Data Center Middleboxes

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CS 5413: High Performance Systems and Networking
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Slides from ACM SIGCOMM 2012 presentation on “Making middleboxes someone else's problem: network processing as a cloud service”
Where are we in the semester?

• Overview and Basics
• Data Center Networks
  – Basic switching technologies
  – Data Center Network Topologies (today and Monday)
  – Software Routers (eg. Click, Routebricks, NetMap, Netslice)
  – Alternative Switching Technologies
  – Data Center Transport
• Data Center Software Networking
  – Software Defined networking (overview, control plane, data plane, NetFGPA)
  – Data Center Traffic and Measurements
  – Virtualizing Networks
  – Middleboxes
• Advanced Topics
Goals for Today

• Making middleboxes someone else's problem: network processing as a cloud service,
“Appliance for Outsourcing Middleboxes”

- Place middleboxes in the cloud.
- Use APLOMB devices and DNS to redirect traffic to and from the cloud.
- That’s it.
Typical Enterprise Networks
A Survey

• 57 enterprise network administrators

• Small (< 1k hosts) to XL (>100k hosts)

• Asked about deployment size, expenses, complexity, and failures.
How many middleboxes do you deploy?

Typically on par with # routers and switches.
What kinds of middleboxes do you deploy?

Many kinds of devices, all with different functions and management expertise required.
How many networking personnel are there?

Average salary for a network engineer - $60-80k USD
How do administrators spend their time?

Most administrators spent 1-5 hrs/week dealing with failures; 9% spent 6-10 hrs/week.

<table>
<thead>
<tr>
<th></th>
<th>Misconfig.</th>
<th>Overload</th>
<th>Physical/Electrical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firewalls</td>
<td>67.3%</td>
<td>16.3%</td>
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</tr>
<tr>
<td>Proxies</td>
<td>63.2%</td>
<td>15.7%</td>
<td>21.1%</td>
</tr>
<tr>
<td>IDS</td>
<td>54.45%</td>
<td>11.4%</td>
<td>34%</td>
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</tbody>
</table>
Recap

- High Capital and Operating Expenses

- Time Consuming and Error-Prone

- Physical and Overload Failures
How can we improve this?
Proposal
A move to the cloud

- High Capital and Operating Expenses
- Economies of scale and pay-per use
- Time Consuming and Error Prone
- Simplifies configuration and deployment
- Physical and Overload Failures
- Redundant resources for failover
Design
Challenges

• Minimal Complexity at the Enterprise

• Functional Equivalence

• Low Performance Overhead
APLOMB

“Appliance for Outsourcing Middleboxes”
Inbound Traffic

Web Server: www.enterprise.com
192.168.1.100

Register:
www.enterprise.com
192.168.1.100
Inbound Traffic

Internet

Cloud Provider

Register: enterprise.com 98.76.54.32

DNS

98.76.54.32
Minimizing latency?
Choosing a Datacenter

Route through cloud datacenter that minimizes end to end latency.

APLOMB Gateway keeps a “routing table” to select best tunnel for every Internet prefix.
Traffic destined to services like caches should be redirected to the nearest node.
“Appliance for Outsourcing Middleboxes”

• Place middleboxes in the cloud.
• Use APLOMB devices and DNS to redirect traffic to and from the cloud.
• That’s it.
Can we outsource all middleboxes?

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<th>Can Outsource?</th>
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<tr>
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<td>✔</td>
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<tr>
<td>IDSes</td>
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<td>✔</td>
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<td>VPNs</td>
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<td>Proxy/Caches</td>
<td>❌  Bandwidth?</td>
</tr>
<tr>
<td>WAN Optimizers</td>
<td>❌  Compression?</td>
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Add generic compression to APLOMB gateway to reduce bandwidth consumption.
Can we outsource all middleboxes?

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Does it work?
Deployment

- Cloud provider: EC2 – 7 Datacenters

- OpenVPN for tunneling, Vyatta for middlebox services

- Two Types of Clients:
  - Software VPN client on laptops
  - Tunneling software router for wired hosts
Implementation & Deployment

• Performance metrics

Wide-Area Measurements

• Network latency

Case Study of a Large Enterprise

• Impact in a real usage scenario
Does APLOMB inflate latency?
For PlanetLab nodes, 60% of pairs’ latency improves with redirection through EC2.
Measured redirection latency between enterprise sites.

- Median latency inflation: 1.13 ms
- Sites experiencing inflation were primarily in areas where EC2 does not have a wide footprint.
How does APLOMB impact other quality metrics, like bandwidth and jitter?
• Bandwidth: download times with BitTorrent increased on average 2.3%

• Jitter: consistently within industry standard bounds of 30ms
Does APLOMB negate the benefits of bandwidth-saving devices?
APLOMB+ incurs a median penalty of 3.8% bandwidth inflation over traditional WAN Optimizers.
Does “elastic scaling” at the cloud provide real benefits?
Some sites generate as much as 13x traffic more than average at peak hours.
Recap

• Good application performance
  – Latency median inflation 1.1ms
  – Download times increased only 2.3%

• Generic redundancy elimination saves bandwidth costs

• Strong benefits from elasticity
Moving middleboxes to the cloud seems to be practical and feasible solution to the complexity of enterprise networks.
Conclusion and Discussion

- Did the soln make the problem simpler?
  - How to measure simplicity/complexity?
- Does the soln also make security problems someone else's problems.
  - Do we trust the cloud provider?
- Privacy concerns?
  - Do we trust the cloud provider?
- Monetary cost: Is APLOMB cheaper or more expensive?
- Precedence
  - Ariaka
  - Total uptime
- Middleboxes not at the edge of your network
  - APLOMB cannot outsource these middleboxes
Before Next time

- Project Interim report
  - Due *Today*, Monday, November 24.
  - And meet with groups, TA, and professor
- Fractus Upgrade: Should be back online

**Required review and reading for Monday, December 1**
  - [http://dl.acm.org/citation.cfm?doid=2517349.2522723](http://dl.acm.org/citation.cfm?doid=2517349.2522723)

- Check website for updated schedule