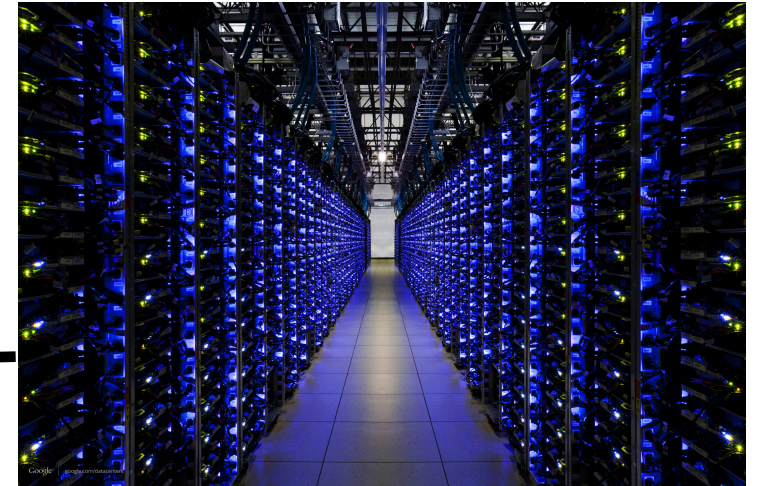
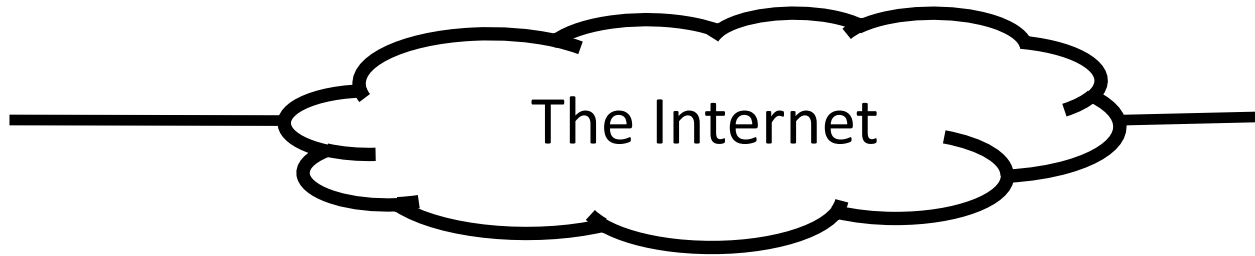


Middleboxes

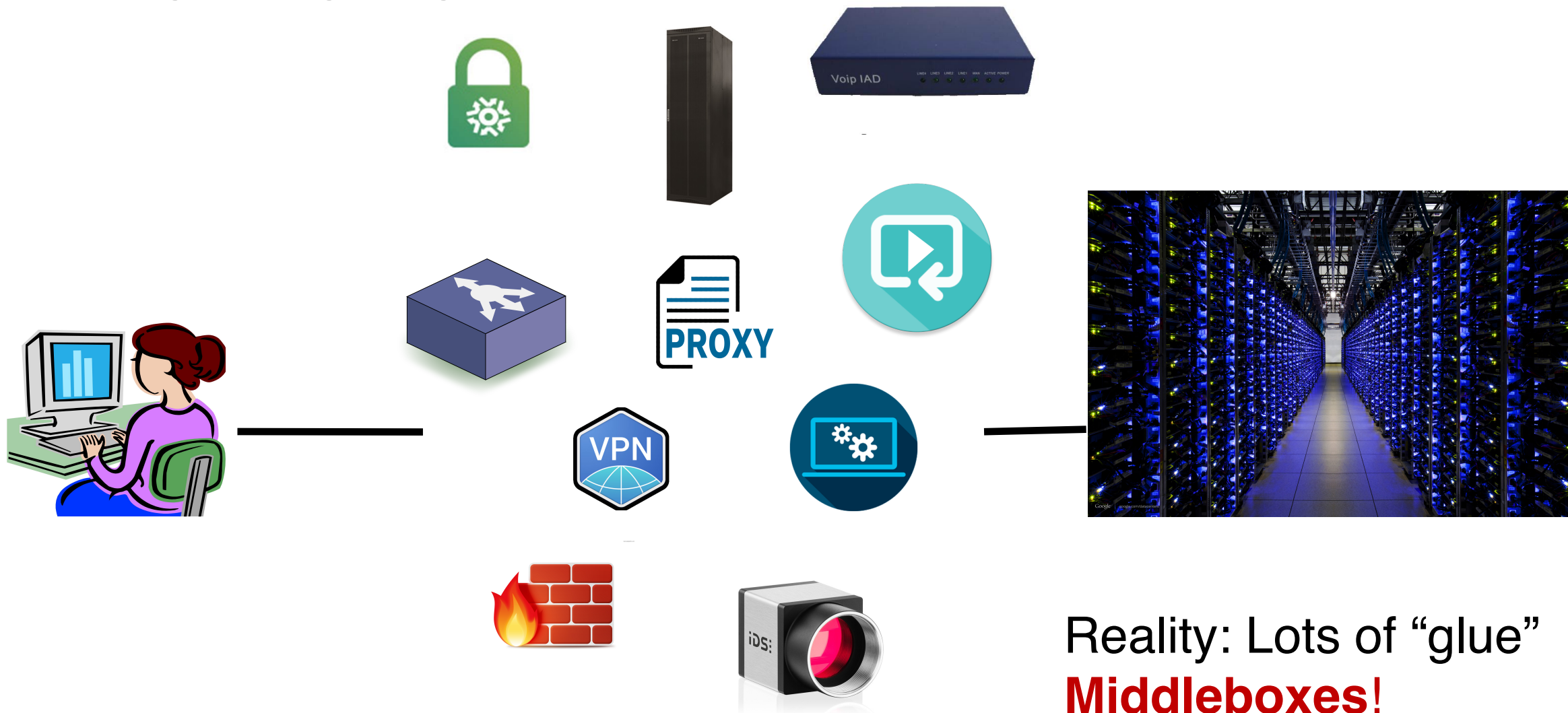
Lecture 21, Computer Networks (198:552)

The Internet

- Textbook view: A “smooth” pipe from source to destination



The Internet



Reality: Lots of “glue”
Middleboxes!

What are middleboxes?

- Specialized applications
 - Security, application optimization, network management
- Specialized *appliances*
 - Hardware boxes with custom management interfaces
- Thousands to millions of \$\$ in equipment
 - ... and more to operate, upgrade, optimize their performance

Significant deployments in enterprises!

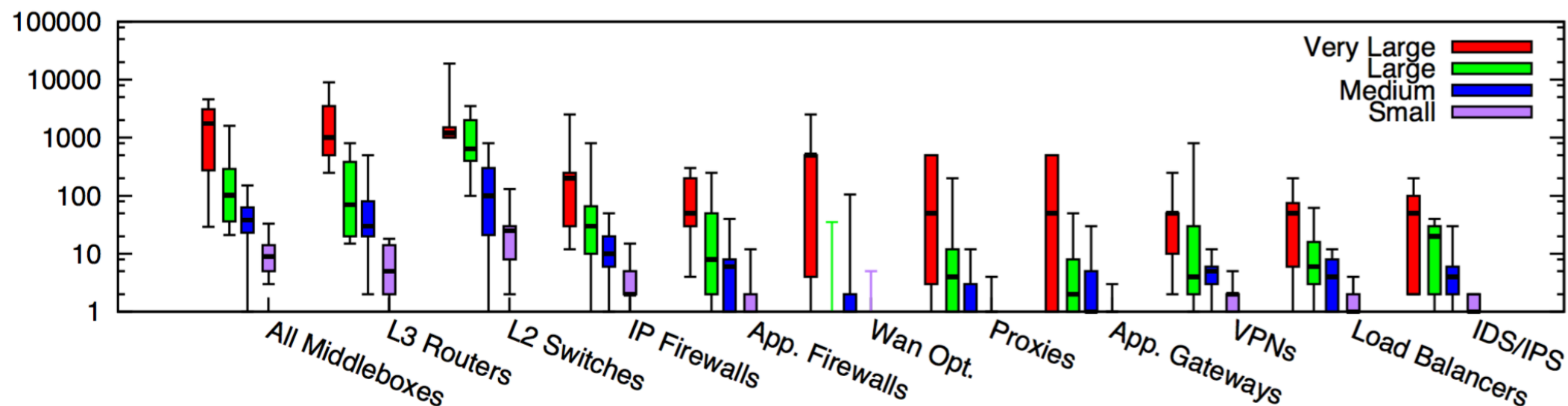


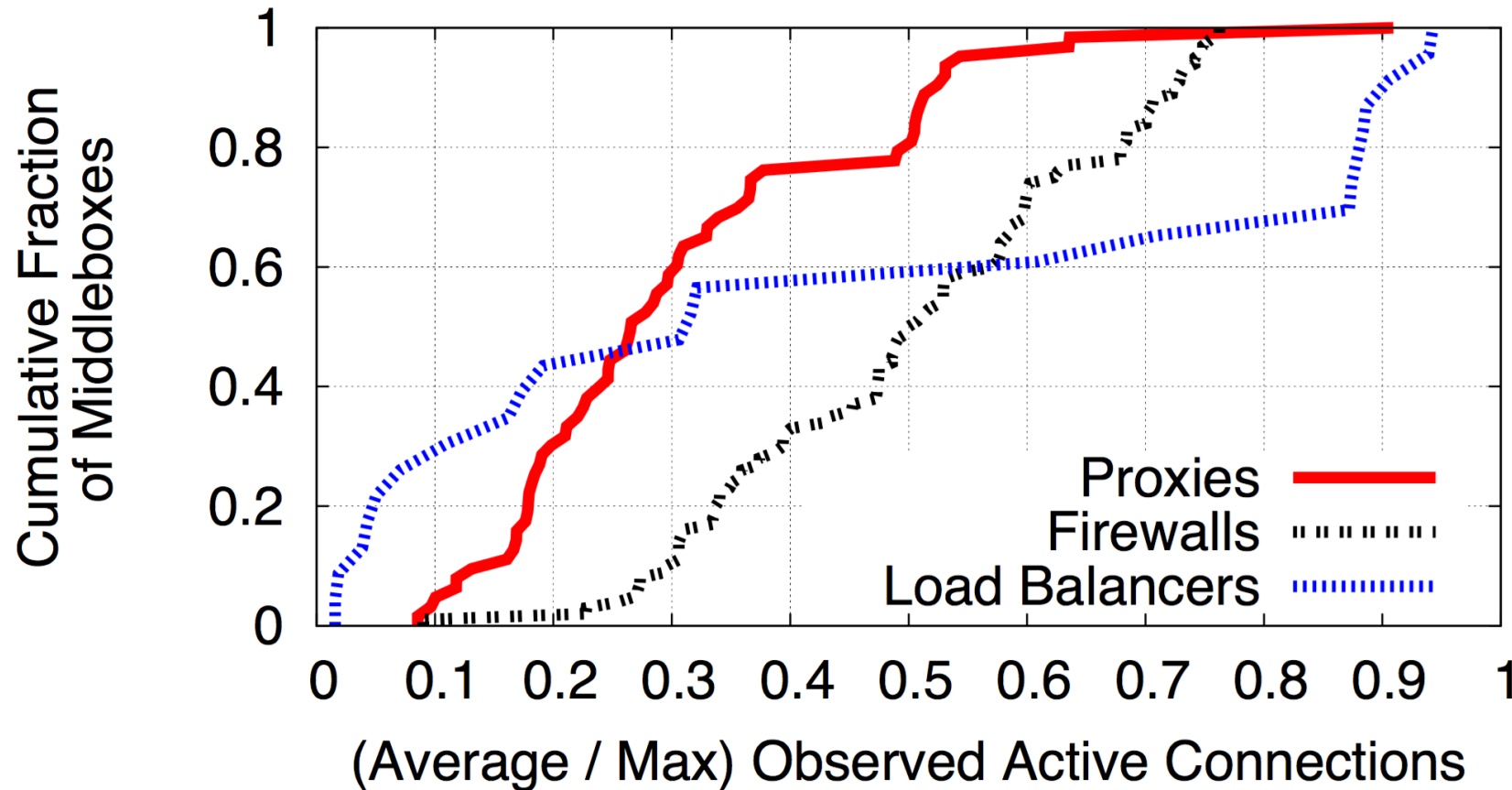
Figure 1: Box plot of middlebox deployments for small (fewer than 1k hosts), medium (1k-10k hosts), large (10k-100k hosts), and very large (more than 100k hosts) enterprise networks. Y-axis is in log scale.

Source: Aplomb, Justine Sherry et al., SIGCOMM '12

Some key concerns for operators

- Upgradability: hardware vs. software
- Expertise to operate: configure, optimize, ...
- Monitoring: Need visibility & diagnostics
- Managing load: what if network traffic suddenly increases?
- Could really use an elastic cloud + SDN-like approach 😊

Example: Need for load management



Source: Aplomb, Justine Sherry et al., SIGCOMM '12

Example: Need for better ways to use

- Most common causes of middlebox failure

	Misconfig.	Overload	Physical/Electric
Firewalls	67.3%	16.3%	16.3%
Proxies	63.2%	15.7%	21.1%
IDS	54.5%	11.4%	34%

Network Function Virtualization (NFV)

- Encapsulate specialized app as software **network functions**
- Run **network functions inside VMs** in a cluster

Benefits of NFV

- Easier to upgrade
 - Regular software maintenance!
- Easier to manage
 - Use server+VM management tools
- Easier to develop
 - Write software instead of develop hardware
- Reduce costs by consolidating VMs
 - And expand elastically as needed

NetBricks: Taking the V out of NFV

Aurojit Panda et al., OSDI '16

(ACK: Material by Aurojit Panda)