Improving Performance and Cost in a Hyperconnected World

Georgios Smaragdakis
The New Internet

Global Internet Core

Global Transit / National Backbones

"Hyper Giants"
Large Content, Consumer, Hosting CDN

Regional / Tier2 Providers

IXP

IXP

IXP

ISP1

ISP2

Customer IP Networks

New core of interconnected content and consumer networks \[1,2\] \rightarrow “Hyperconnectivity”

\[1\] “Internet Interdomain Traffic”, Labovicz et al. SIGCOMM 2010
\[2\] “Anatomy of a large European IXP”, Ager et al. SIGCOMM 2012
The New Internet

Google, Akamai, Netflix, Amazon, ...

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Customer IP Networks

Traffic Engineering:
Adjust routing or peering
- Offline process
- Oscillations [1]

Source: Arbor Networks 2010

New Challenges

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IXP

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IXP

ISP1

ISP2

Source: Arbor Networks 2010

Moving Target I:
Popular Applications, new CDN paradigms

Moving Target II:
Bottlenecks [1]

other corporate ASN (aggregation step which we only observed downstream from reflecting geographic backbone segmentation and merger or since many large transit providers manage dozens of ASNs by each Internet provider in our study either originating or tra
domain tra
terns.
illustrates emerging dominant Internet tra
erally reflects historical BGP topology while Figure B
3.1 Provider Inter-domain Traffic Share

As a category, the ten largest providers by inter-domain

Microsoft) and Comcast, we anonymize provider names in
2009. With the exception of content providers (look at the ten largest contributors (based on our analysis)

3. ASN TRAFFIC ANALYSIS

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Global Internet

When ISPs loose the control and monetization of their network: "René Obermann, Deutsche Telekom’s chief executive, said Google and others should pay telecoms groups for carrying content on their networks"
Content Distribution Challenges

Content Distribution Challenges

Client → CDN DNS → Internet Service Provider (ISP) → Provider/3rd party DNS → CDN Host → User

Mis-location

Unawareness of Network Bottlenecks [1]

Content Distribution Challenges

- Mis-location
- Unawareness of Network Bottlenecks
- Diminishing Revenue of “Bytes Delivery”
- Provider/3rd party DNS
- User DNS

Client → CDN DNS → CDN Host

1. Client
2. Provider/3rd party DNS
3. Internet Service Provider (ISP)
4. 3rd party
5. User
Grand Challenge

Dynamically adapts traffic demand by taking advantage of server and path diversity, and ISP network knowledge!

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Dynamically adapts traffic demand by taking advantage of server and path diversity, and ISP network knowledge!

Requirements:
- Online Process
- No Routing Re-configuration
- No Additional Investments/Possible OpEx Reduction
- Transparent to end-users

Grand Challenge

Dynamically adapts traffic demand by taking advantage of server and path diversity, and ISP network knowledge!

→ A new paradigm for negotiations and collaboration!
  E.g. joint products, rethinking VoD, rewards if your behave nicely.

→ A new blue print to design networks!
  E.g., making decisions: backbones or colocation/exchange points?
  Is remote peering enough?

Network Diversity of CDN Servers

- Significant Network Diversity of servers over time for top content providers, especially during peak time
- Typically, a significant number (3 to 10) of different paths to access the content are available
ISP-CDN Collaboration

1. Client
2. Provider/3rd party DNS
3. Internet Service Provider (ISP)
4. Full View of the ISP Network and user location
5. External DNS
6. Available Servers, CPU load, TTL (seconds)
7. Network Monitor

[Available Servers], CPU load, TTL (seconds)
ISP-CDN Collaboration

1. Client
2. External DNS
3. Provider DNS
4. Internet Service Provider (ISP)
5. Host 1
6. Host 2
7. Host 3
8. Host 4
ISP-CDN Collaboration

External DNS

Provider DNS

Internet Service Provider (ISP)

Network Monitor

Host

Host1
Host2
Host3
Host4

Host1
Host2
Host3
Host4

Host1

Host2

Host3

Host4

Client

Host 1

Host 2
Demand Request
Available Locations
Slice Specifications
Slice Allocation
Slice Commit

Full View of the ISP
Network & Resources, and user location

ISP
Resource Broker[1]

Generic Appliance

Network Function Virtualization

Short-time scales: on-demand CDN deployment

Long-time scales: Placement of CDN servers (Google GGC, Netflix, OpenConnect,..), Licensed CDN (Akamai, Edgecast,..)

Network Load Balancing

Host A

Host B

Host C

Clients in PoP
Network Load Balancing

Host A

Host B

Host C

Clients in PoP
Network Load Balancing
Network Load Balancing

Host A  Host B  Host C

New Host

Clients in PoP
An Opportunity for Better Traffic Engineering

- Moving traffic from congested link to less congested
- Improvement in the networks capacity (10-20%)
- Performance improvements in multiple metrics
Summary

- A large fraction of the Internet traffic is due to a small number of CDNs
- Opportunity for joint CDN deployment and co-operation by ISP and CDN by utilizing:
  (1) server and path diversity
  (2) knowledge about the network and user location
  (3) flexible server deployment
- Benefits for all involved parties including CDNs, ISPs, end-users
Thank you!

http://www.smaragdakis.net/research/Collaboration