Content Delivery and the Natural Evolution of DNS

Remote DNS Trends, Performance Issues and Alternative Solutions

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Domain Name System evolution

- DNS designed to map names to addresses
  - Evolved into a large-scale distributed system
- CDNs leverage DNS for dynamic routing
  - Assume *proximity* between users and their resolvers
- Use of remote DNS
  - Servers concentrated farther from users
  - Susceptible to configuration errors (e.g. Comcast DNS outages)
- Growing alternative third-party DNS services
  - Public DNS usage has **grown to 11% of users**!

So what?

Ubiquity of Content Delivery Networks

Visit cnn.com…

34 DNS lookups

204 HTTP requests

520 KB of data downloaded

Ubiquity of Content Delivery Networks

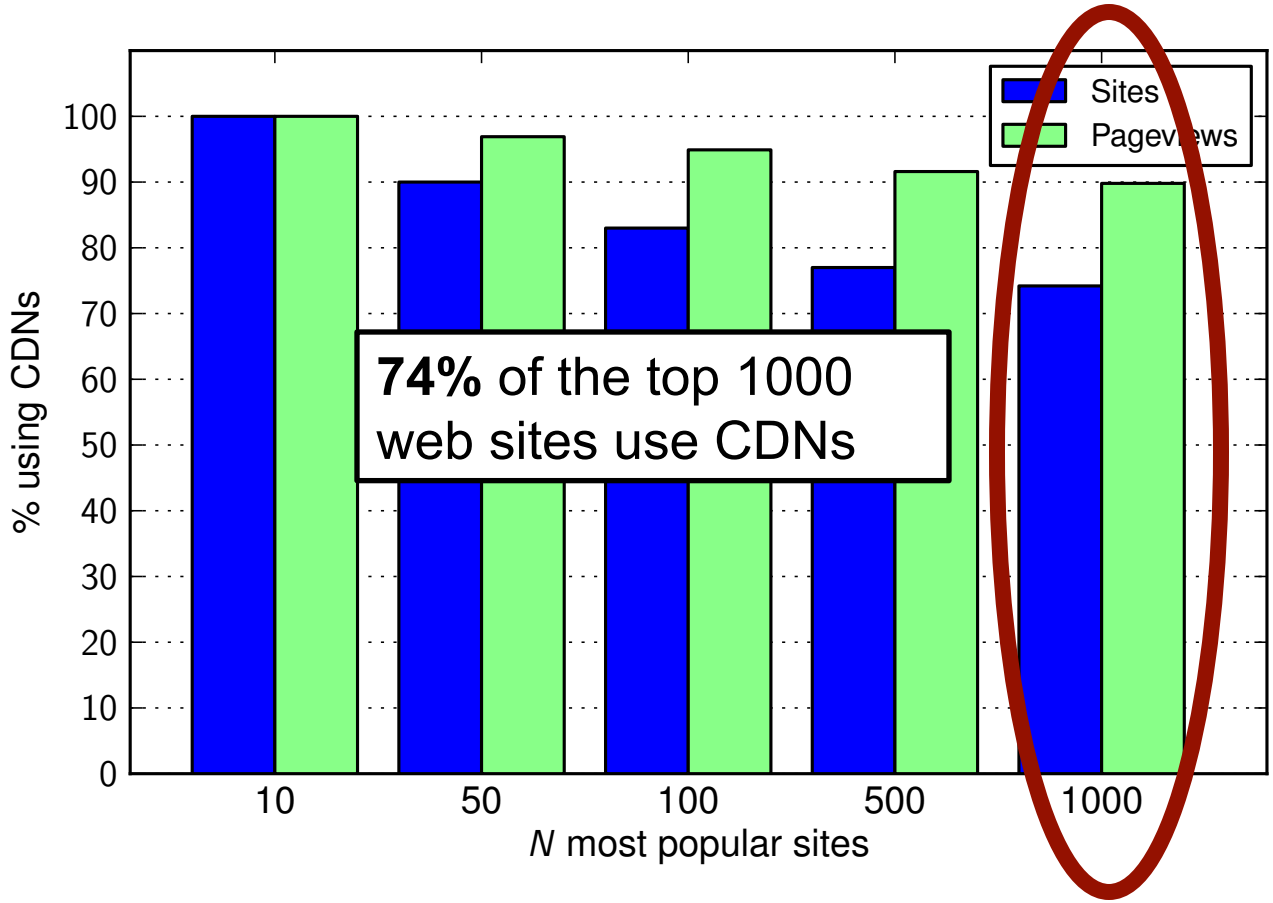
Chartbeat
ScorecardResearch
insightexpress
discover tomorrow, today
TRUSTe
CERTIFIED PRIVACY
DoubleVerify
Trust in Advertising
AudienceScience
CNN
atlas
TURNER
BROADCASTING SYSTEM, INC.
quigo
Deep Web Technologies
AOL
facebook
nielsen

amazon web services™
Akamai
Level (3) COMMUNICATIONS
Google™

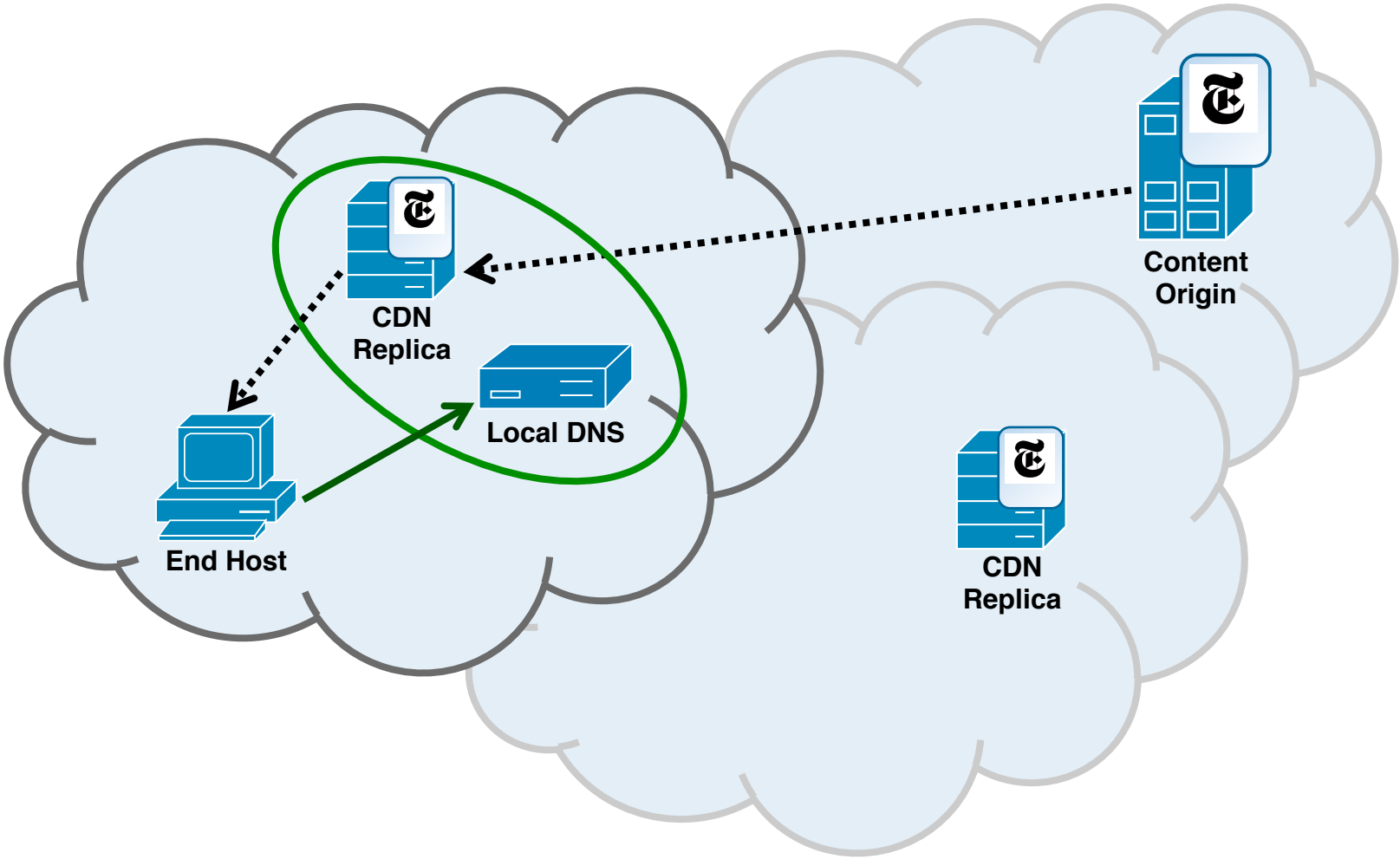
56% of domains resolve to a CDN

Ubiquity of Content Delivery Networks

- It's not just cnn.com…

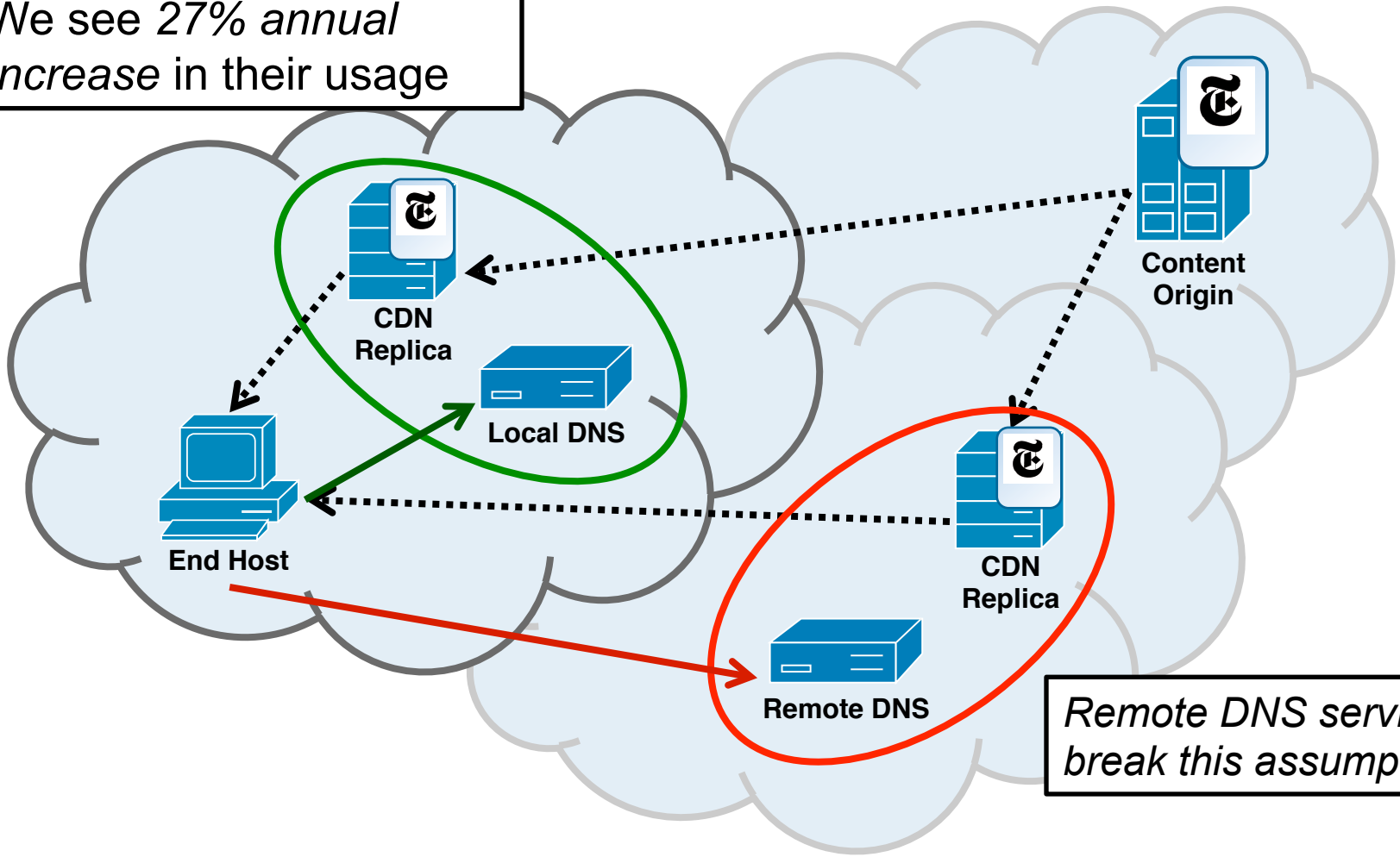


CDNs depend on user's DNS to direct requests



CDNs depend on user's DNS to direct requests

We see *27% annual increase* in their usage

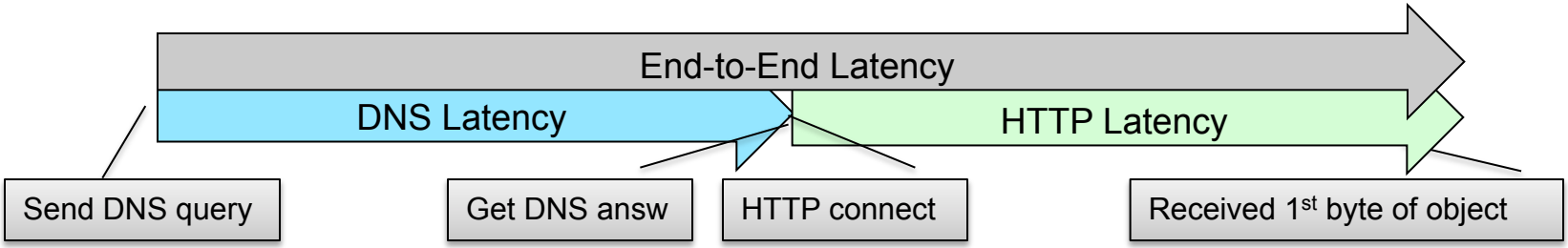


Roadmap

- The cost of remote DNS
- The industry response
- An end-host-based solution

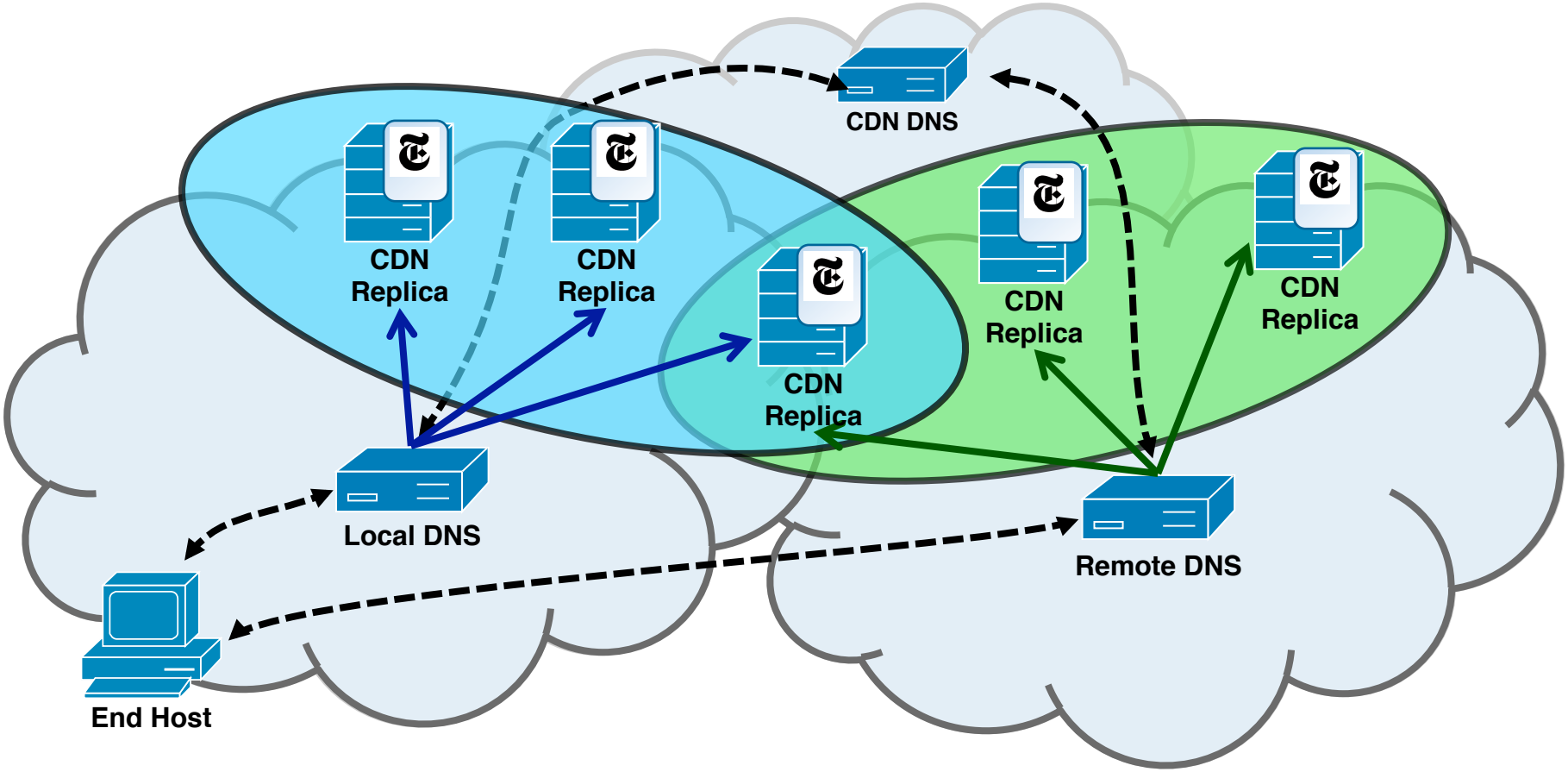
The numbers

- An experiment in Dasu – a BitTorrent-based platform for network characterization and experimentation
  - Subset of clients: 10,923 hosts, 99 countries, 752 ISPs
- Measure DNS servers
  - ISP servers and public DNS services
  - Network and application level probes
- Obtain CDN redirections for each DNS service
  - Download small web objects hosted by several CDNs
  - Do iterative resolution for baseline
  - In this talk… Google DNS and Akamai CDN as examples



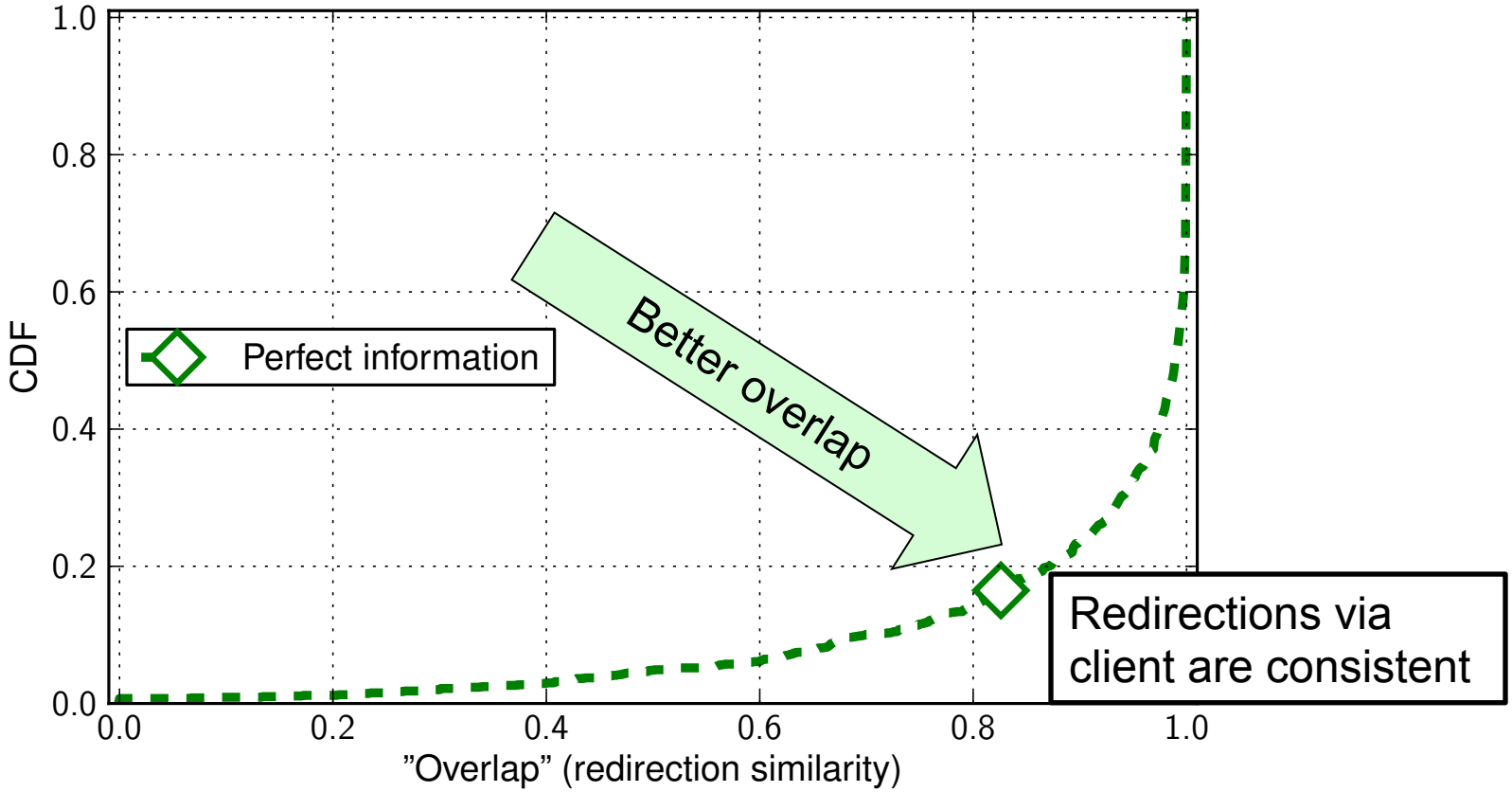
Evaluating CDN redirections

- Multiple redirections show *typical* set of servers
  - Depends on DNS location, CDN load balancing, network conditions
- Compare *overlap* of servers between locations



Impact of remote DNS on CDN redirections

- Remote DNS services yield radically different redirections
  - Minimal overlap with those seen from the client



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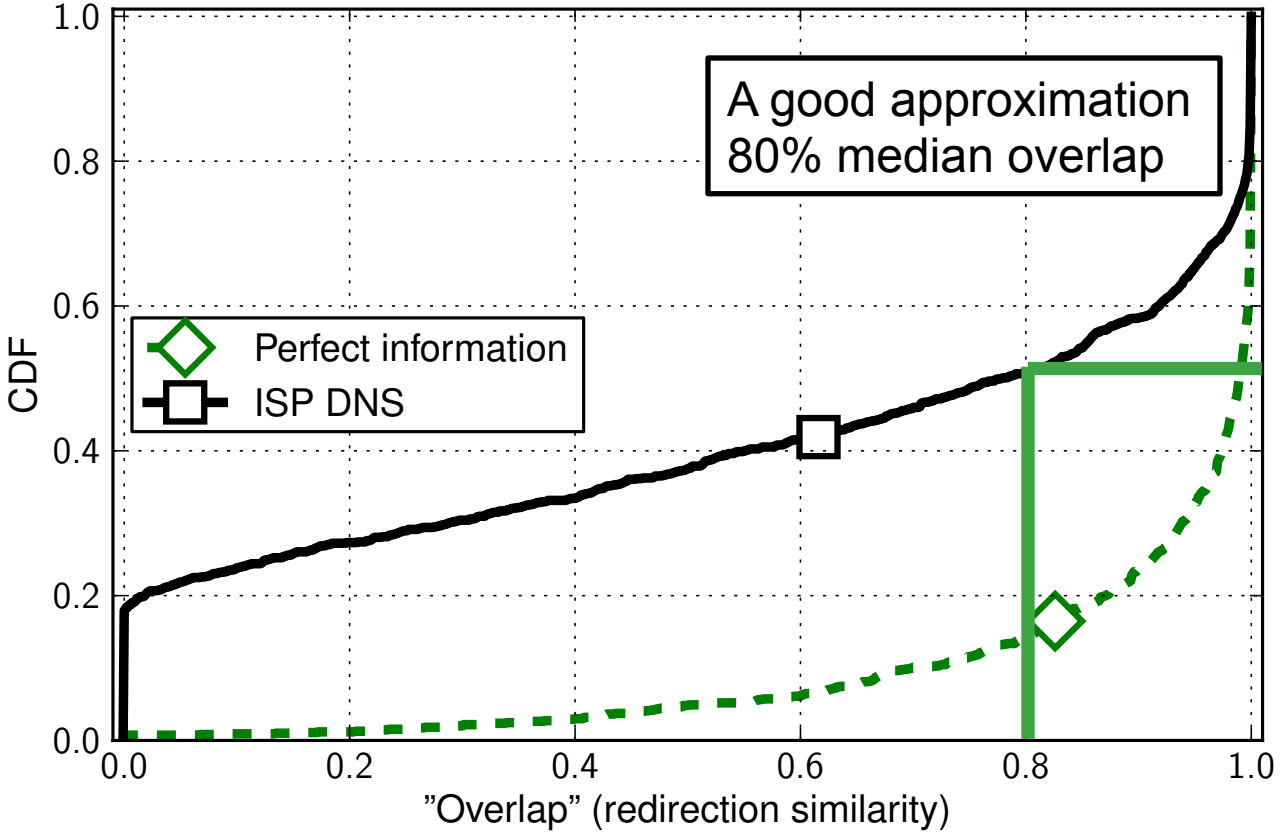

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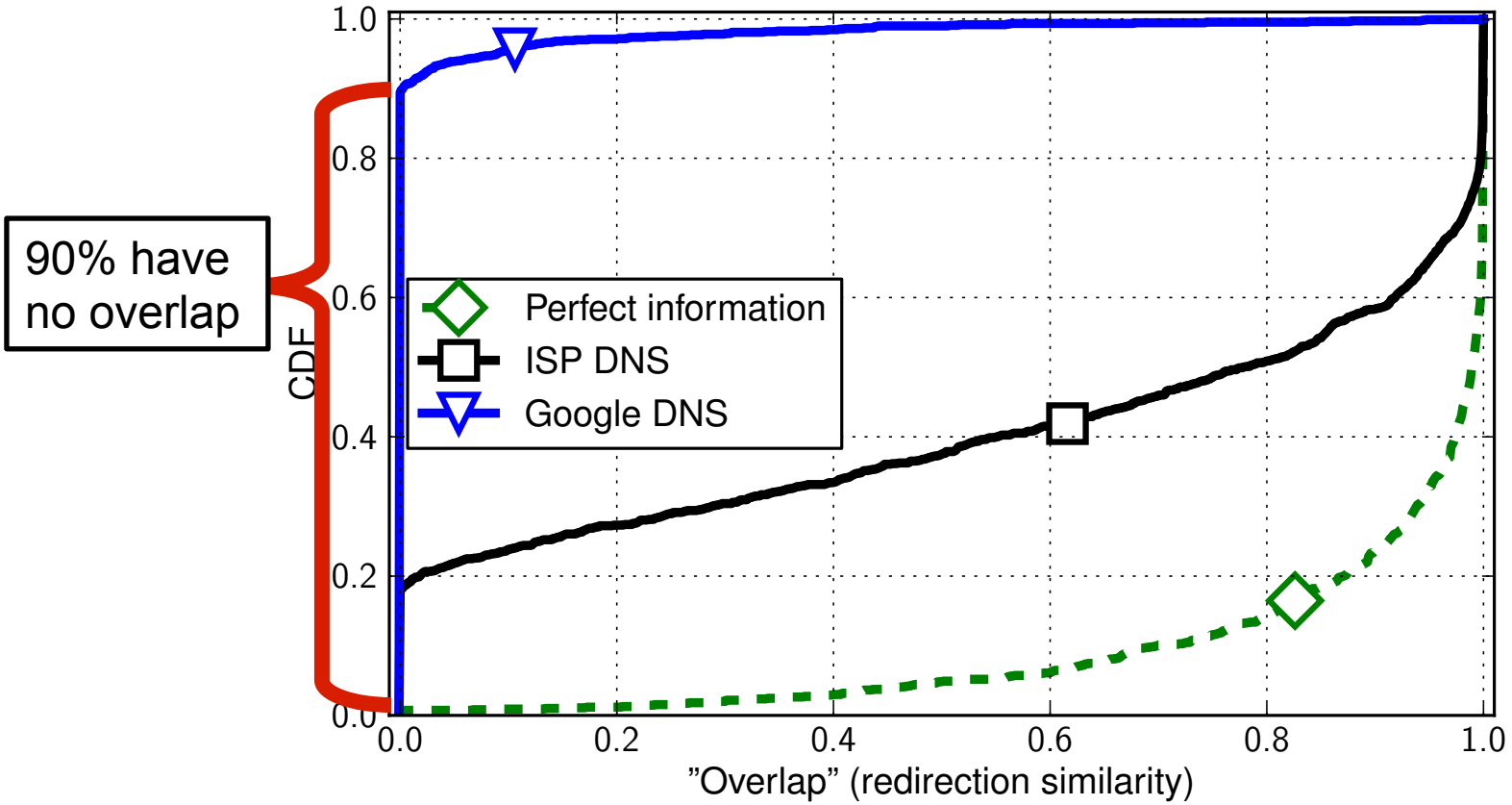
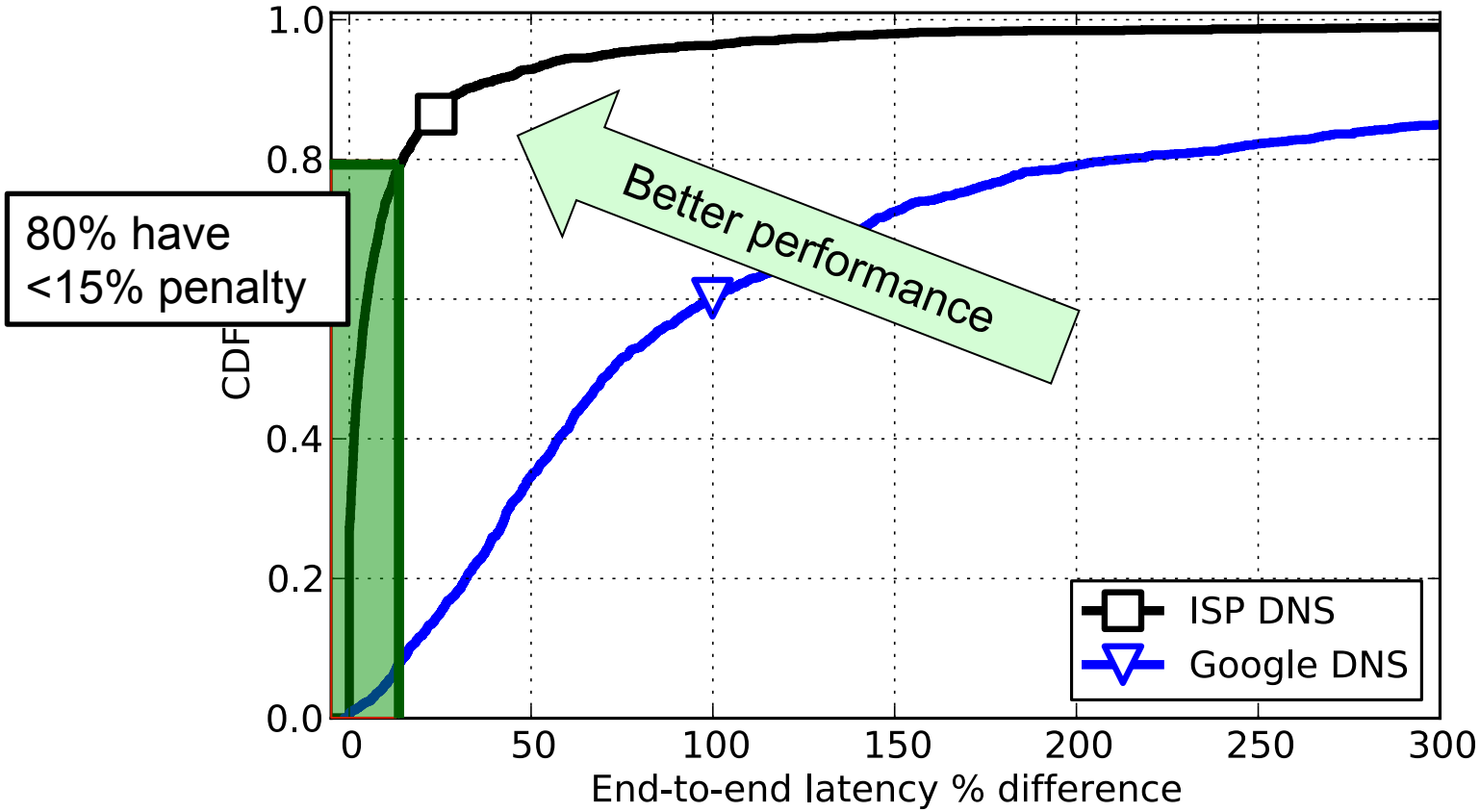


- *Different redirections, but does it affect performance?*

Impact of remote DNS on CDN performance

- Different redirections mean different performance



Impact of remote DNS on CDN performance

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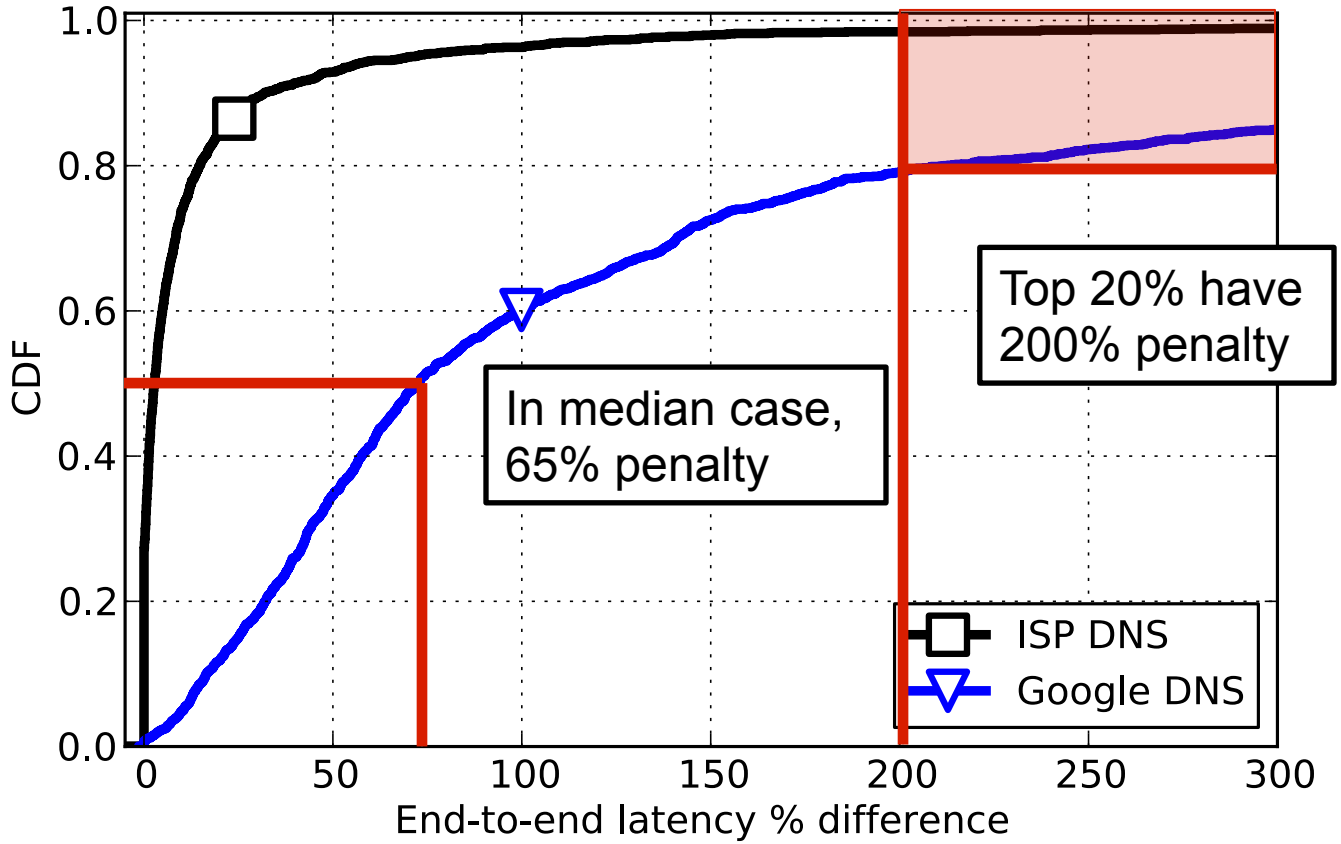


Roadmap

- The cost of remote DNS
  - Yields *different* CDN redirections to 90% of users
  - Increasing end-to-end web latency by 65% for median user
- The industry response
- An end-host-based solution

DNS extension approach

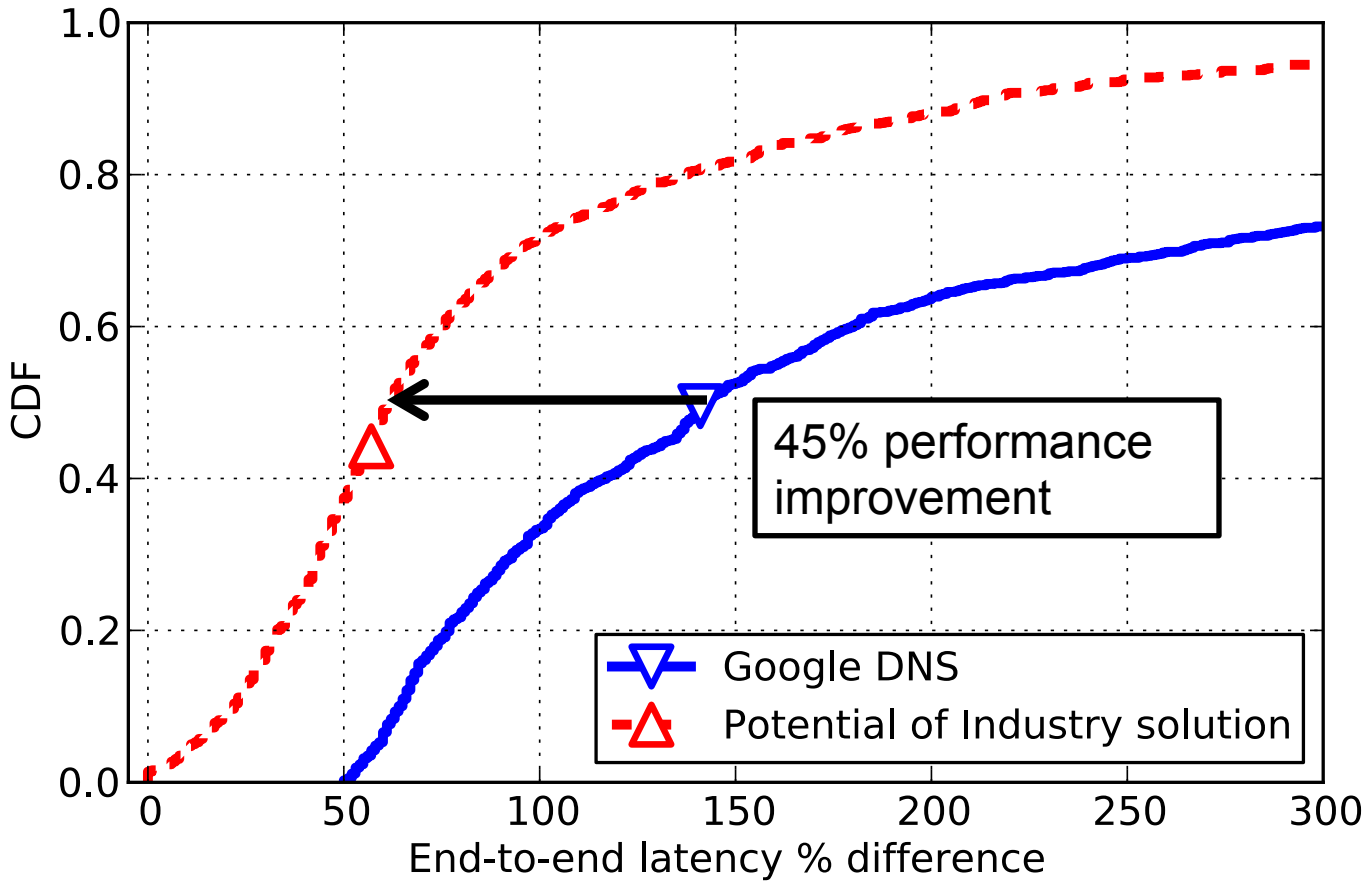
- Idea: avoid impact of remote DNS by changing localization approach – directly provide *client location* to CDN

- Implemented as an EDNS0 extension "*edns-client-subnet*"
- DNS resolver adds client's IP prefix to request
- CDN redirection based on client's location, not resolver's

- First evaluation of EDNS effectiveness
- Approximate client location approach typically sufficient
  - /16 prefix enough for Google and EdgeCast CDNs

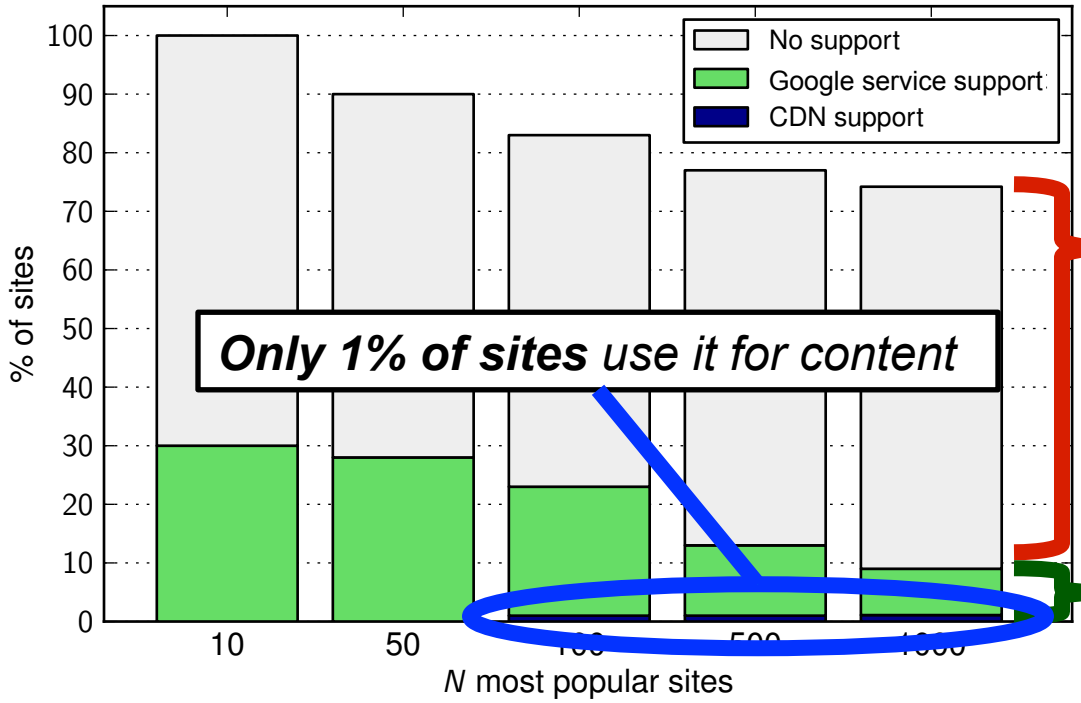
Evaluating the DNS extension approach

- Focus on places where remote DNS affects performance



DNS extension adoption

- *Minor* issue – both DNS *and* CDN services *must* support it



*most sites **don't support it***

Most support seen for Google services

Should we just wait?
5-10 public DNS
100's of ISPs
50+ CDNs

Roadmap

- The cost of remote DNS
  - Yields *different* CDN redirections to 90% of users
  - Increasing end-to-end web latency by 65% for median user
- The industry response – *edns-client-subnet*
  - First evaluation of its effectiveness
  - Median user could get 45% performance improvement
  - Nearly 2 years since proposed; 1% of sites support it
- An end-host-based solution

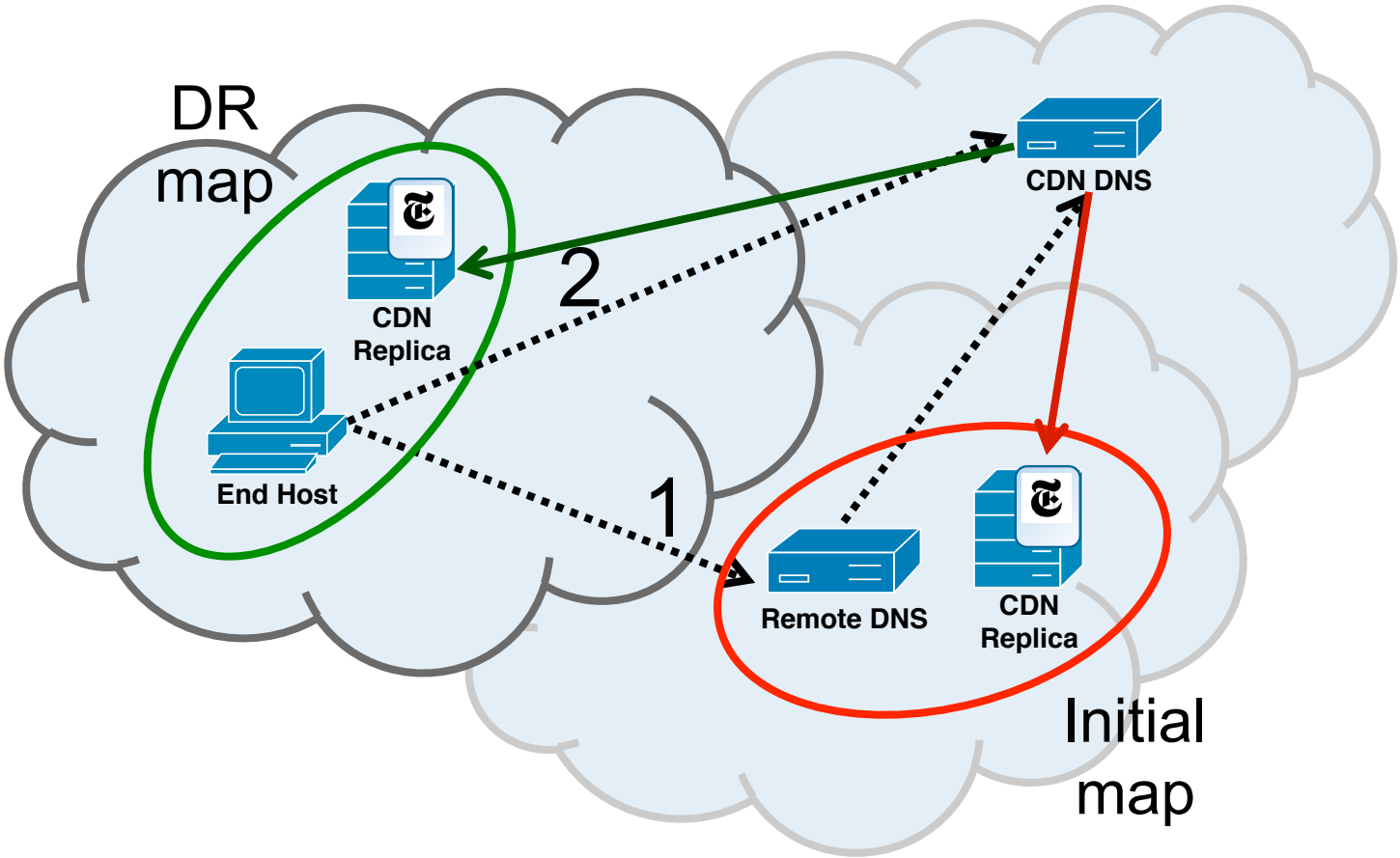
End host solution – `namehelp`

- Different approach: move the resolver *close to the user*
- End host directly queries for CDN redirection
  - CDN redirection based on client's location

- Run a DNS proxy on the user's machine
- Monitor stream of requests to identify CDN redirections
- Use *Direct Resolution* to improve redirection quality

Direct Resolution approach

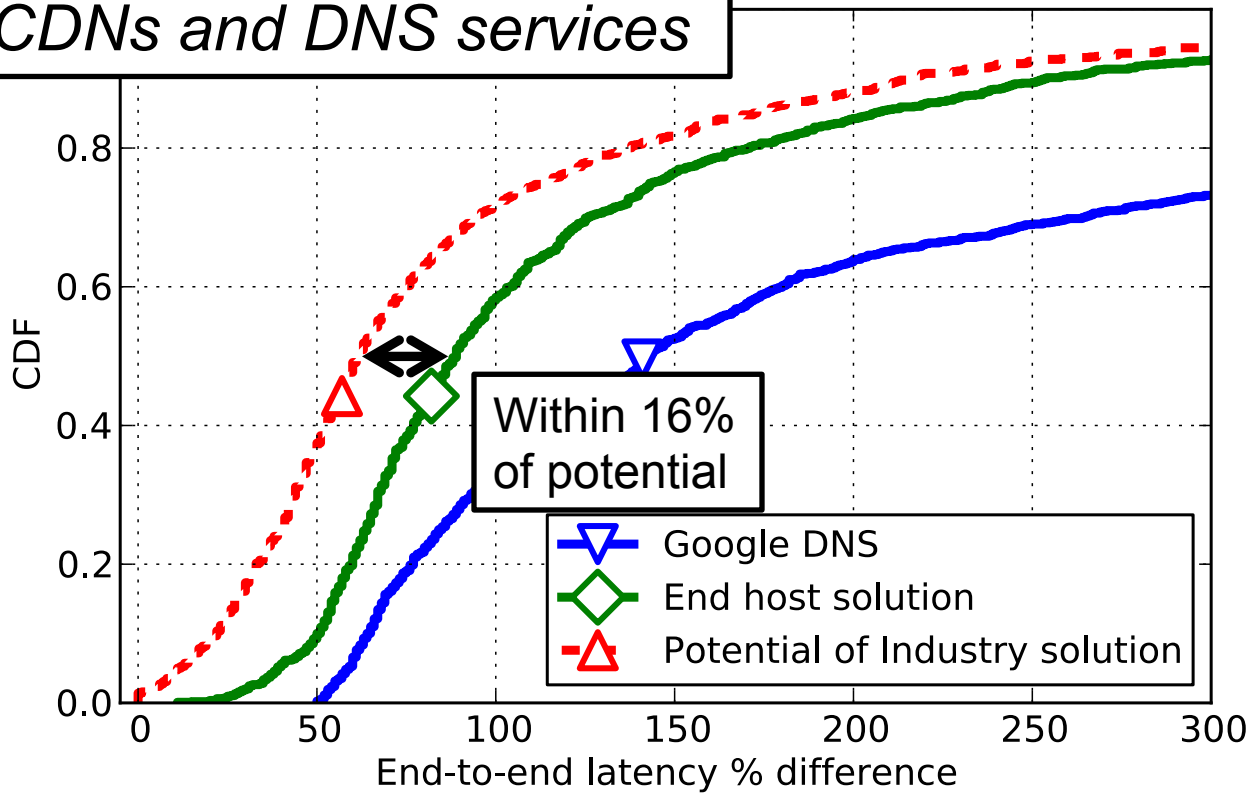
- Step 1: typical DNS query to recursive resolver
  - Use recursive DNS to translate customer name to CDN
- Step 2: directly query CDN for an improved redirection



Evaluating solutions

- Focus on places where remote DNS affects performance

Available now – works with all CDNs and DNS services



Improves performance in 76% of locations

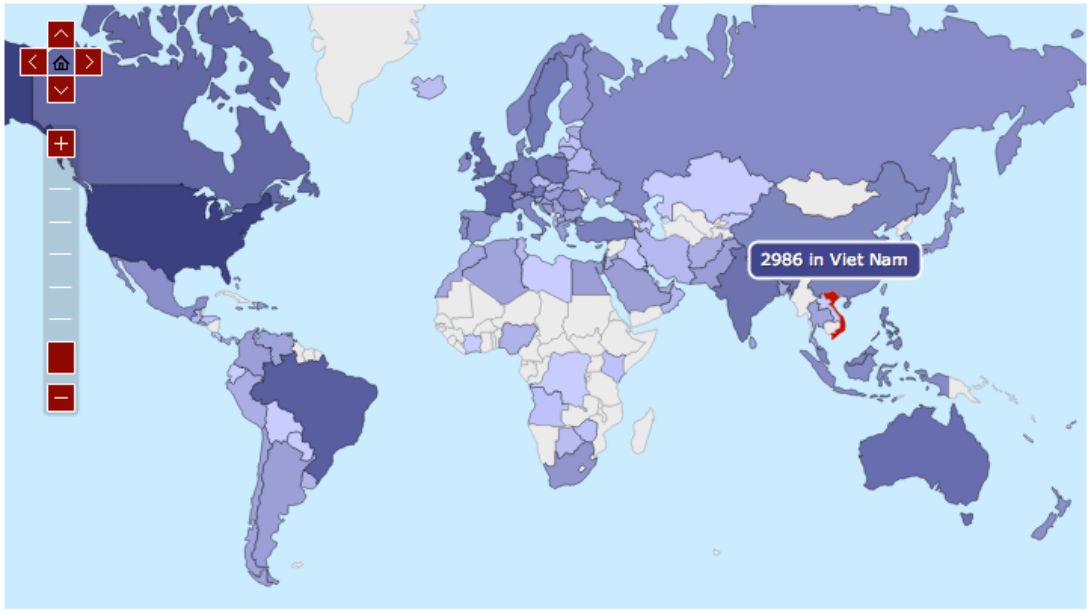
Summary

- The cost of remote DNS
  - Gives *different* CDN redirections to 90% of users
  - Increases end-to-end web latency by 65% for median user
- The industry response – *edns-client-subnet*
  - First evaluation of its effectiveness
  - Median user could get 45% performance improvement
  - Nearly 2 years since proposed; 1% of sites support it
- An end-host-based solution
  - 40% improvement for median user
  - Gives better performance in **76% of affected locations**
  - Readily available
  - …

namehelp

- … more than *just* better CDN performance
  - Faster lookups with proactive caching
  - Automatic, personalized server selection
  - Graceful handling of DNS outages …

- First 23 days
- 13,800 users
- 125 countries



- Get it today!

http://aqualab.cs.northwestern.edu/projects/namehelp