Data Center Middleboxes

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CS 5413: High Performance Systems and Networking

November 24, 2014

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

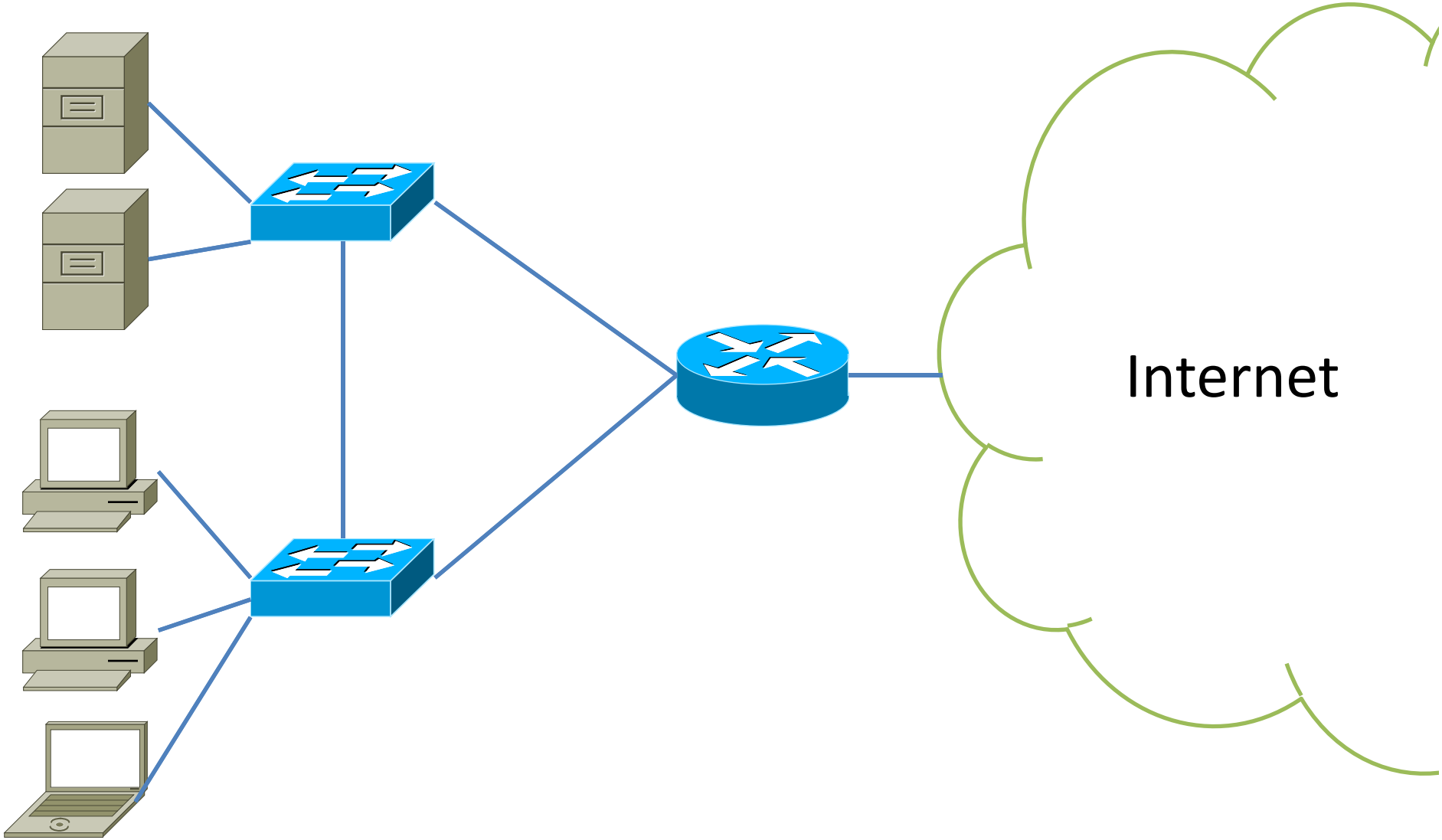
- Making middleboxes someone else's problem: network processing as a cloud service,
  - J. Sherry, S. Hasan, C. Scott, A. Krishnamurthy, S. Ratnasamy, and V. Sekar. ACM SIGCOMM Computer Communication Review (CCR) Volume 42, Issue 4 (August 2012), pages 13-24.

APLOMB

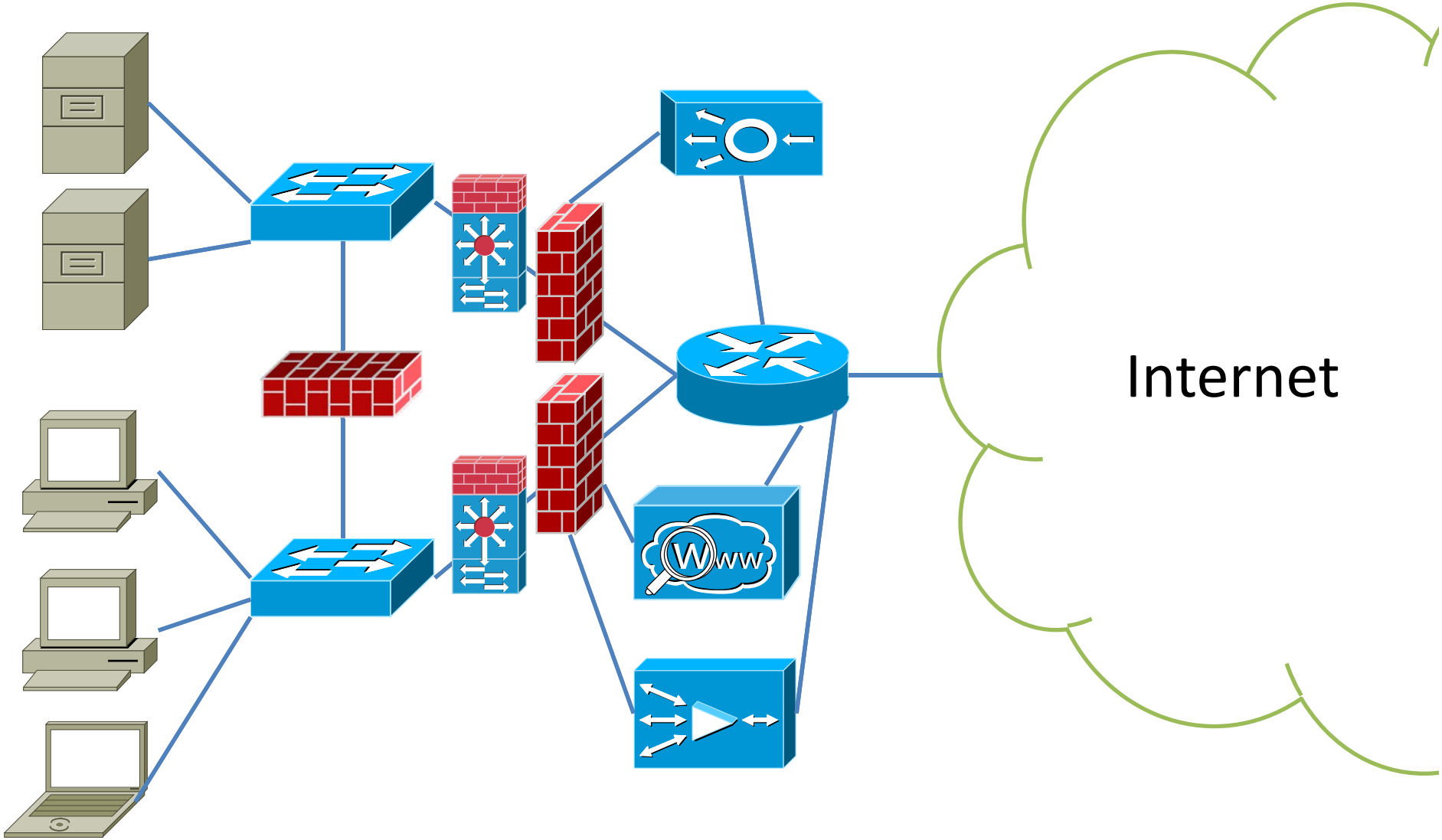
"Appliance for Outsourcing Middleboxes"

- Place middleboxes in the cloud.
- Use APLOMB devices and DNS to redirect traffic to and from the cloud.
- That's it.

Typical Enterprise Networks



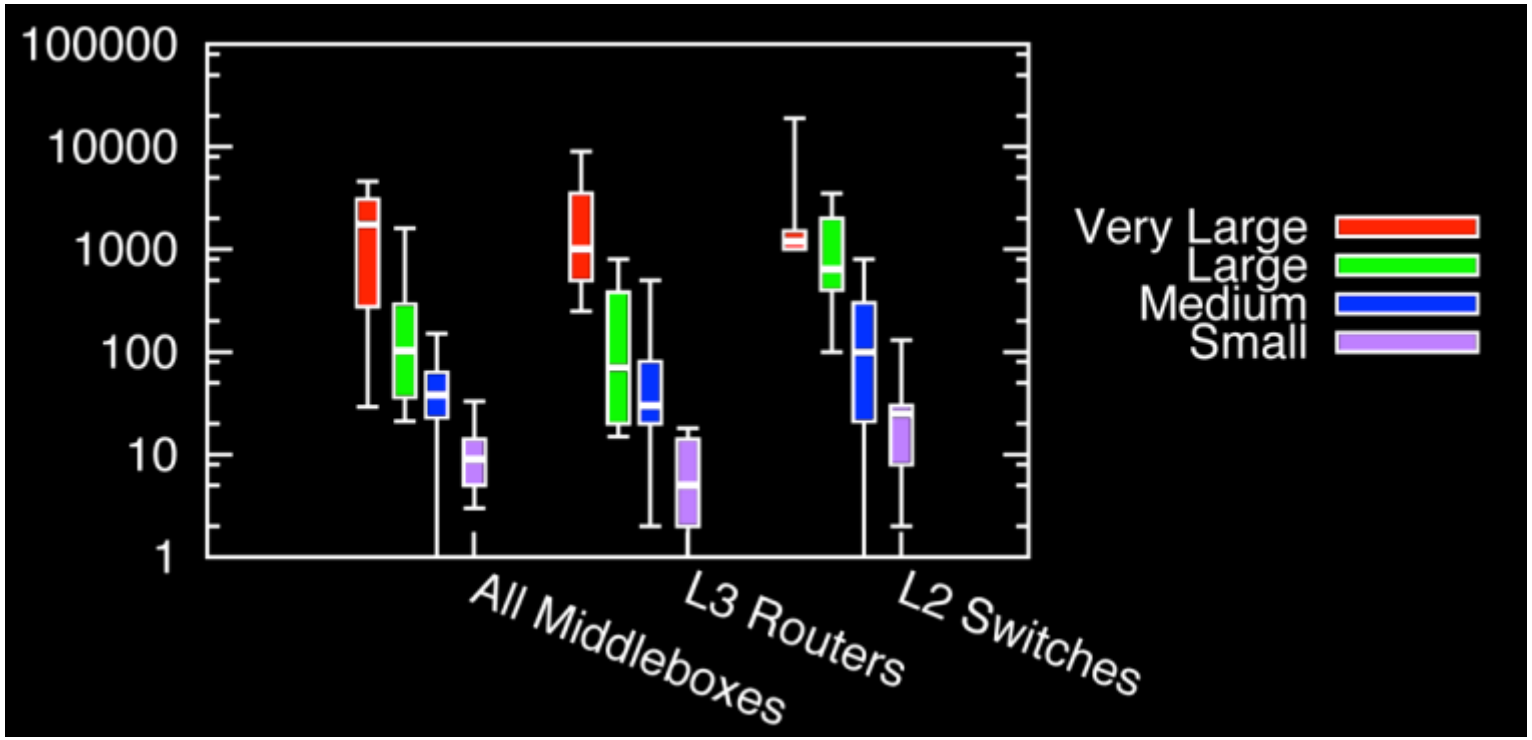
Typical Enterprise Networks



A Survey

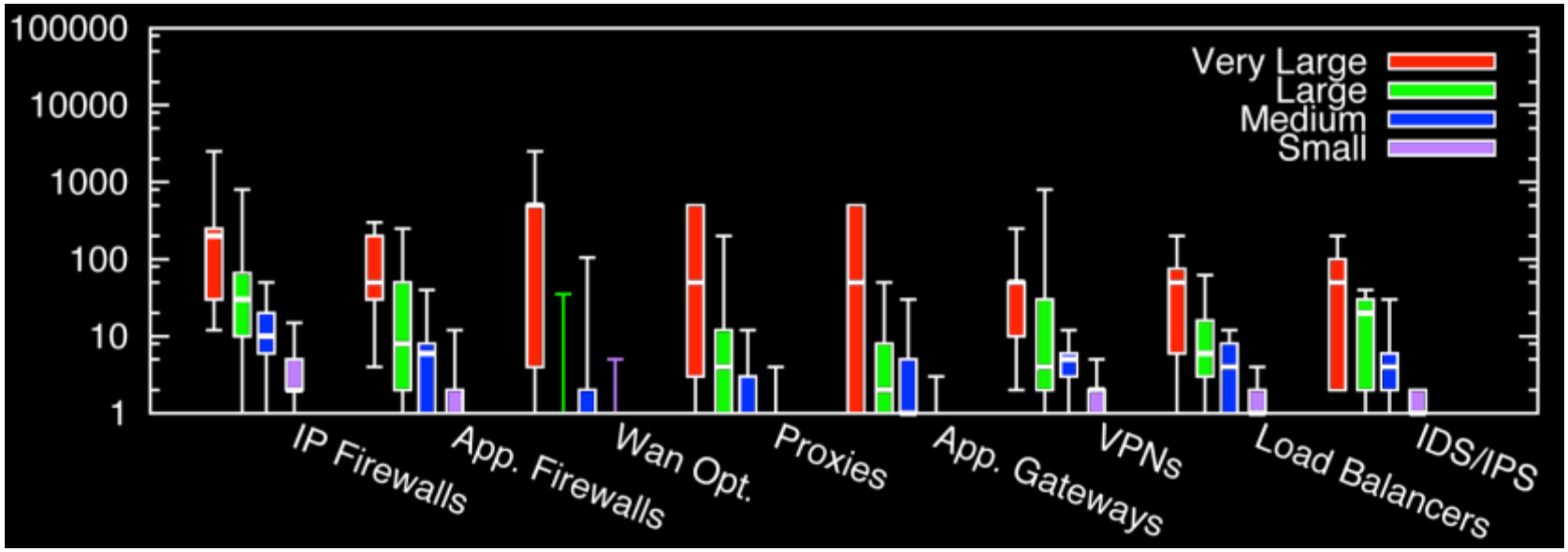
- 57 enterprise network administrators
- Small (< 1k hosts) to XL (>100k hosts)
- Asked about deployment size, expenses, complexity, and failures.

How many middleboxes do you deploy?



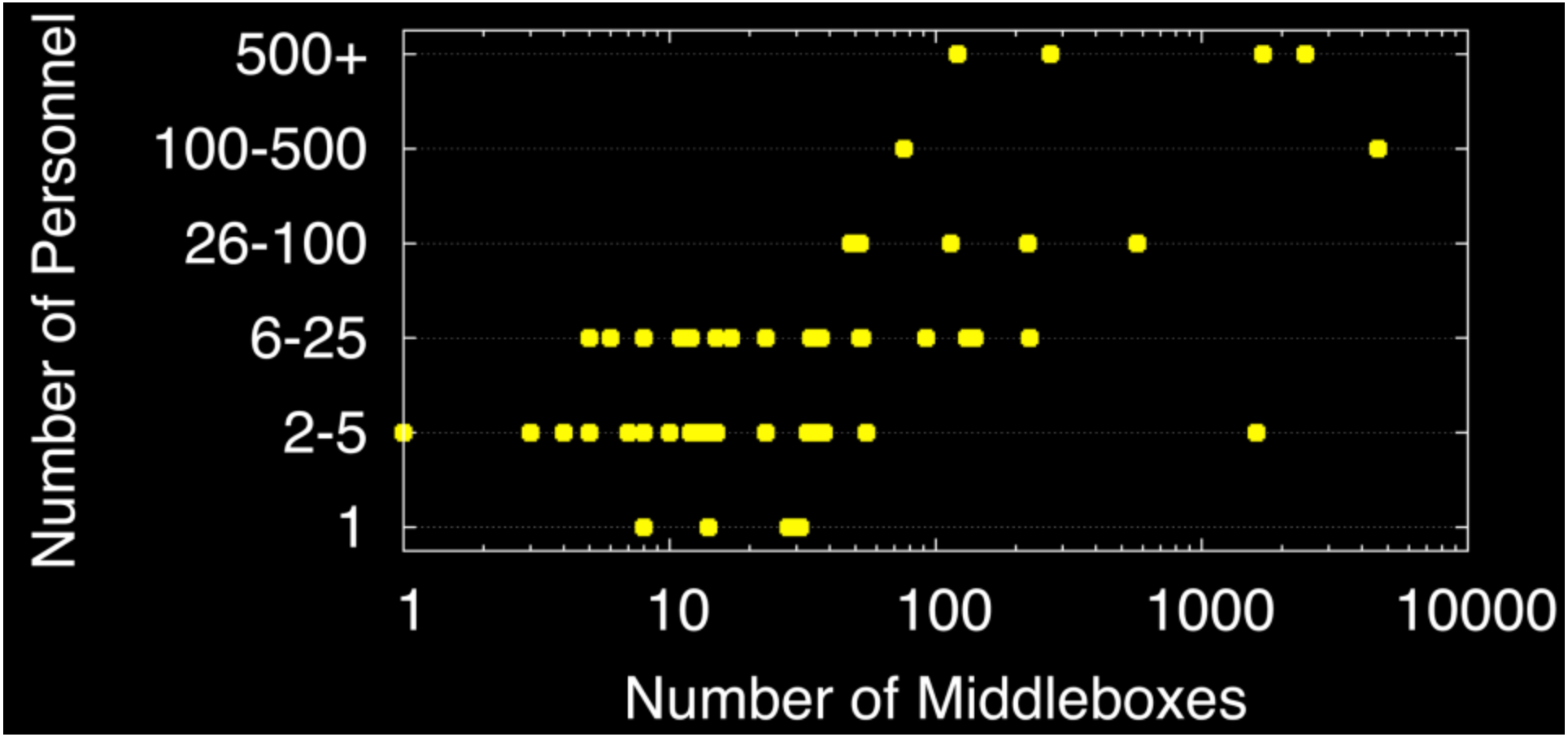
Typically on par with # routers and switches.

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.

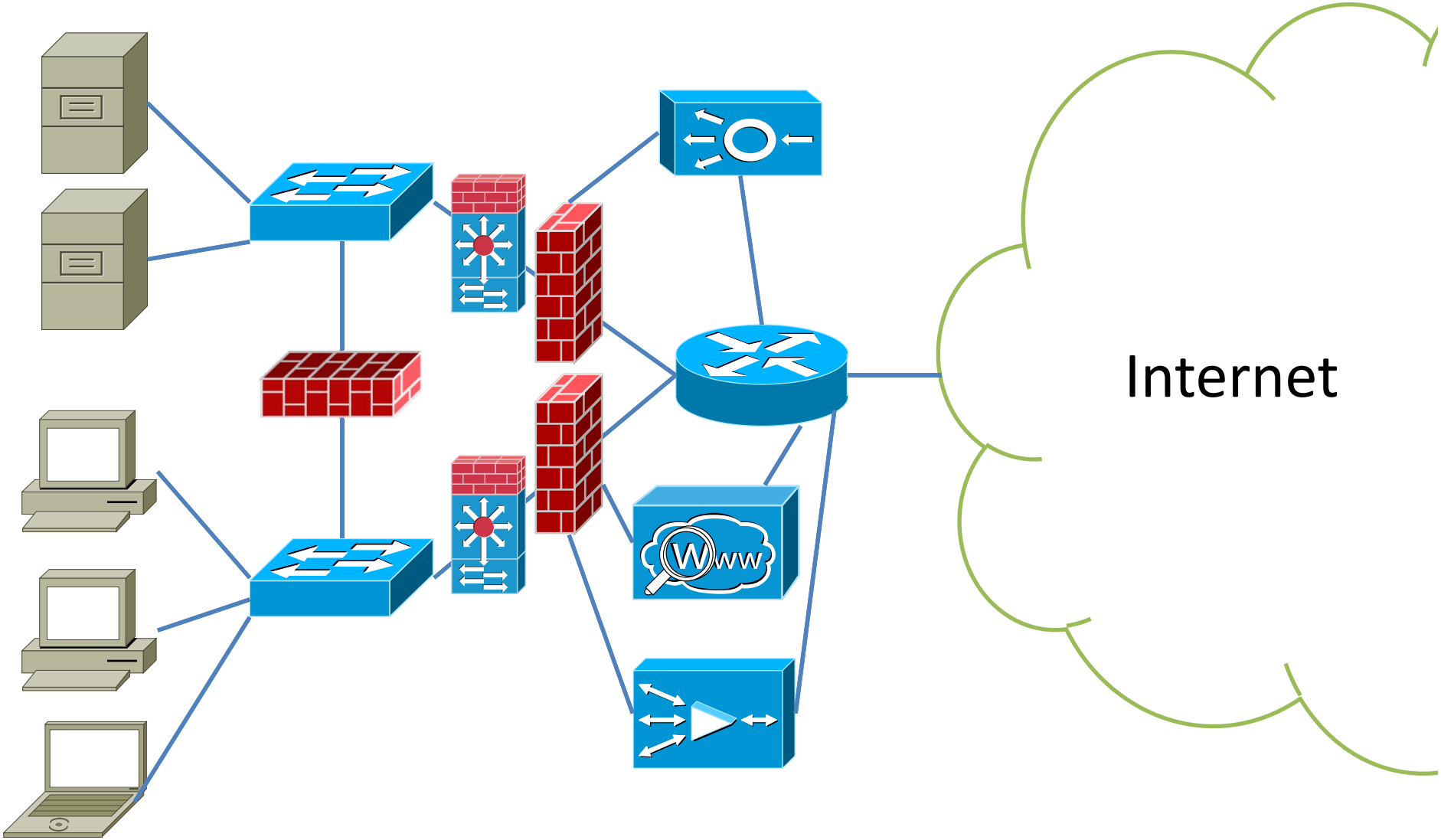
	Misconfig.	**Overload**	**Physical/ Electrical**
Firewalls	67.3%	16.3%	16.3%
Proxies	63.2%	15.7%	21.1%
IDS	54.45%	11.4%	34%

Recap

- High Capital and Operating Expenses
- Time Consuming and Error-Prone
- Physical and Overload Failures

How can we improve this?

Proposal



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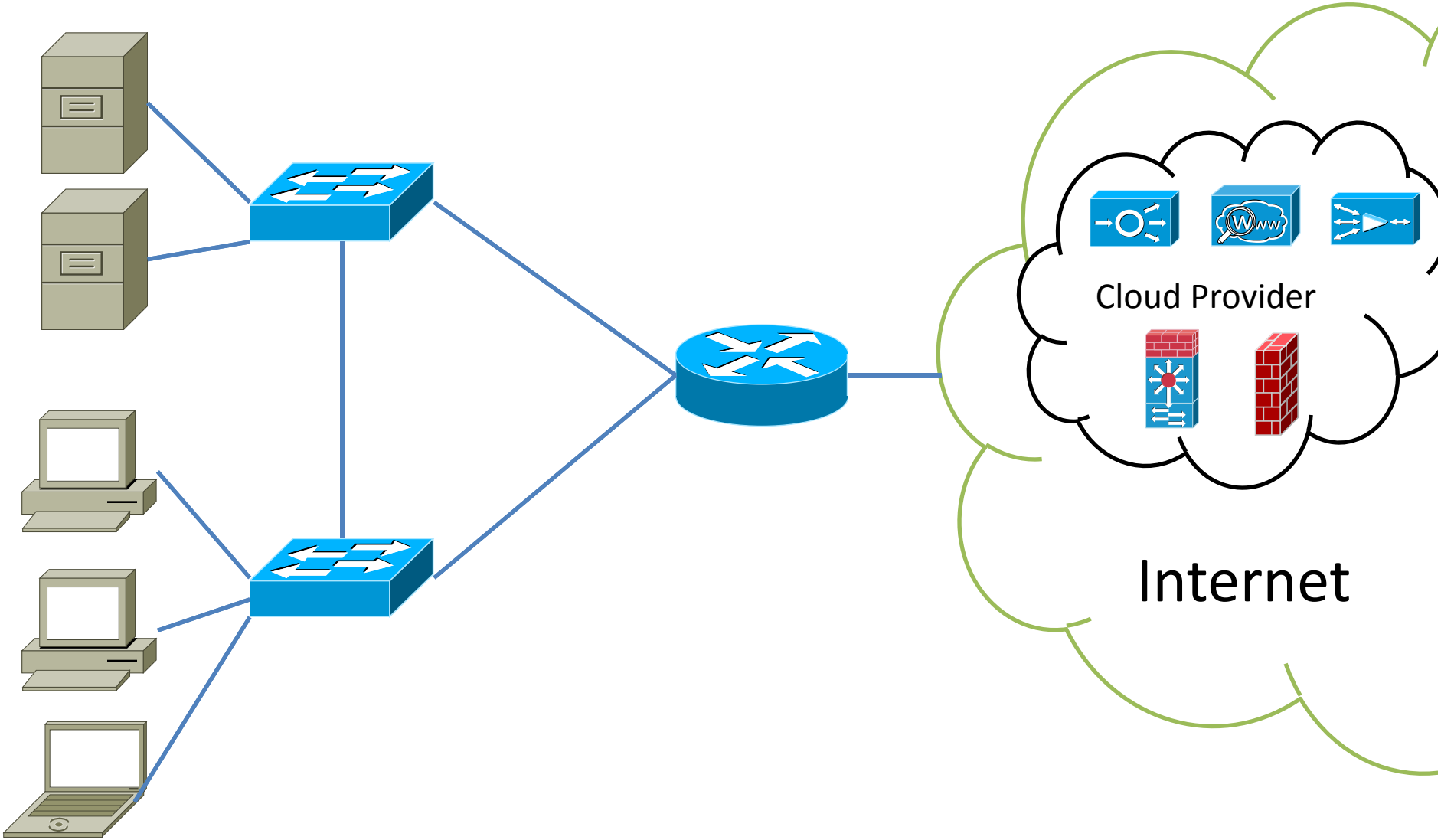


A move to the cloud

- ~~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

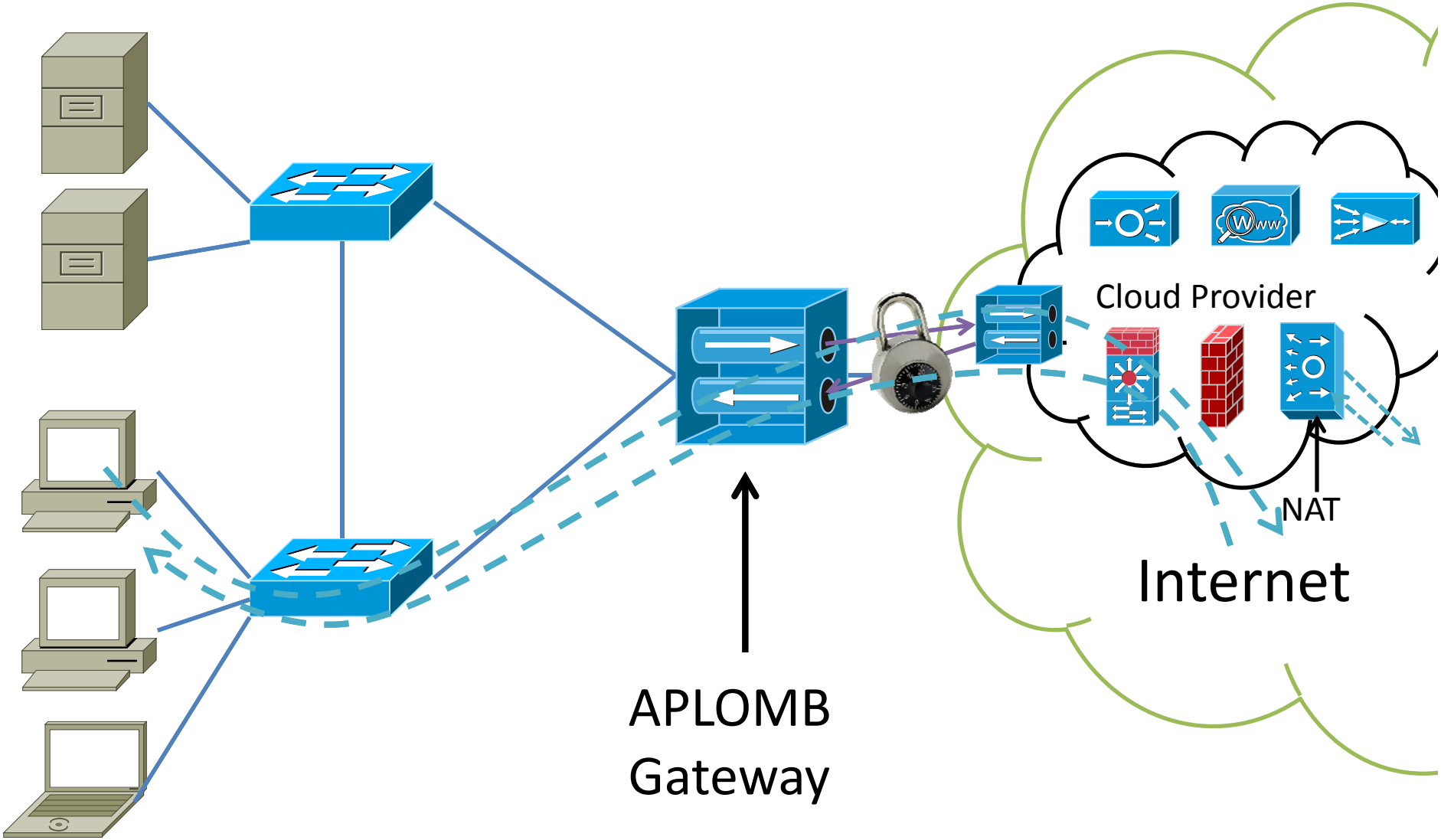
Challenges

- Minimal Complexity at the Enterprise
- Functional Equivalence
- Low Performance Overhead

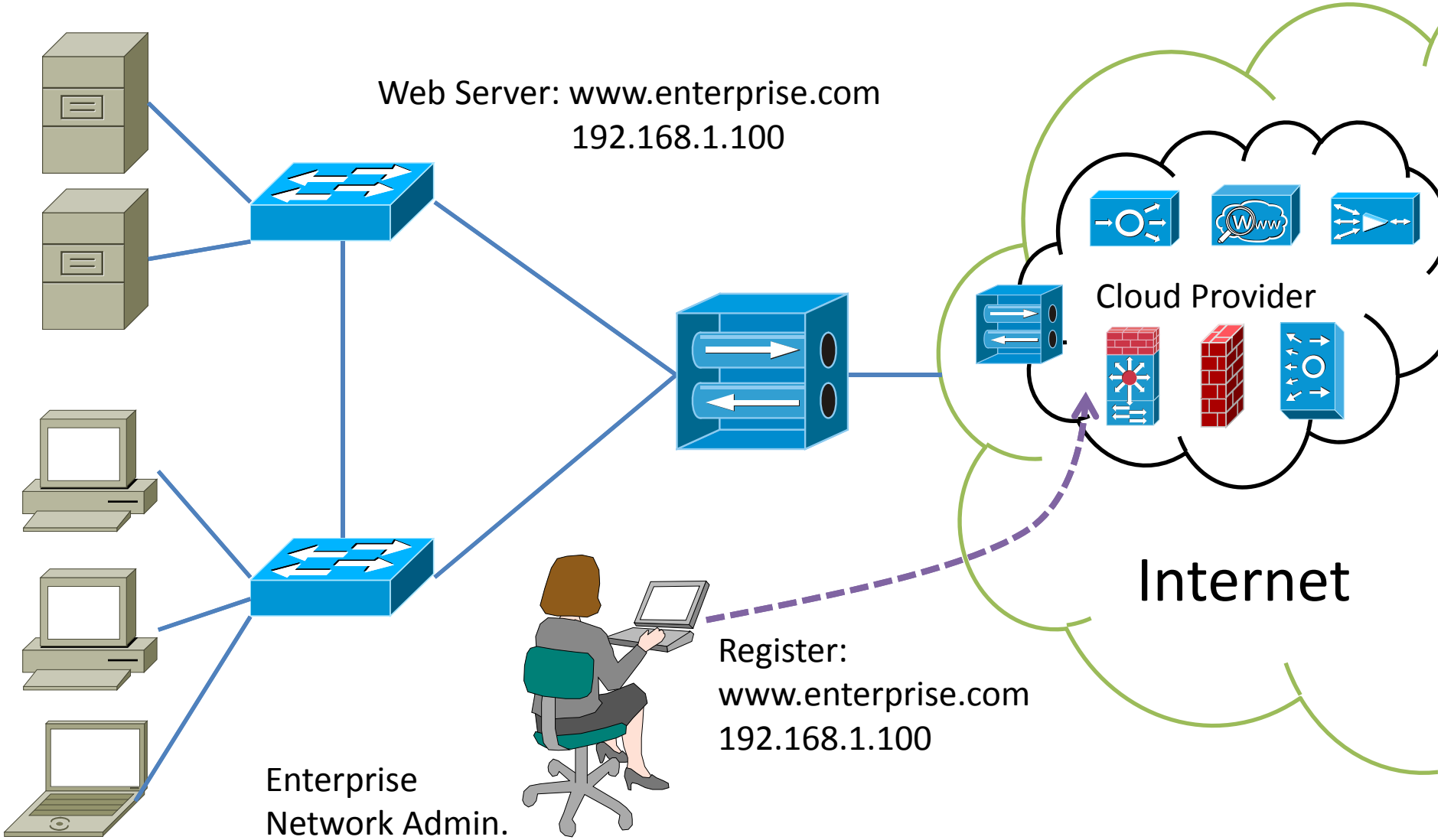
APLOMB

"Appliance for Outsourcing Middleboxes"

Outsourcing Middleboxes with APLOMB



Inbound Traffic



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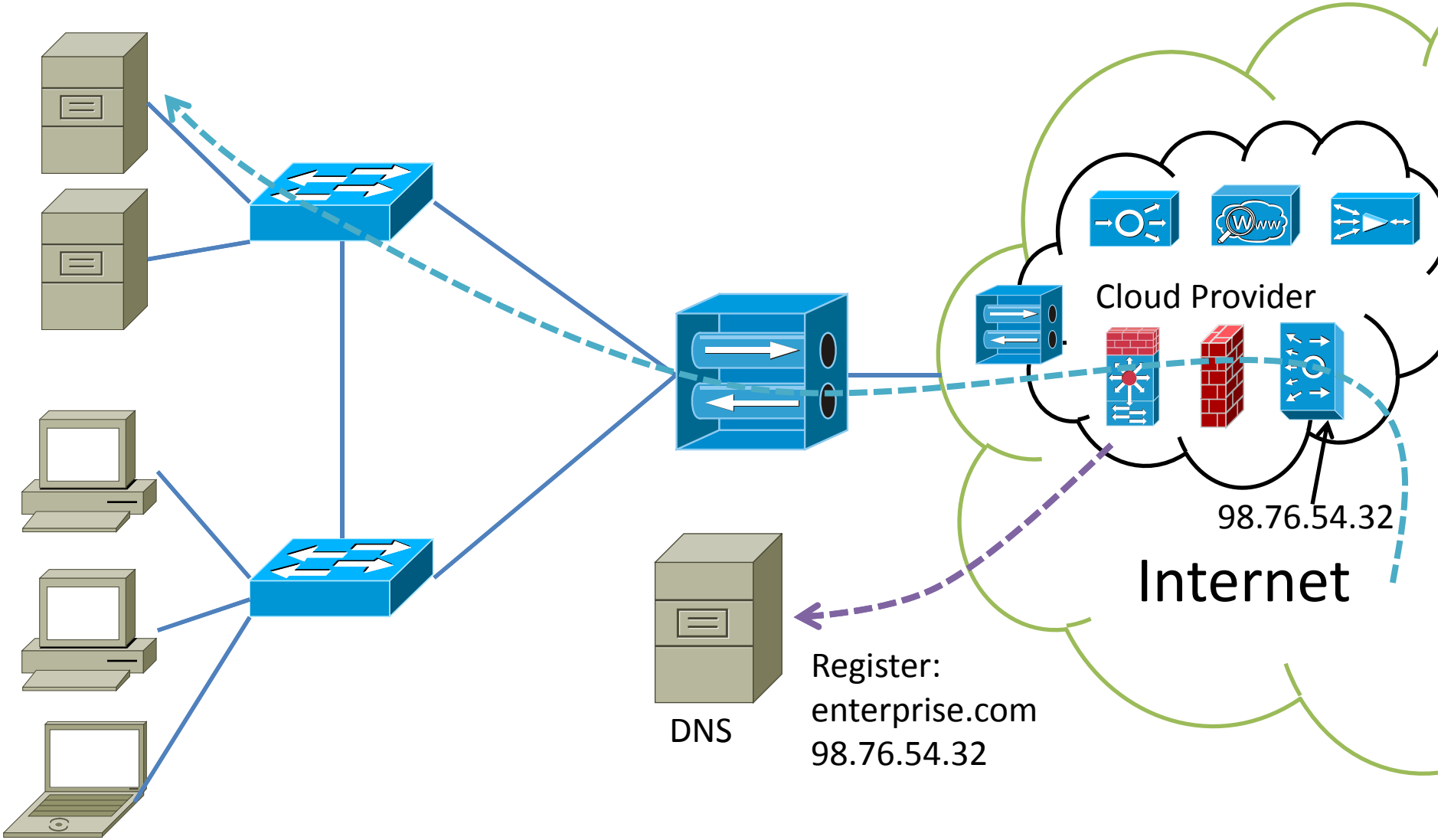
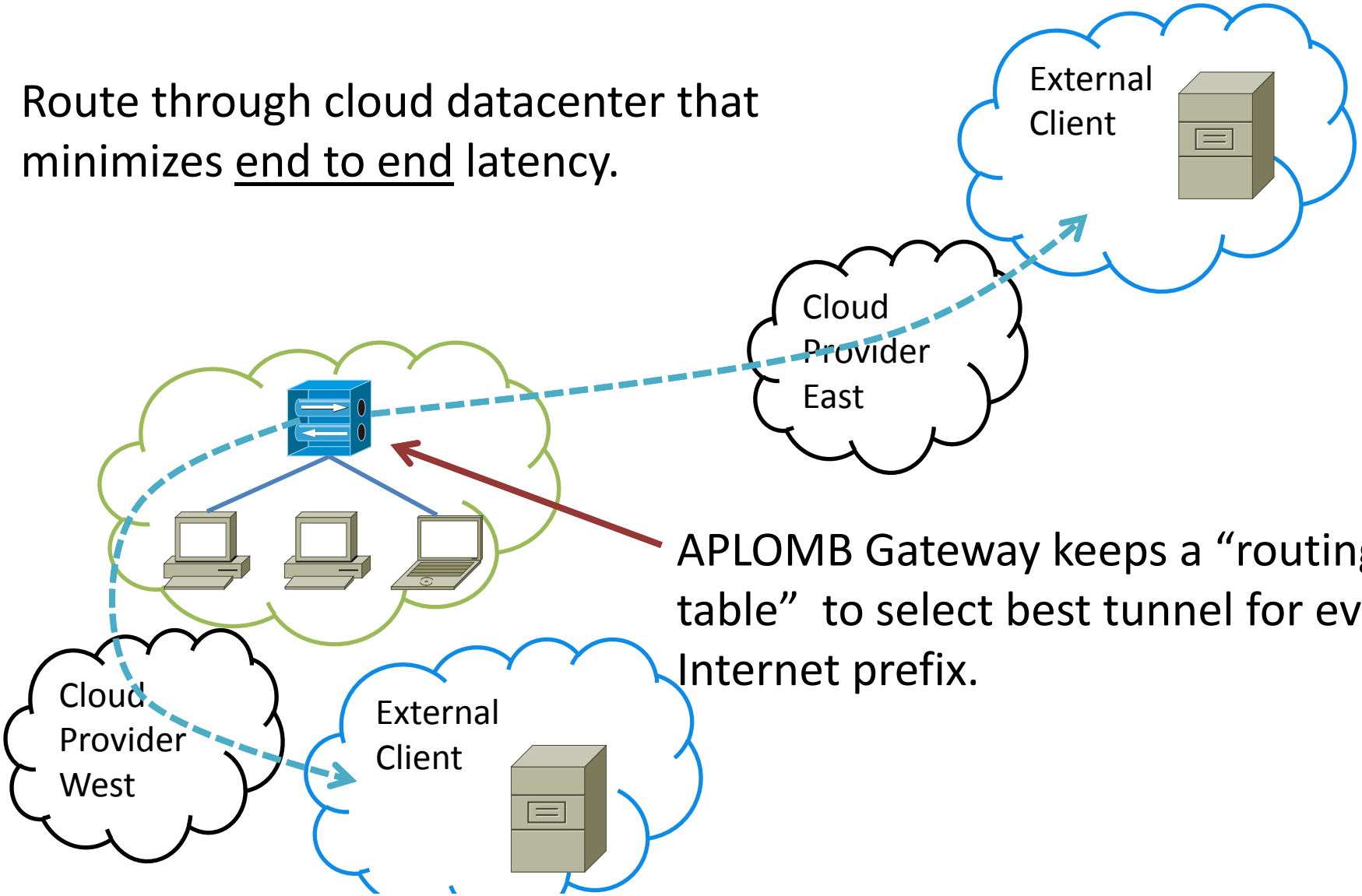


Minimizing latency?

Choosing a Datacenter

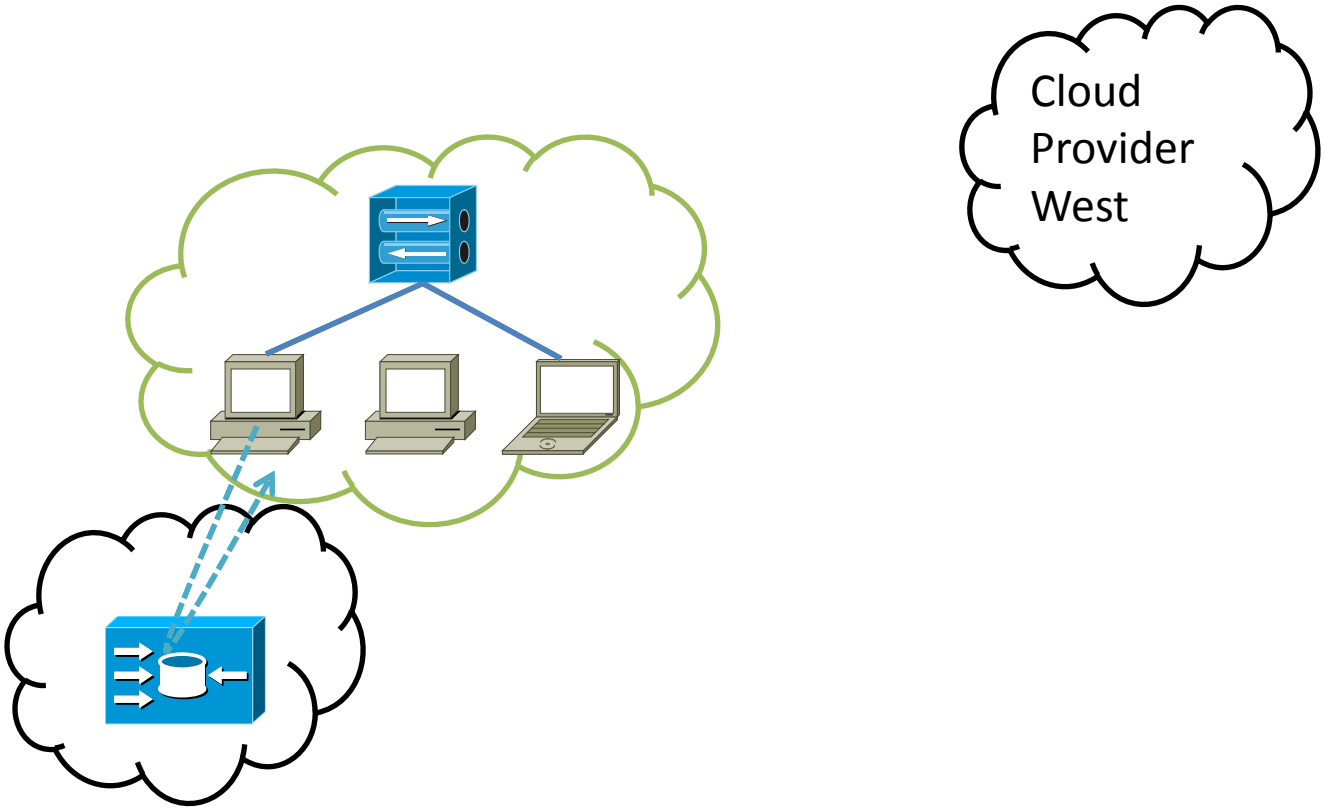
Route through cloud datacenter that minimizes <u>end to end</u> latency.



APLOMB Gateway keeps a "routing table" to select best tunnel for every Internet prefix.

Caches and “Terminal Services”

Traffic destined to services like caches should be redirected to the nearest node.



APLOMB

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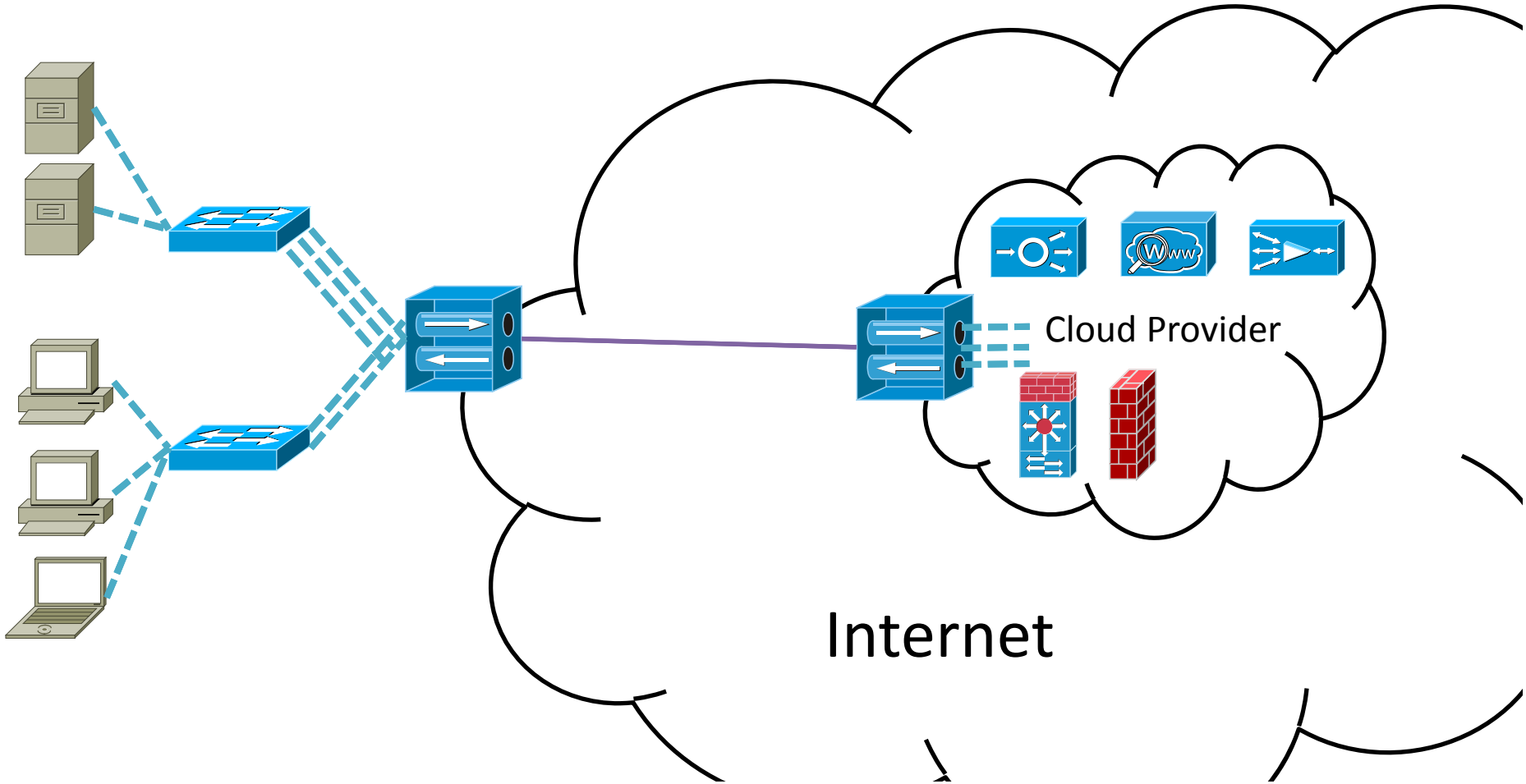
Can we outsource all middleboxes?

Firewalls	✓	
IDSes	✓	
Load Balancers	✓	
VPNs	✓	
Proxy/Caches	✗	Bandwidth?
WAN Optimizers	✗	Compression?

APLOMB+ for Compression

Add generic compression to APLOMB gateway to reduce bandwidth consumption.



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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

Three Part Evaluation

Implementation & Deployment

- Performance metrics

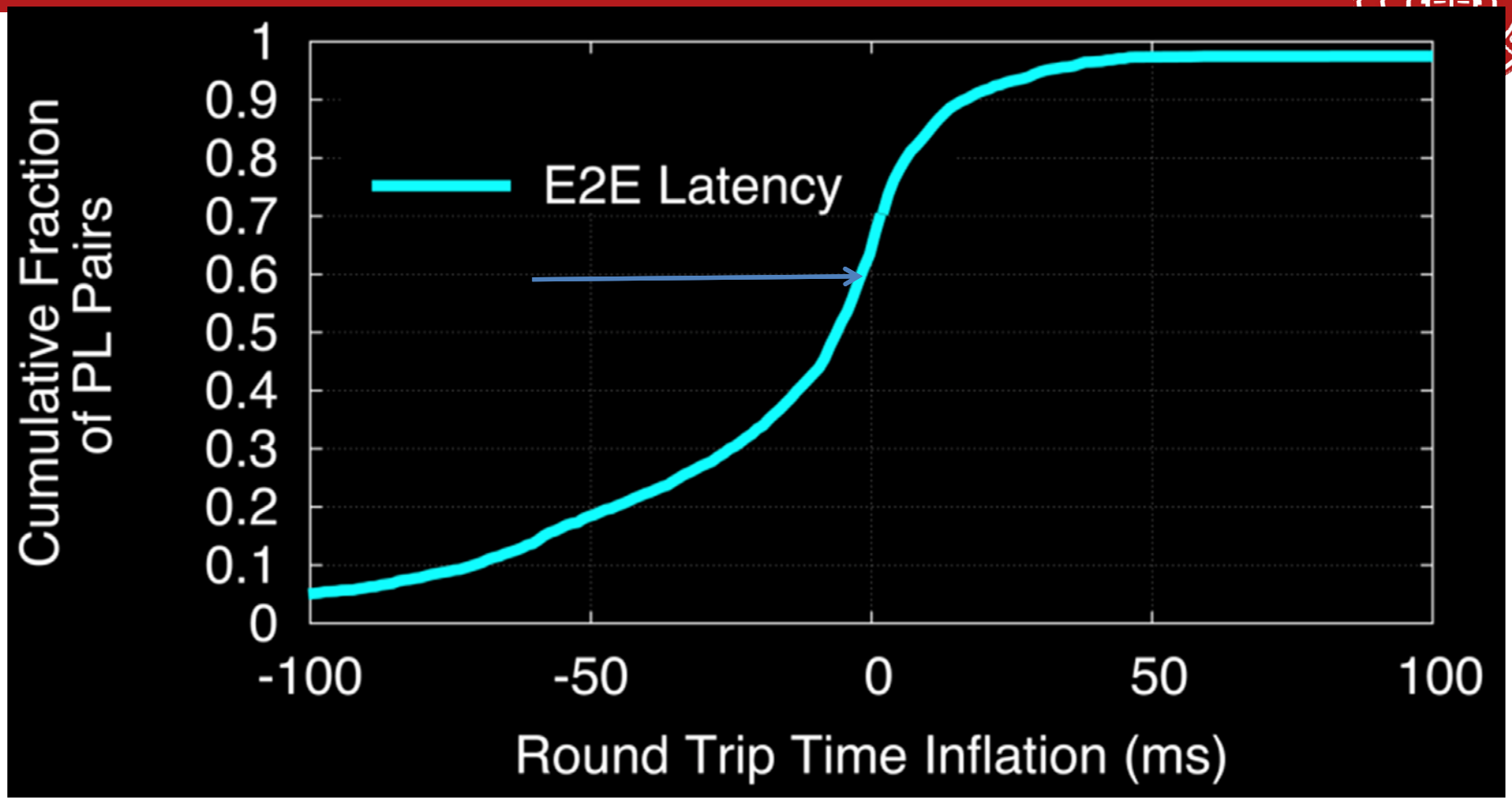
Wide-Area Measurements

- 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 <u>improves</u> with redirection through EC2.

Latency at a Large Enterprise

Measured redirection latency between enterprise sites.

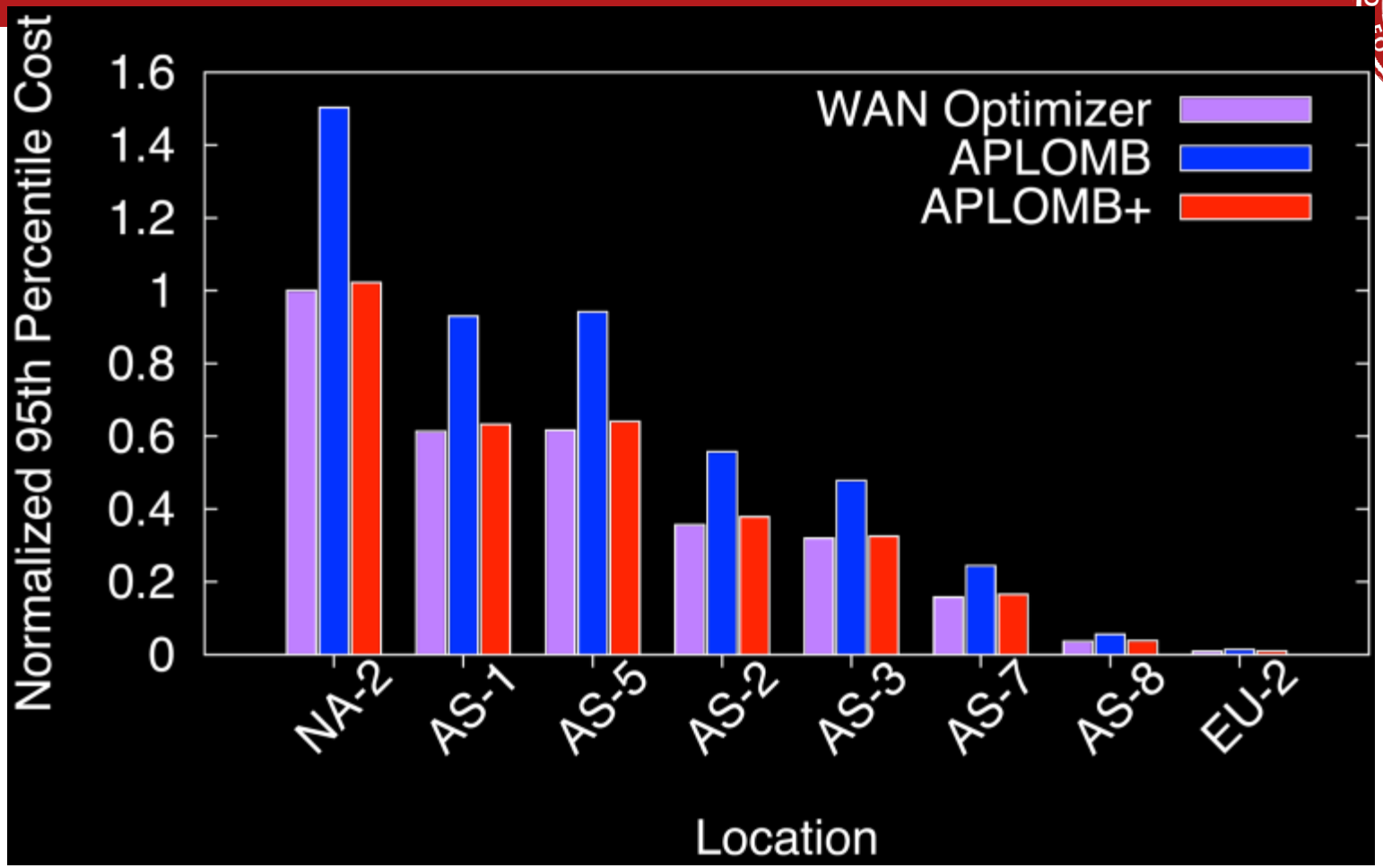
- Median latency inflation: 1.13 ms
- Sites experiencing inflation were primarily in areas where EC2 does not have a wide footprint.

How does APLOMB impact other quality metrics, like bandwidth and jitter?

- Bandwidth: download times with BitTorrent increased on average 2.3%

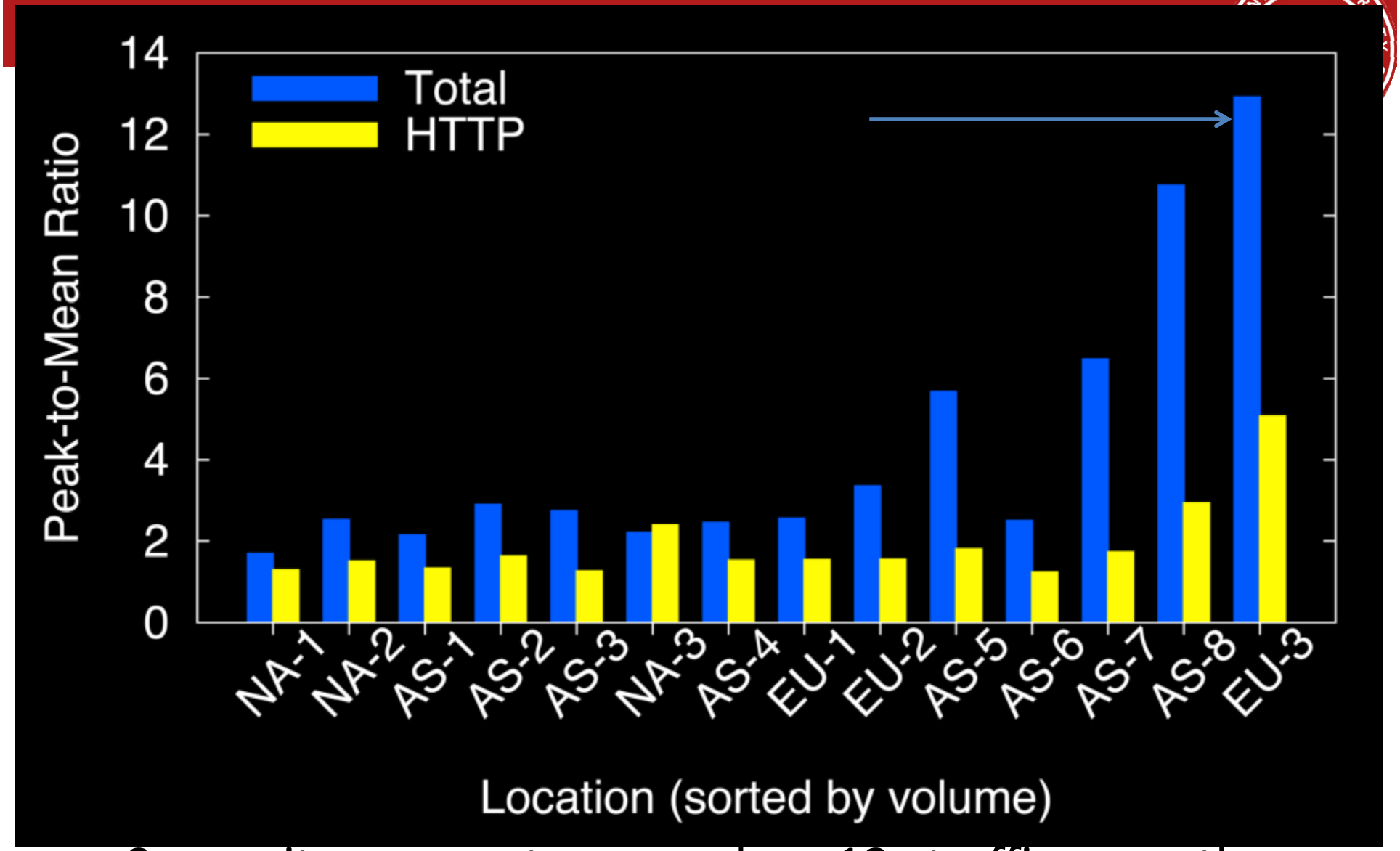
- Jitter: consistently within industry standard bounds of 30ms

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

Conclusion and Discussion

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***
  - IOFlow: a software-defined storage architecture, E. Thereska, H. Ballani, G. O'Shea, T. Karagiannis, A. Rowstron, T. Talpey, R. Black, T. Zhu. ACM Symposium on Operating Systems Principles (SOSP), October 2013, pages 182-196.
  - http://dl.acm.org/citation.cfm?doid=2517349.2522723

- Check piazza: http://piazza.com/cornell/fall2014/cs5413
- Check website for updated schedule