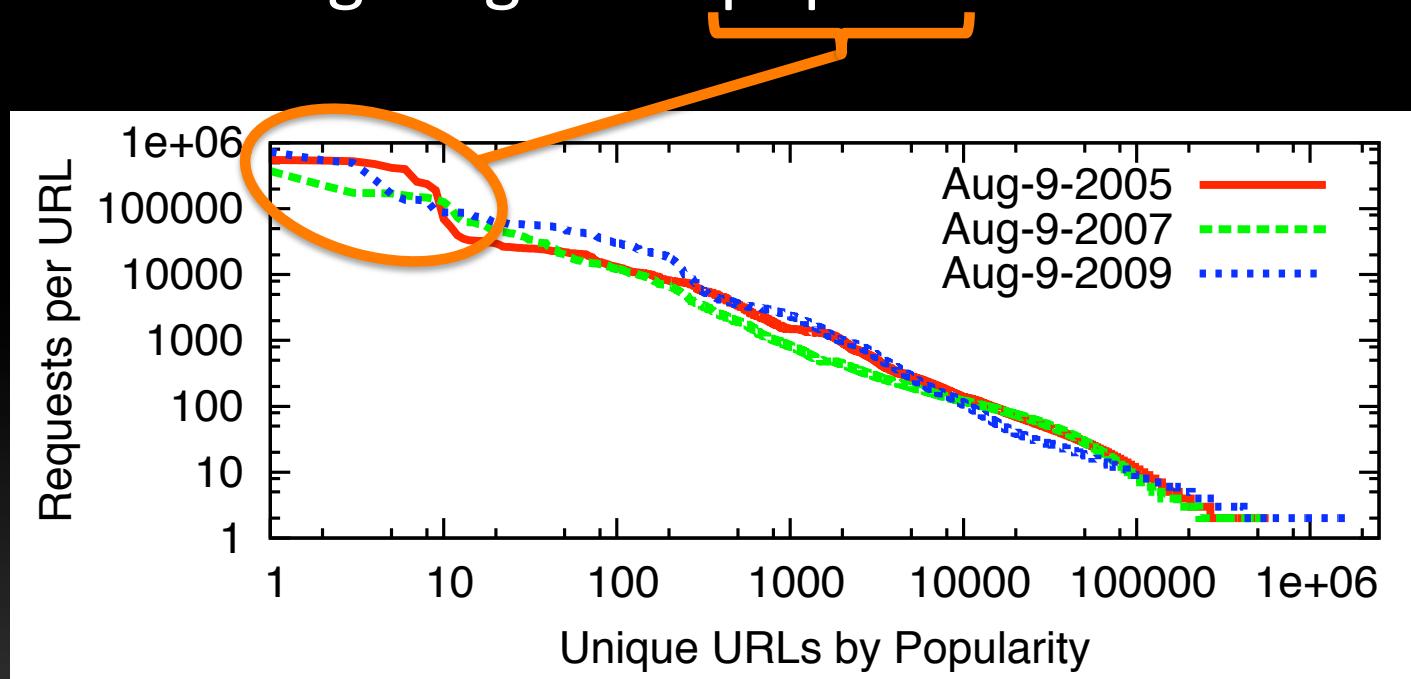
# Usage Scenarios

1. Resurrecting old content
2. Accessing unpopular content



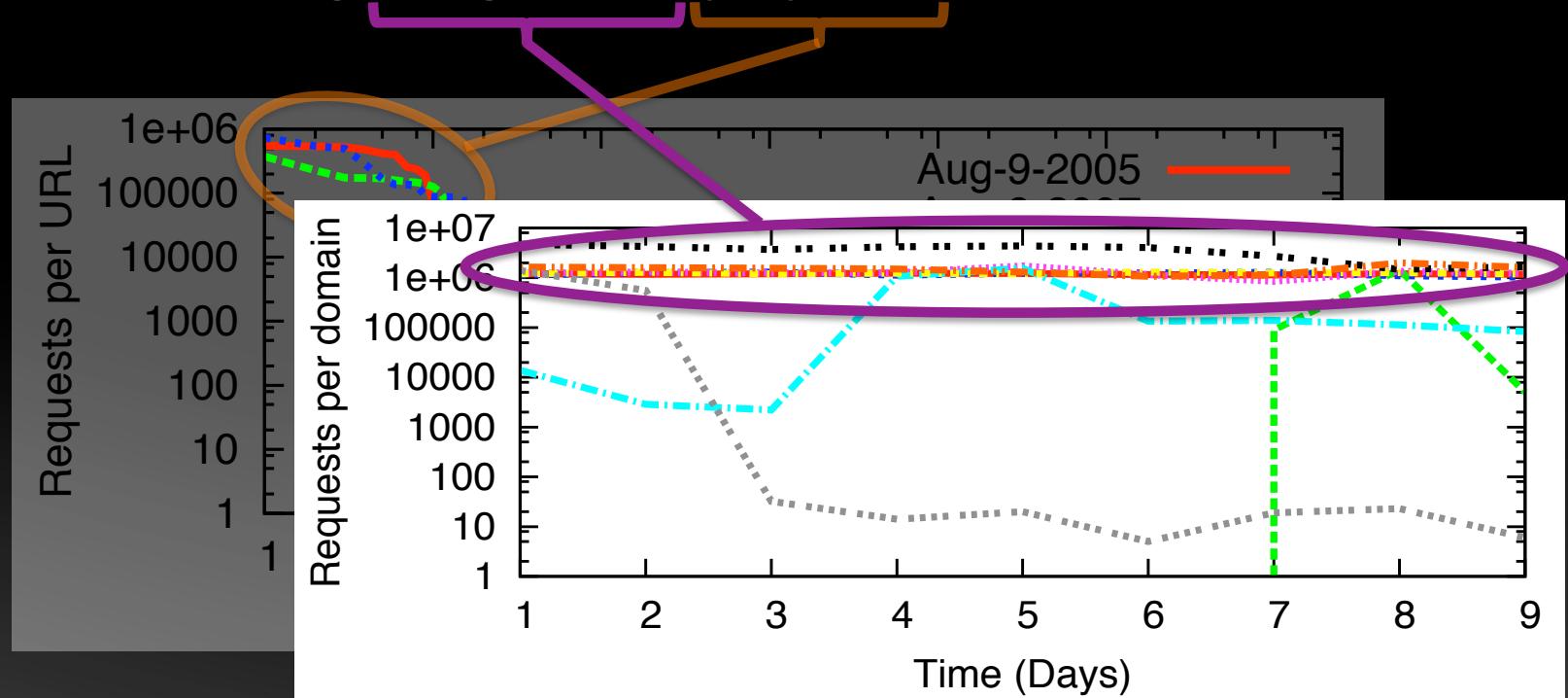
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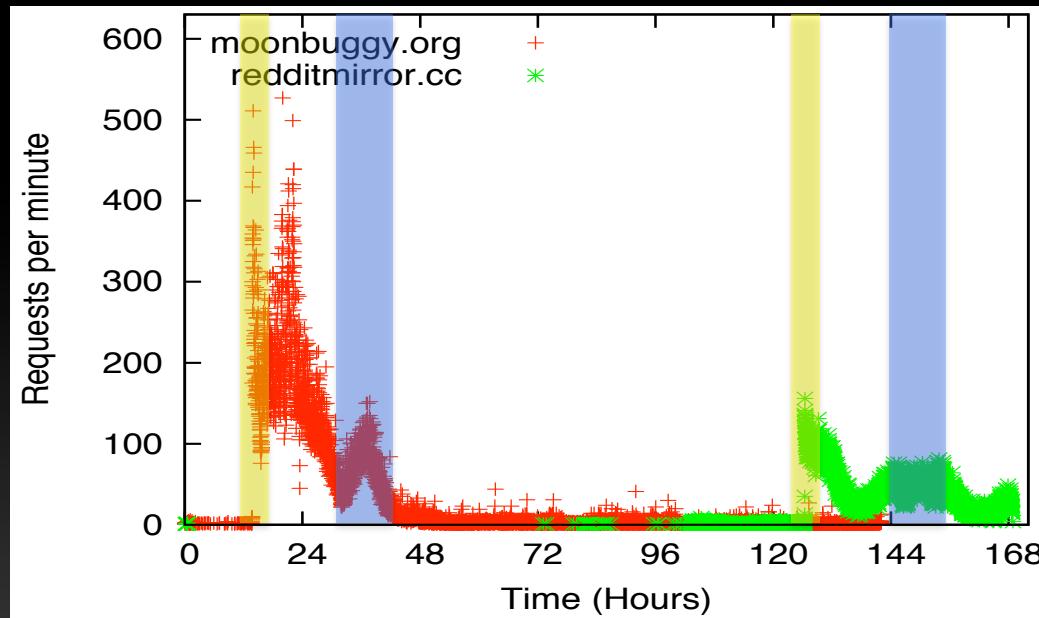
1. Resurrecting old content
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3. Serving long-term popular content

| Top URLs | % Reqs | Agg Size (MB) |
|----------|--------|---------------|
| 0.01 %   | 49.1 % | 14            |
| 0.10 %   | 71.8 % | 157           |
| 1.00 %   | 84.8 % | 3744          |
| 10.00 %  | 92.2 % | 28734         |

| Result         | Frequency |
|----------------|-----------|
| Local Cache    | 70.4 %    |
| Origin Site    | 9.9 %     |
| CoralCDN Proxy | 7.1 %     |
| 4xx/5xx Error  | 12.6 %    |

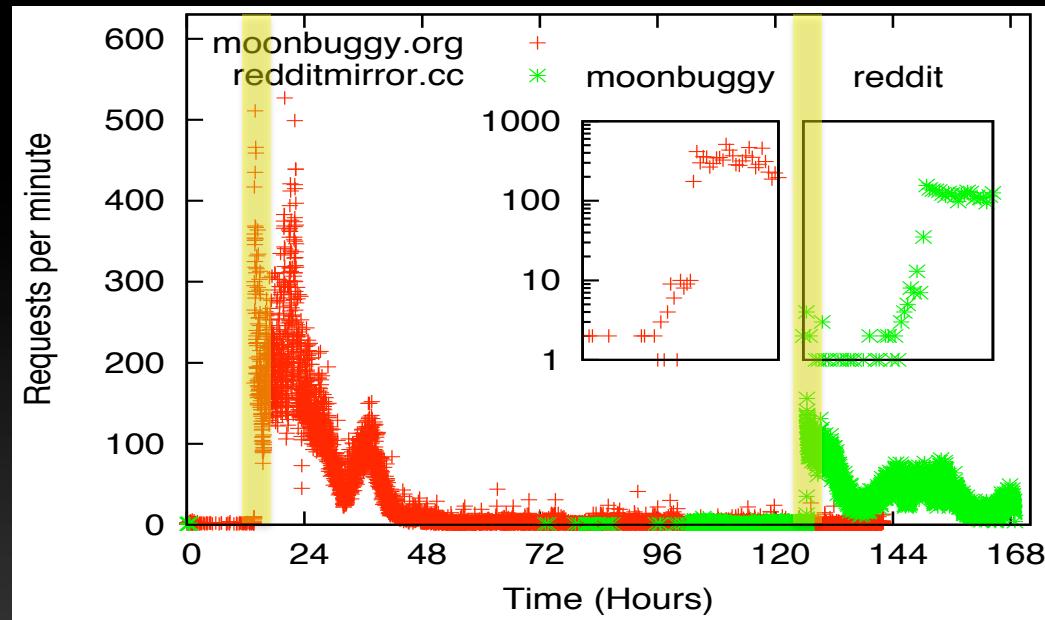
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4. Surviving flash crowds to content



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5 second epochs

10 minute epochs

|               |                                    |               |                                    |
|---------------|------------------------------------|---------------|------------------------------------|
| 24% epochs    | $\geq 1$ domain with<br>10x incr   | 99.93% epochs | $\geq 1$ domain with<br>10x incr   |
| 0.006% epochs | $\geq 1$ domain with<br>100x incr  | 28% epochs    | $\geq 1$ domain with<br>100x incr  |
| 0 % epochs    | $\geq 1$ domain with<br>1000x incr | 0.21% epochs  | $\geq 1$ domain with<br>1000x incr |

# Conclusions?

- Most requested content is long-term popular and already cached locally
- “Flash” crowds occur, but on order of minutes

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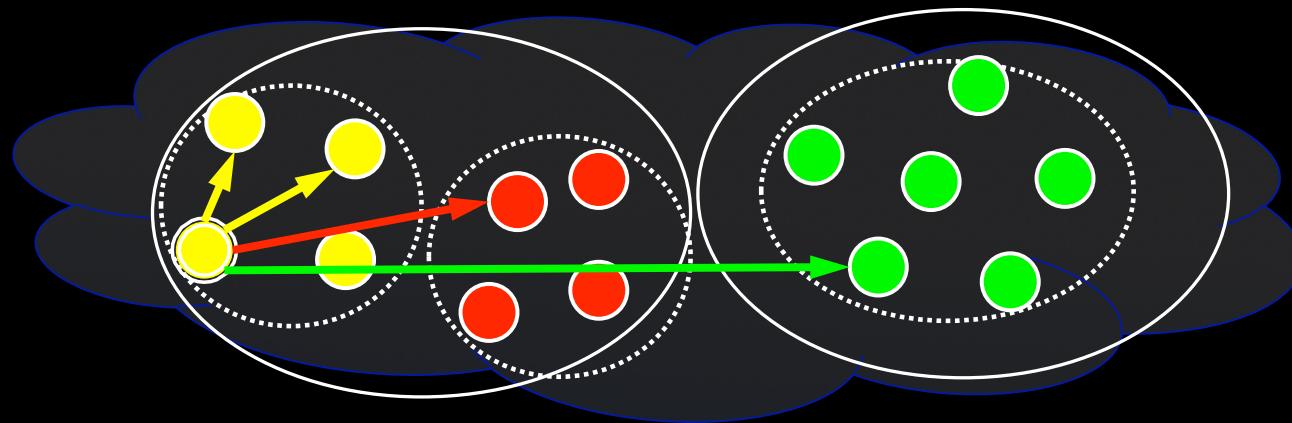


- Focus on long-term popular
- Little / no HTTP cooperation
- Global discovery (e.g., DNS)

- Focus on flash crowds
- Regional coop. as default
- Global coop. as failover

# Reconfiguring CoralCDN's design

- Leverage Coral hierarchy for lookup



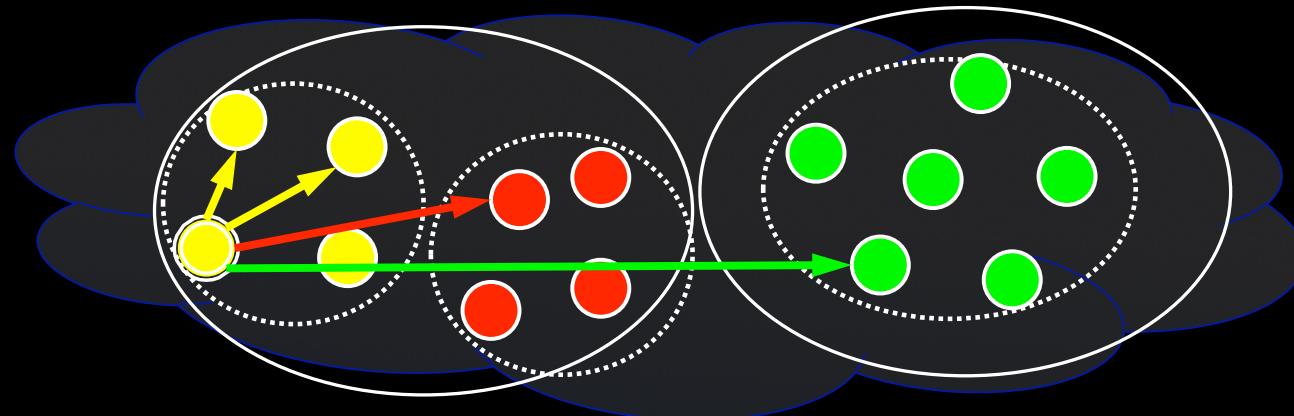
Latency 90% ↓

Origin Load 5% ↑

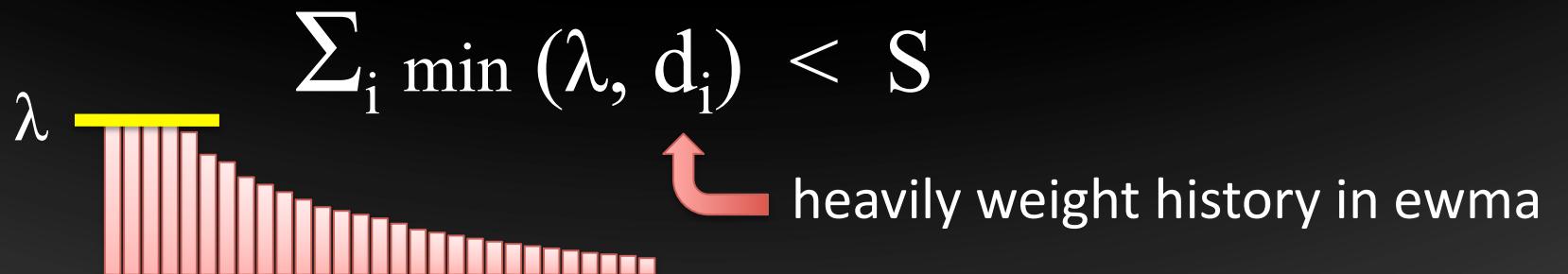
Failover to global 0.5%

# Reconfiguring CoralCDN's design

- Leverage Coral hierarchy for lookup



- During admission control, bias against long-term use



# Conclusions

## 1. Experiences

- Naming
- Fault Tolerance
- Resource management

## 2. Revisit CoralCDN's design

- Current design unnecessary for deployment / most use
- Easy changes to promote flash-crowd mitigation

# Can we reach Internet scale?



[www.firecoral.net](http://www.firecoral.net)

Initial beta-release  
of browser-based P2P web cache