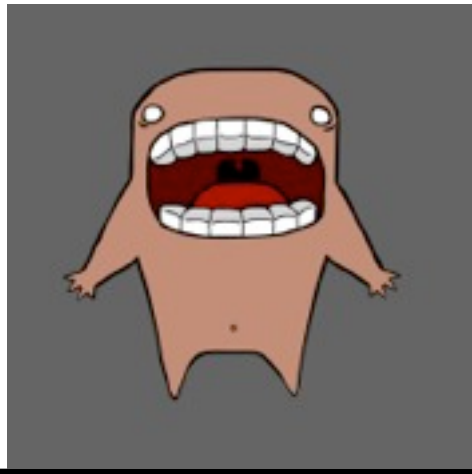
Georgia Tech College of Computing

CS 3251- Computer Networks:
Link Layer(3) and Exam

Professor Patrick Traynor
Lecture 19
10/24/13

Announcements

- Schedule change next week
  - Enjoy! Relax! Study networking?
- Exams are coming back to you now.
- Project 3 is due 11/05...
  - Designed to be easy, but get it done.

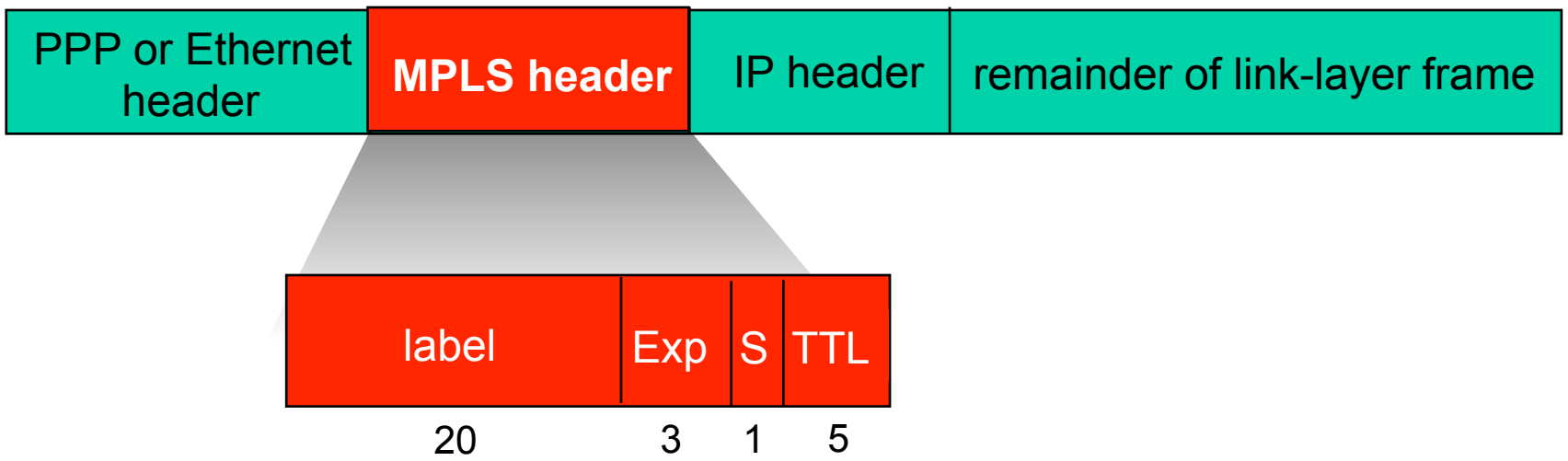


Link Layer

- 5.1 Introduction and services
- 5.2 Error detection and correction
- 5.3 Multiple access protocols
- 5.4 LANs
  - addressing, ARP
  - Ethernet
  - switches
  - VLANS
- 5.5 link virtualization: MPLS
- 5.6 data center networking
- 5.7 a day in the life of a web request

Multiprotocol label switching (MPLS)

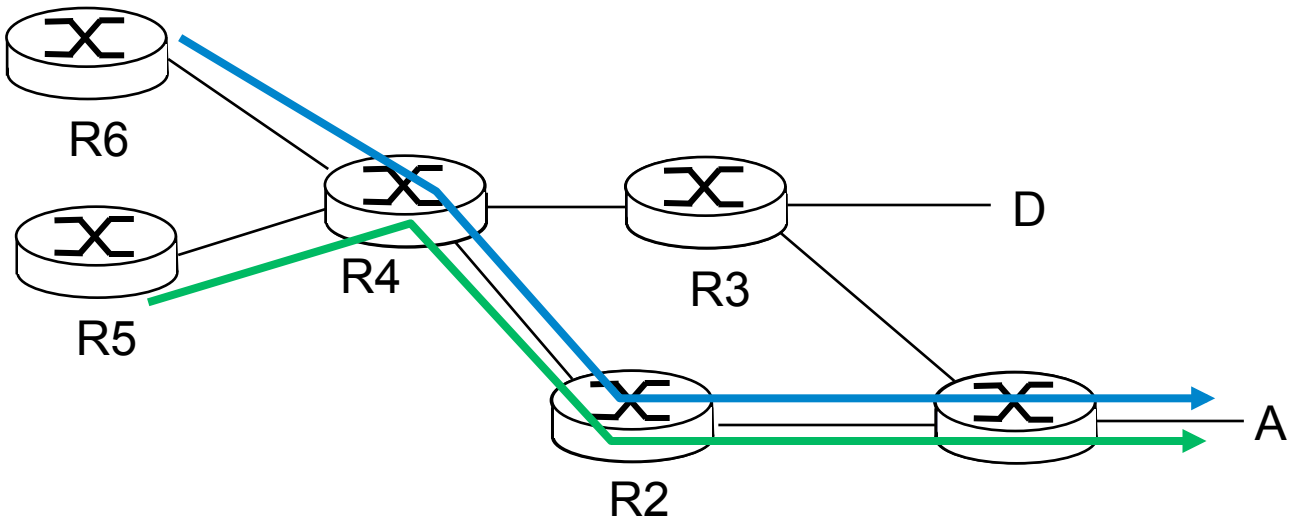
- initial goal: high-speed IP forwarding using fixed length label (instead of IP address)
  - fast lookup using fixed length identifier (rather than shortest prefix matching)
  - borrowing ideas from Virtual Circuit (VC) approach
  - but IP datagram still keeps IP address!



MPLS capable routers

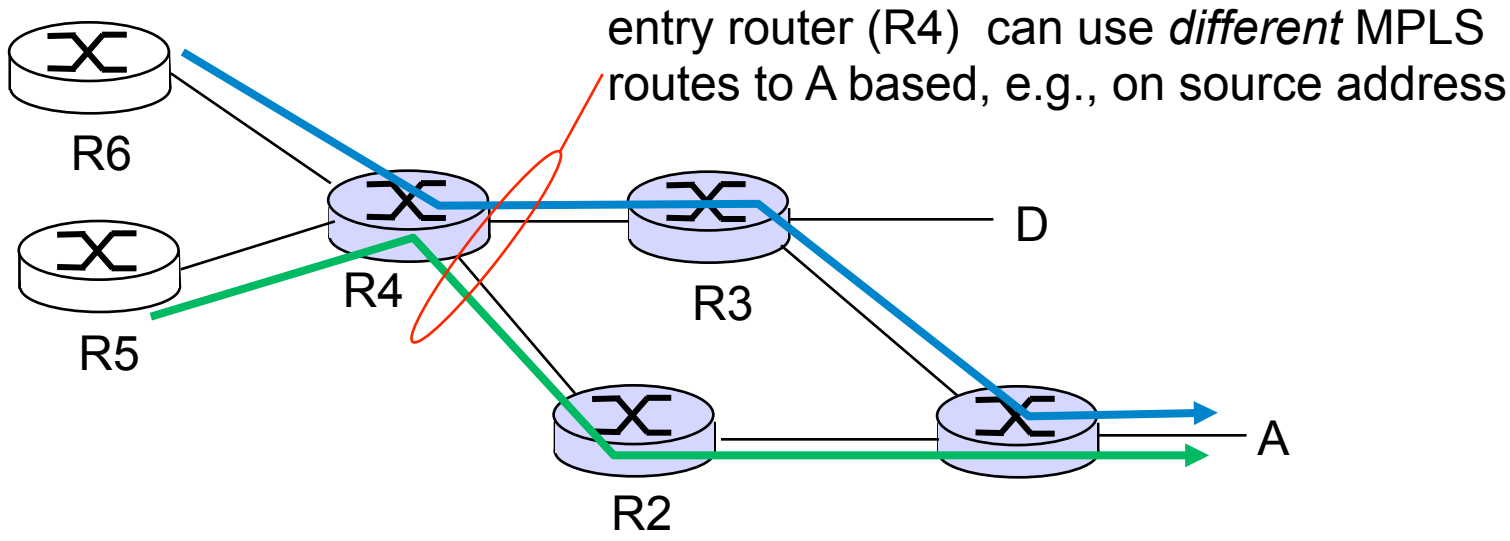
- a.k.a. label-switched router
- forward packets to outgoing interface based only on label value (don't inspect IP address)
  - MPLS forwarding table distinct from IP forwarding tables
- *flexibility*: MPLS forwarding decisions can differ from those of IP
  - use destination and source addresses to route flows to same destination differently (traffic engineering)
  - re-route flows quickly if link fails: pre-computed backup paths (useful for VoIP)

MPLS versus IP paths



- IP routing: path to destination determined by destination address alone

MPLS versus IP paths



- IP routing: path to destination determined by destination address alone
- MPLS routing: path to destination can be based on source and dest. address
  - fast reroute: precompute backup routes in case of link failure

Traffic Engineering and VPNs

- MPLS is becoming very popular because it allows admins to engineer traffic flowing through their network.

- Virtual Private Networks (VPNs) can allow certain customers to flow on paths not available to other traffic.
  - Or at the very least, reserve some set of resources to make disparate networks "feel" as if they are one system.

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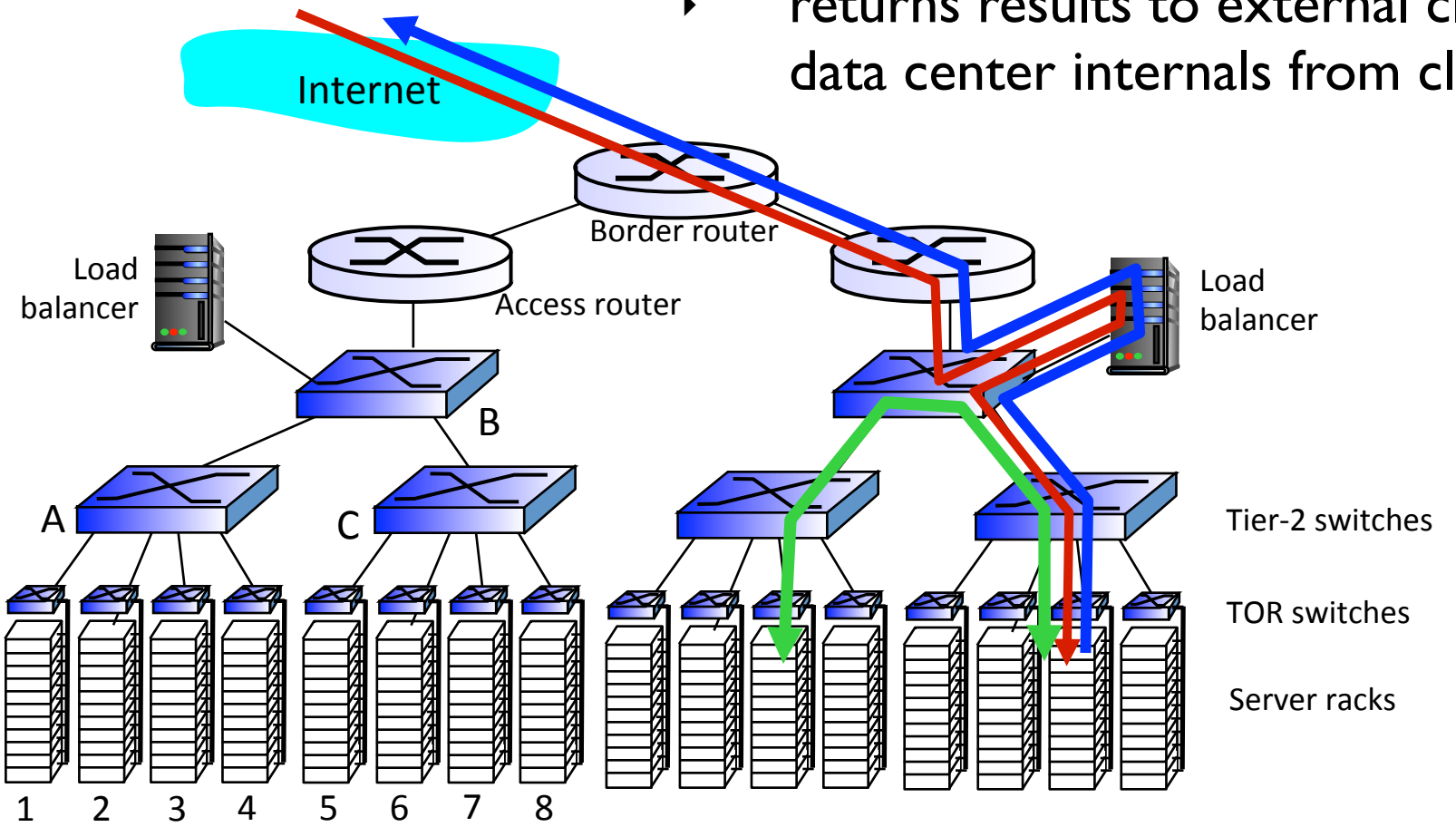
Data center networks

- 10's to 100's of thousands of hosts, often closely coupled, in close proximity:
  - e-business (e.g. Amazon)
  - content-servers (e.g., YouTube, Akamai, Apple, Microsoft)
  - search engines, data mining (e.g., Google)
- challenges:
  - multiple applications, each serving massive numbers of clients
  - managing/balancing load, avoiding processing, networking, data bottlenecks

Inside a 40-ft Microsoft container, Chicago data center

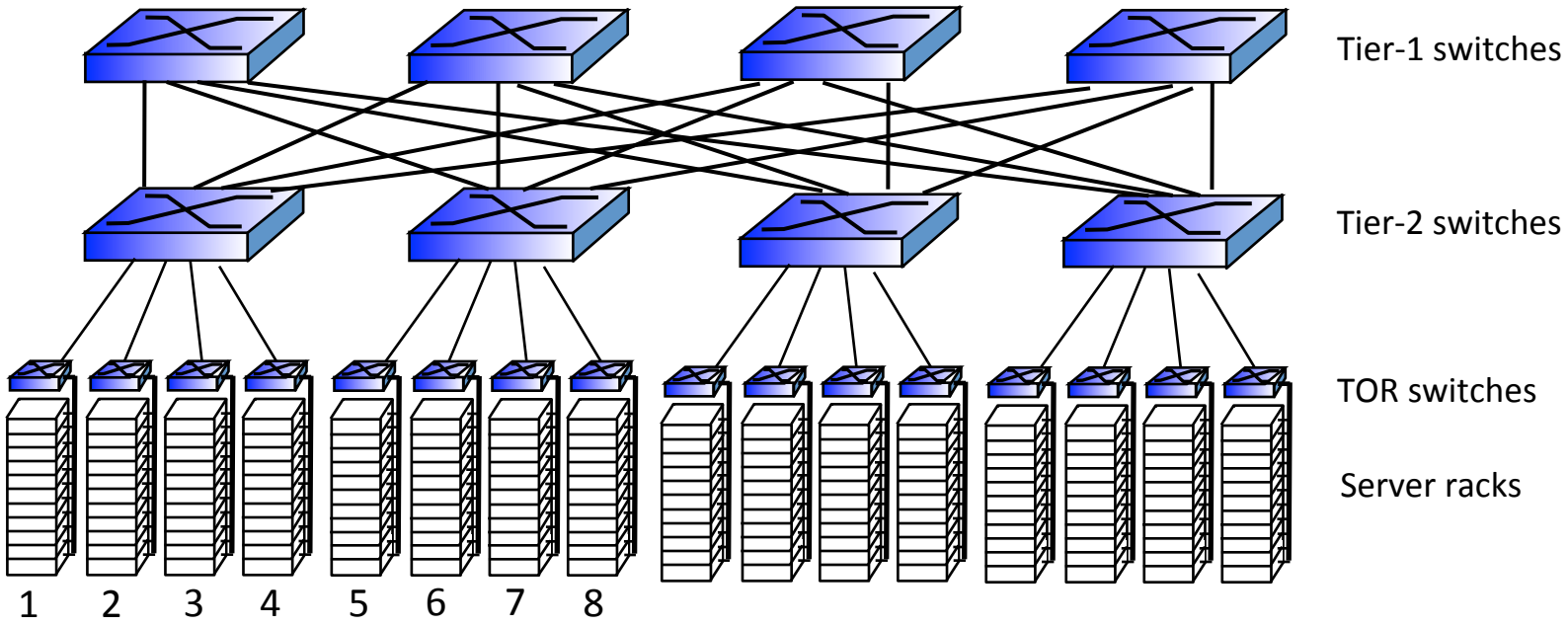
Data center networks

- load balancer: application-layer routing
  - receives external client requests
  - directs workload within data center
  - returns results to external client (hiding data center internals from client)



Data center networks

- rich interconnection among switches, racks:
  - increased throughput between racks (multiple routing paths possible)
  - increased reliability via redundancy



Next Time

- No class on Tuesday
  - As always, keep an eye on that course calendar!
- The Physical Layer...
  - No reading this time around.
  - Enjoy your break...
  - ...but come back ready to tackle the second half of the class. We won't be slowing down!