Should a load-balancer choose the path as well as the server?

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Can’t choose path :’( 
Outline and goals

- A new architecture for distributed load-balancing
  - joint (server, path) selection
- Demonstrate a nation-wide prototype
- Interesting preliminary results
I’m here to ask for your help!
Software Defined Networking

Network OS

Custom Hardware

OS

Custom Hardware

Feature

Feature

Feature

Feature

Feature

Feature

OS

Custom Hardware

OS

Custom Hardware

OS

Custom Hardware

OS

Custom Hardware

Feature

Feature

Feature

Feature

Feature

Feature
Load Balancing is just Smart Routing
Load-balancing as a network primitive

Network OS

Load-balancing decision
Load-balancing decision
Load-balancing decision
Load-balancing decision

Custom Hardware
Custom Hardware
Custom Hardware
Custom Hardware

Custom Hardware

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Aster*x Controller
http://www.openflow.org/videos
So far...

- A new architecture for distributed load-balancing
  - joint (server, path) selection
- Aster\*x – a nation-wide prototype
- Promising results that joint (server, path) selection might have great benefits
What next?
How big is the pie?

Characterizing and quantifying the performance of joint (server, path) selection
Load-balancing Controller
Parameters

Topology

- Intra-AS topologies
  - BRITE (2000 topologies)
  - CAIDA (1000 topologies)
  - Rocketfuel (~100 topologies)
- 20-50 nodes
- Uniform link capacity
Parameters

Servers
- 5-10 servers
- Random placement

Service
- Simple HTTP service
- Serving 1 MB file
- Additional server-side computation
Parameters

Clients

- 3-5 client locations
- Random placement

Request pattern

- Poisson process
- Mean rate: 5-10 req/sec
Load-balancing strategies?
Design space

Simple but suboptimal

Complex but optimal

Disjoint-Shortest-Path

Disjoint-Traffic-Engineering

Joint
Anatomy of a request-response
Disjoint-Shortest-Path

- CDN selects the least loaded server
  - Load = retrieve + deliver
- ISP independently selects the shortest path
Disjoint-Traffic-Engineering

- CDN selects the least loaded server
  - Load = retrieve + deliver
- ISP independently selects path to minimize max load
  - Max bandwidth headroom
Joint

- Single controller jointly selects the best (server, path) pair

Total latency = retrieve + estimated deliver
Disjoint-Shortest-Path vs Joint

Disjoint-Shortest-Path performs ~2x worse than Joint
Disjoint-Traffic-Engg. vs Joint

Disjoint-Traffic-Engineering performs almost as well as Joint
Is Disjoint truly disjoint?

Server response time contains network information
The bottleneck effect

A single bottleneck resource along the path determines the performance.
The CDN-ISP game

Clients

ISP

CDN
The CDN-ISP game

- System load monotonically decreases
- Both push system in the same direction
Summary of observations

- Disjoint-SP is \(\sim 2x\) worse than Joint
- Disjoint-TE performs almost as well as Joint
  (despite decoupling of server selection and traffic engineering)
- Game theoretic analysis supports the empirical observation
Questions for you!

- How should I change the model to mimic a real CDN?
Questions for you!

- How can I get real data?
- What network topologies should I use?
- How should I decide the no. of servers and their location?
- How should I decide the client request pattern?
Questions for you!

- How can I try it out in your network?
- Elastic Load Balancing in EC2
- Amazon CloudFront
Conclusion

- A new architecture for distributed load-balancing
  - joint (server, path) selection
- Aster*-x - a nation-wide prototype
- Interesting preliminary results
- Future – Evaluation with real data
Let’s chat more!
Extra slides...
Sample topologies

BRITE

CAIDA
Disjoint-SP vs Ideal
Disjoint-TE vs Ideal