SIGCOMM Preview Session: Data Center Networking (DCN)

George Porter, UC San Diego

2015

“The cloud”

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Google

amazon.com

NETFLIX

Microsoft Office 365

Spotify

Google docs

bing

salesforce

facebook

“The Cloud” = Lots of computing and data

+ amazon.com =

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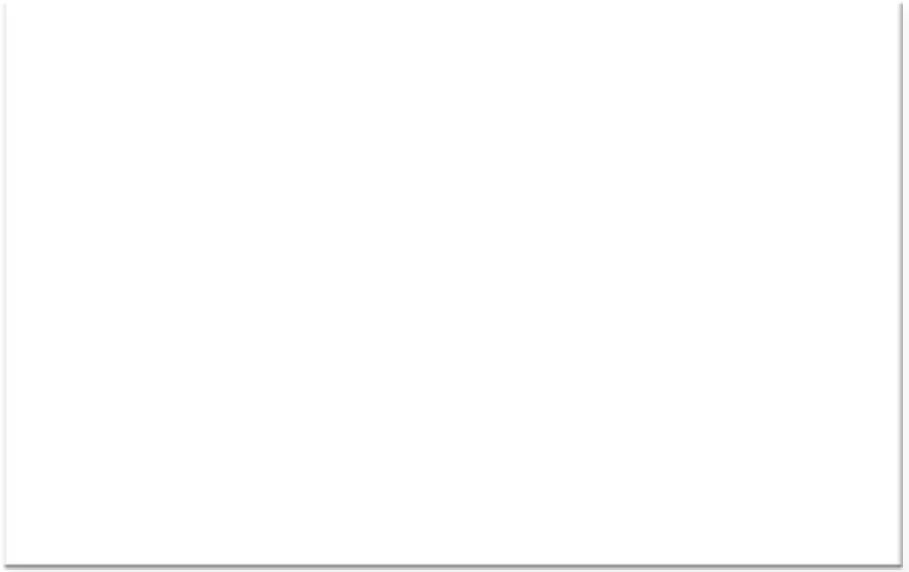

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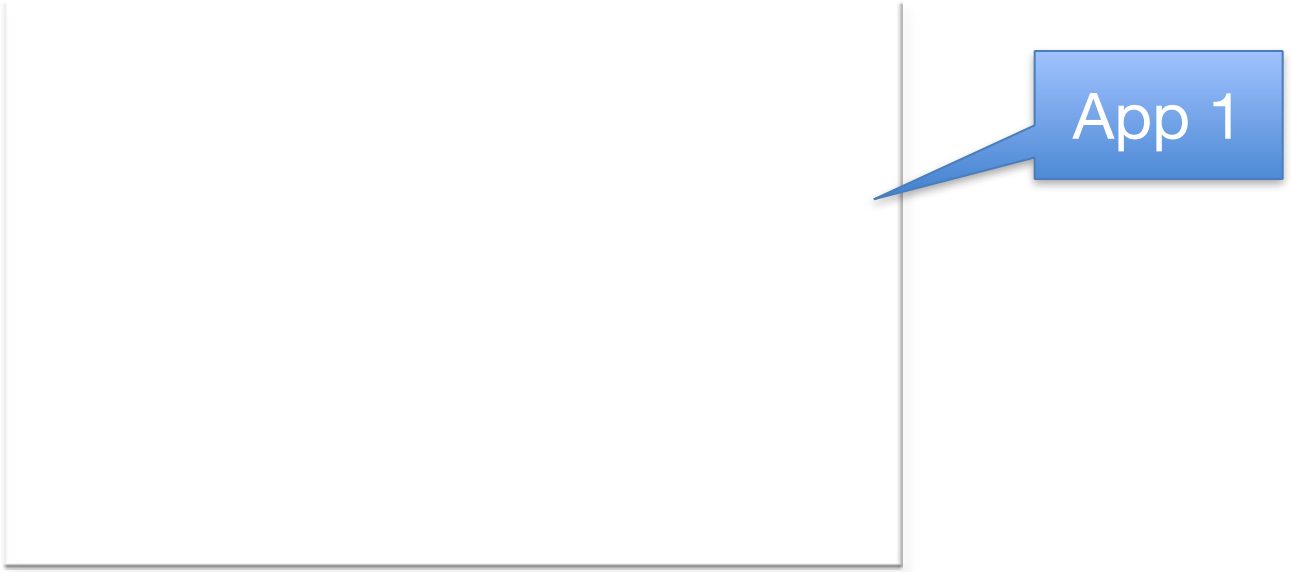

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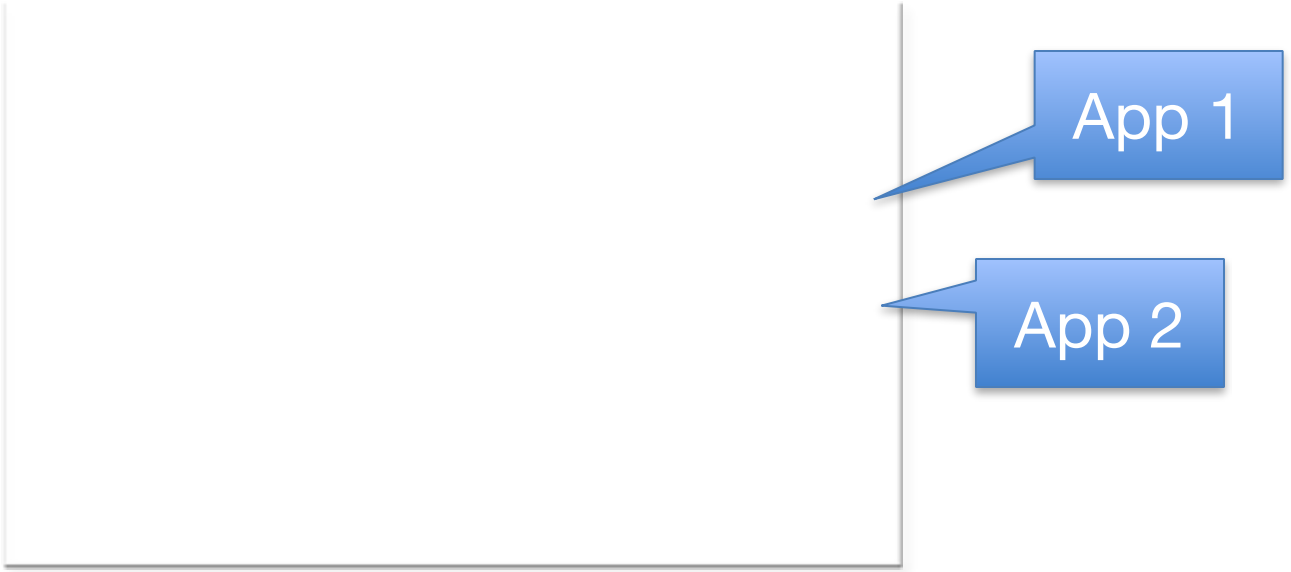

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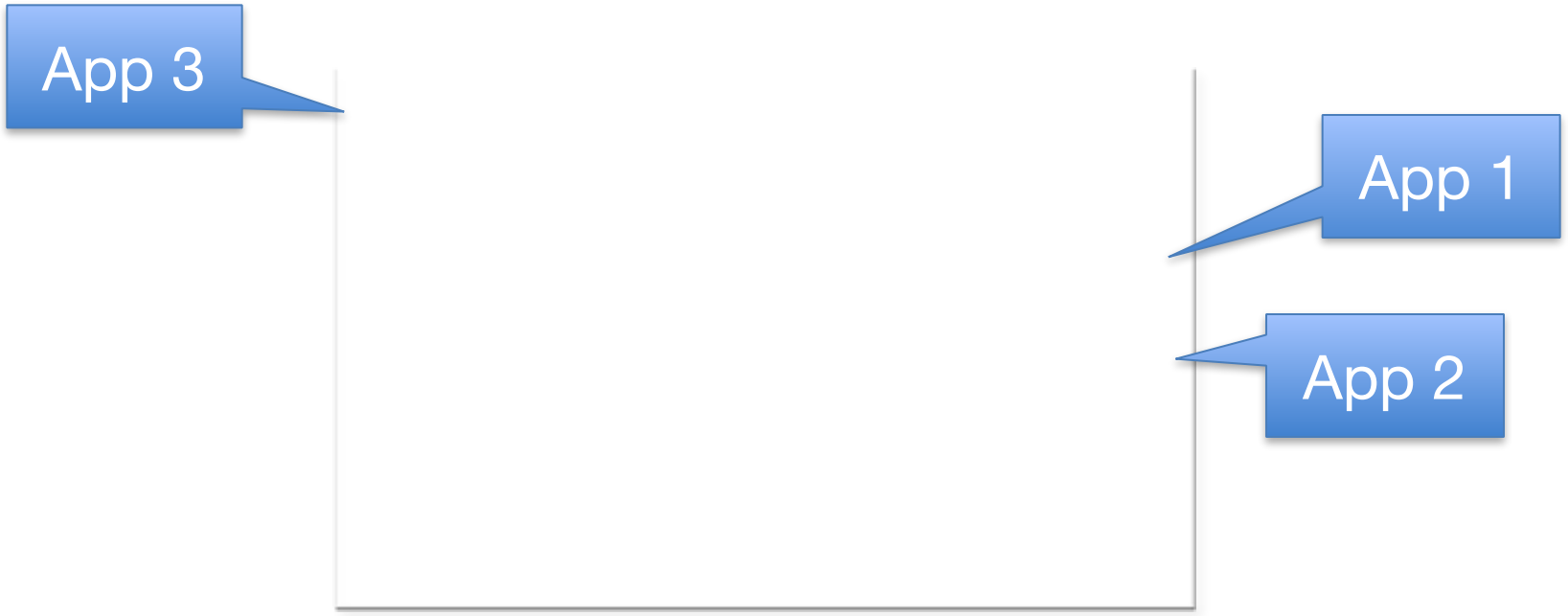

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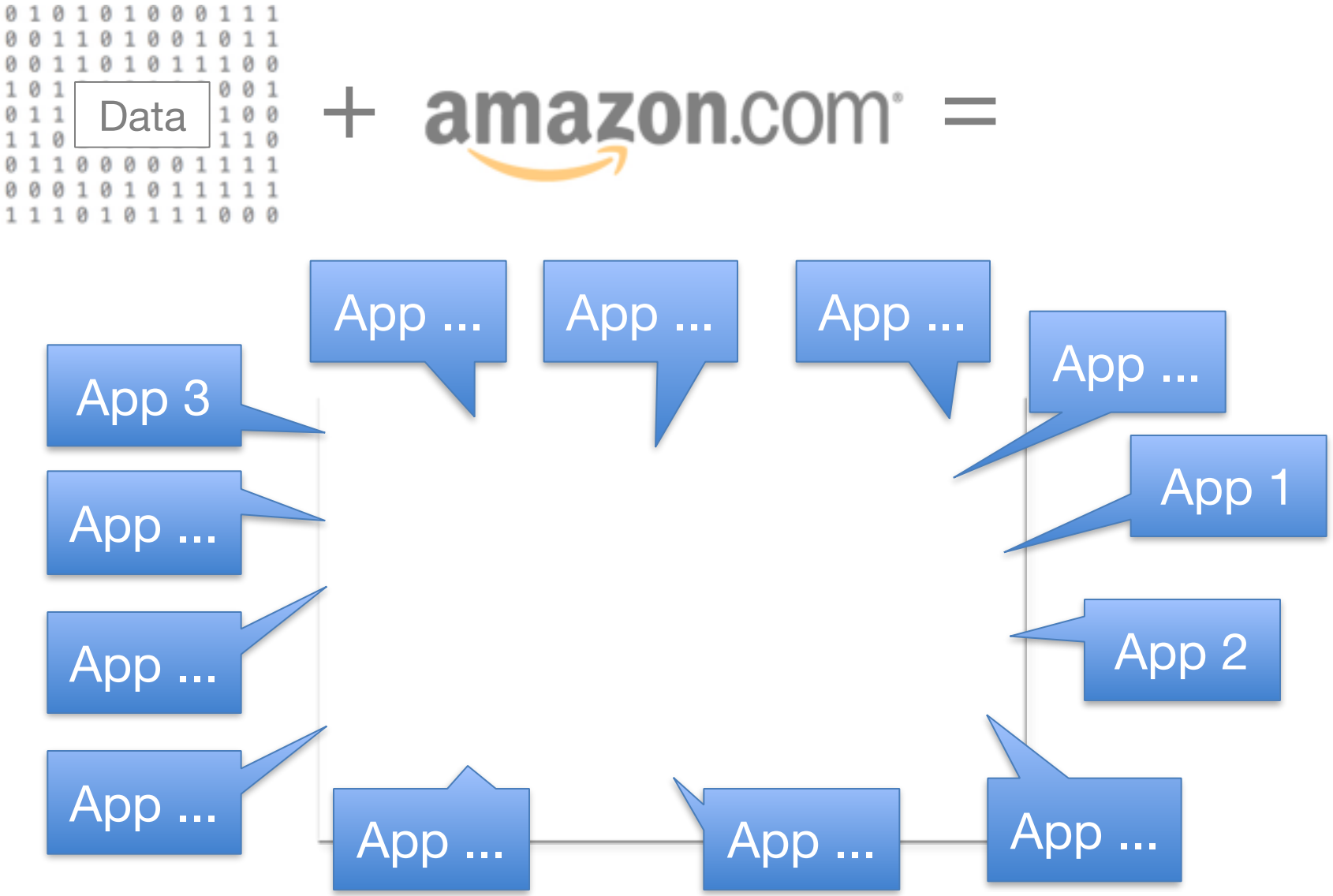

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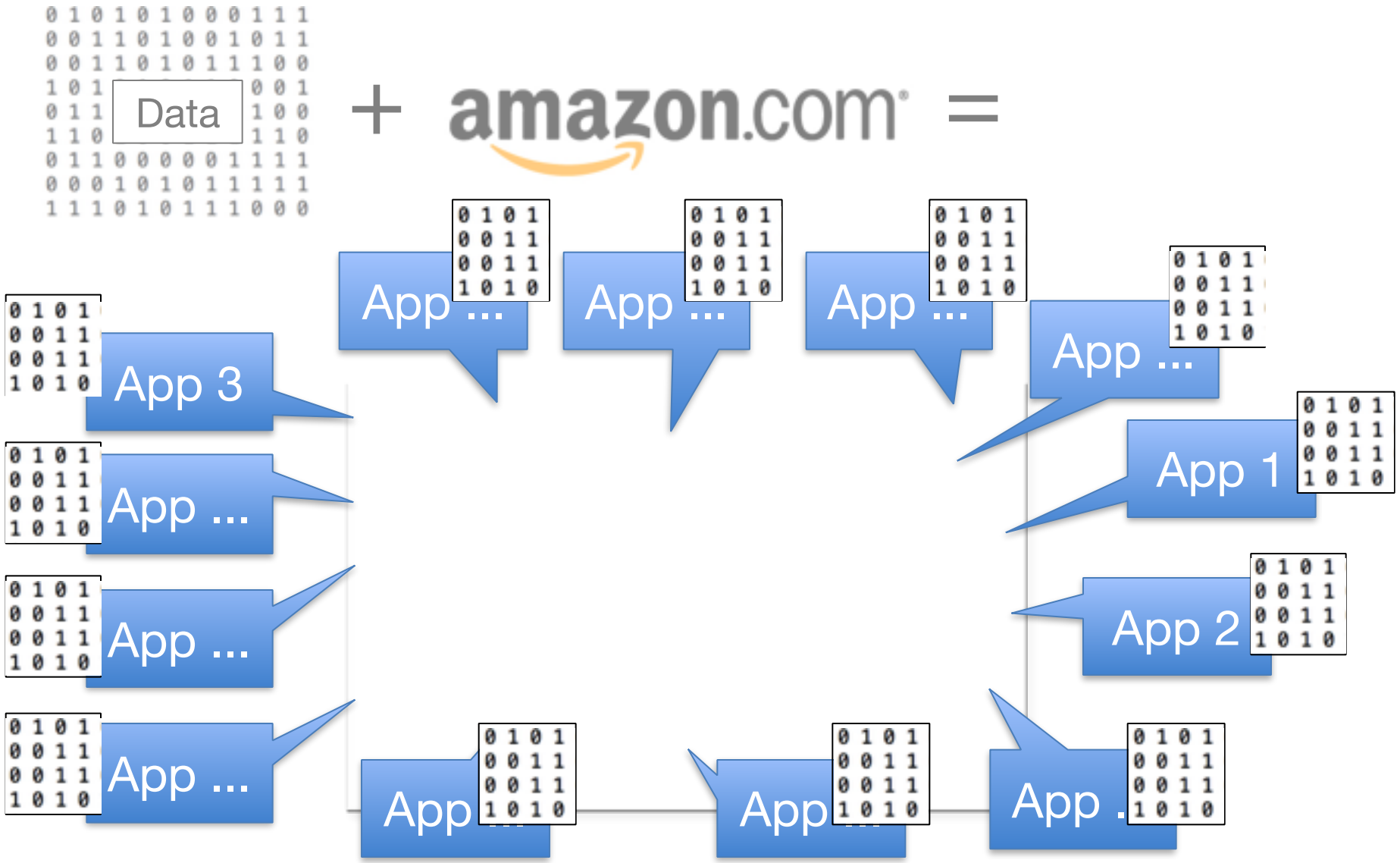

Computing and data has to live somewhere…

Inside a data center

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- Single “applications” spread across many thousands of servers (e.g., Amazon.com)
  - Application components such as caches, web servers, data bases, distributed file servers, …
  - Each component is “scaled” to meet needs of millions of users

Why study DCNs?

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- Cost:
  - To build: Google ($3B/year), MSFT ($15B/total)
  - To operate: 1-2% of global energy consumption*
  - *Must deliver apps using efficient HW/SW footprint*

* LBNL, 2013.

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"Network of networks"	*"Backplane of giant supercomputer"*

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- If you could…
  - Control all the endpoints and the network?
  - Violate layering, end-to-end principle?
  - Build custom hardware?
  - Assume common OS, dataplane functions?

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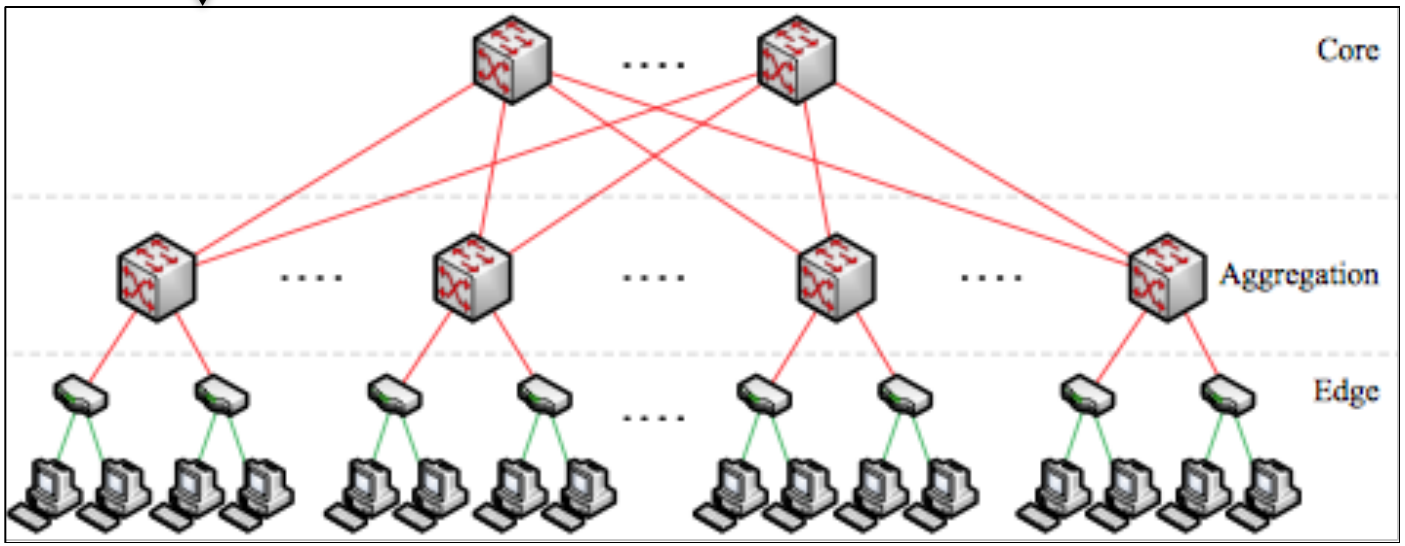
Top-to-bottom rethinking of the network

Paper previews: Topologies

Tree-based network topologies

1993 1997 2001 2005 2009 2013



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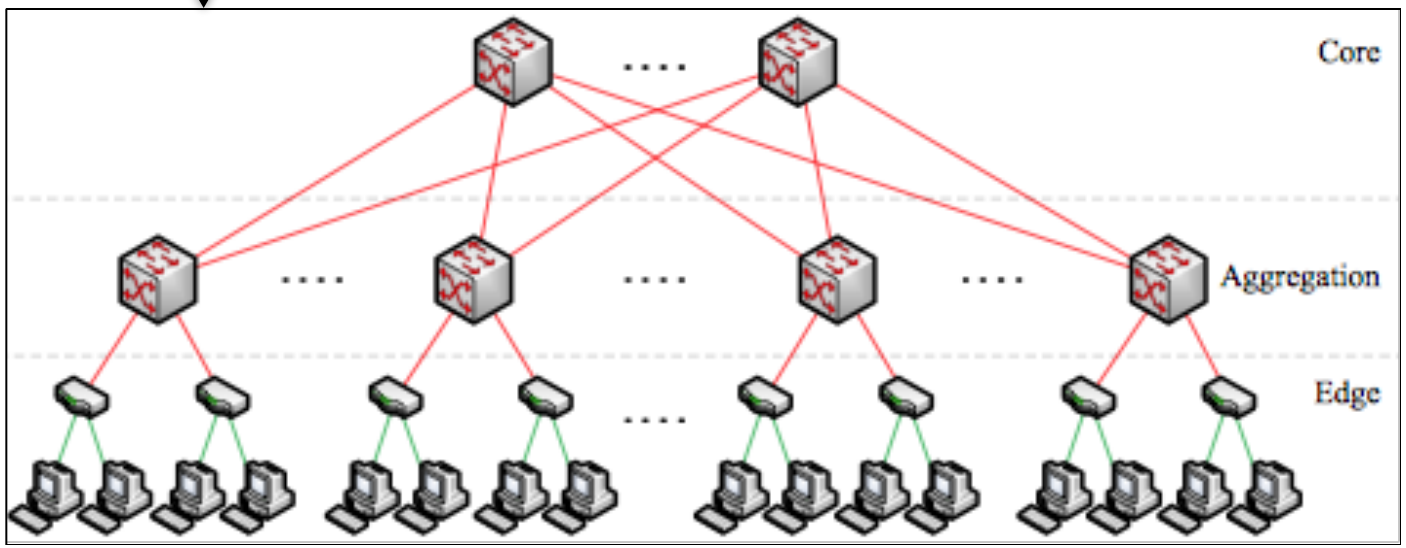

100,000 x 10 Gb/s = 1 Pb/s

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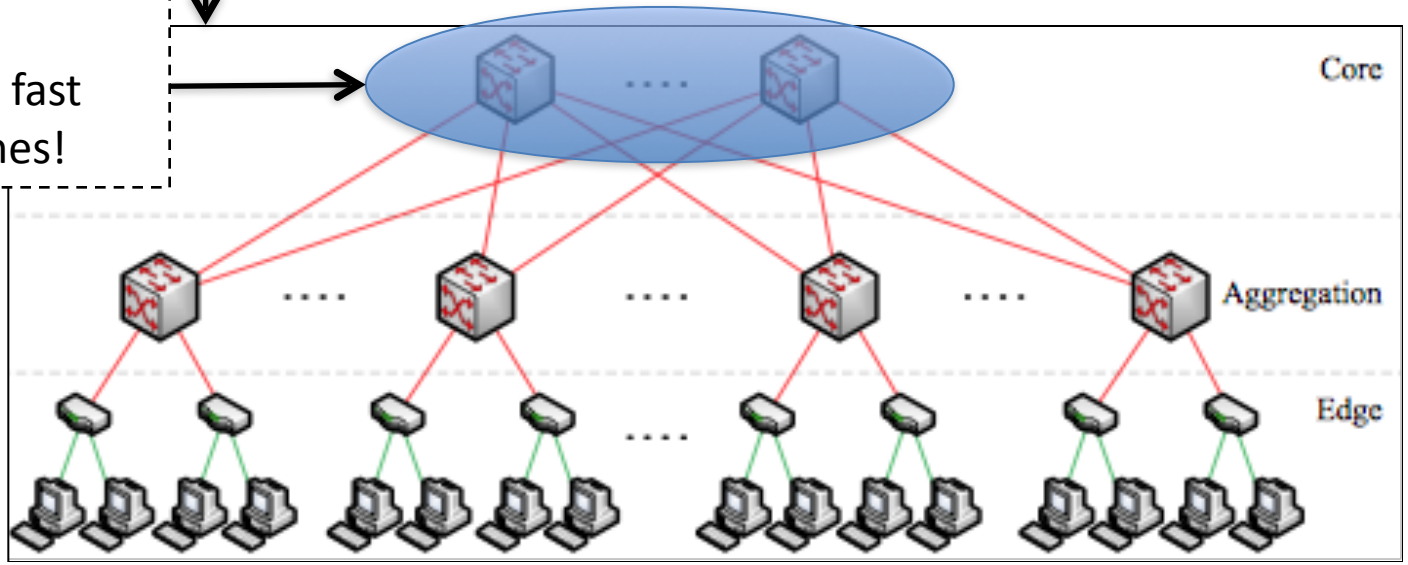
Can't buy sufficiently fast core switches!



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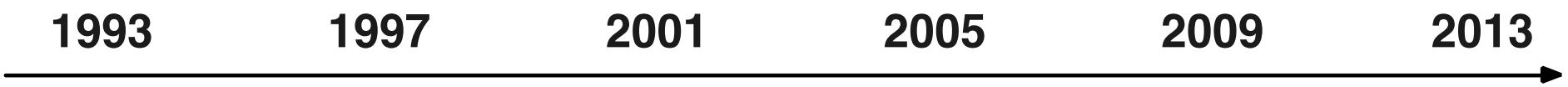
Folded-Clos multi-rooted trees



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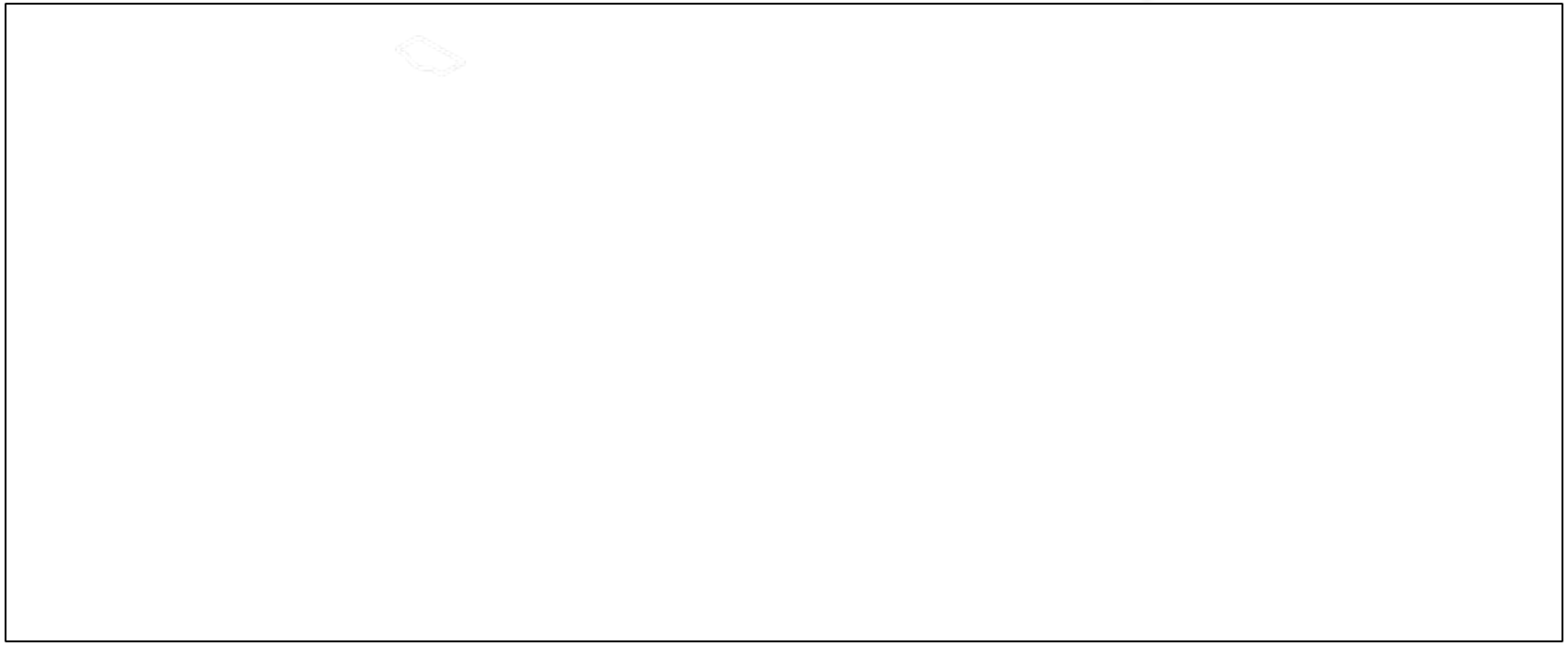

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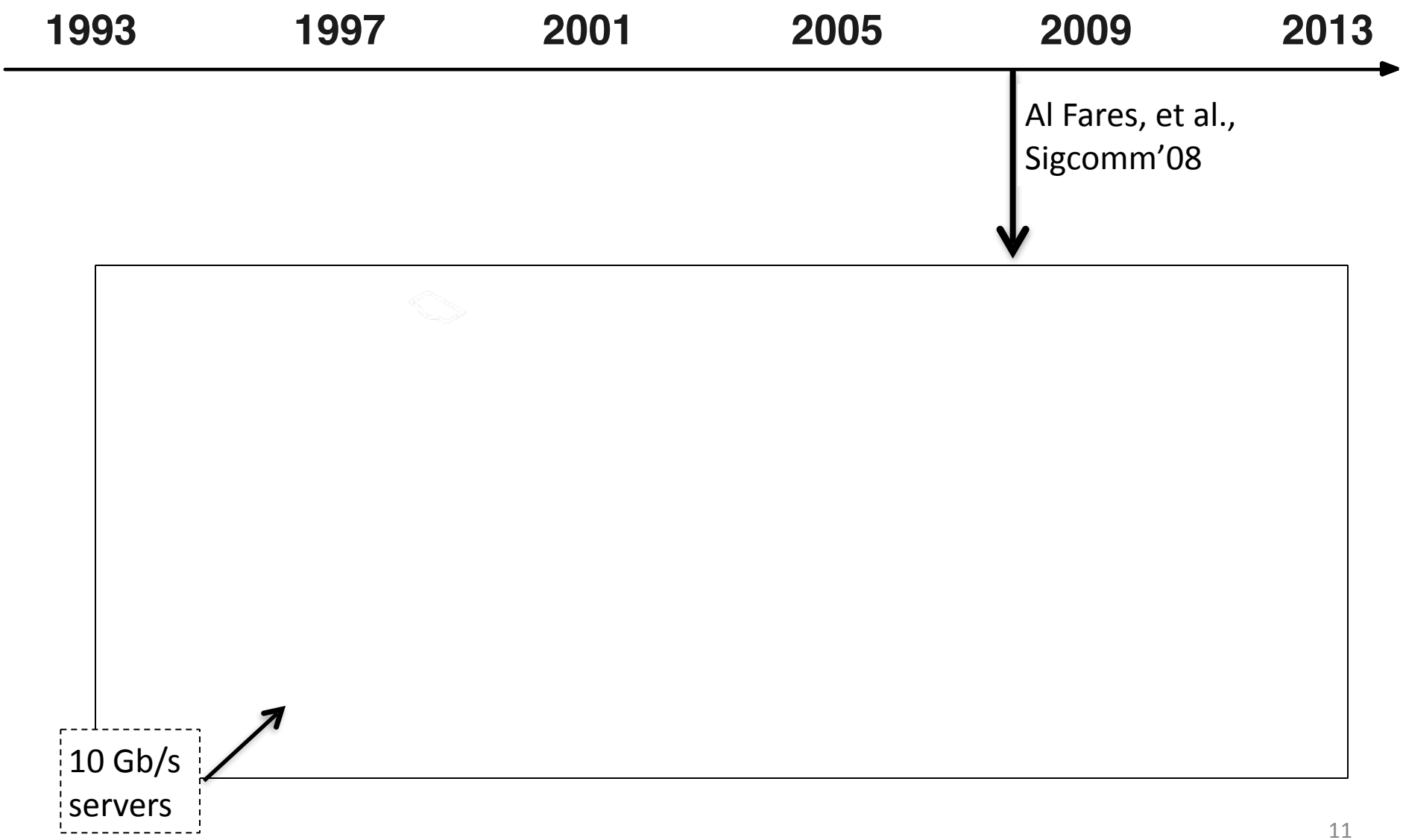

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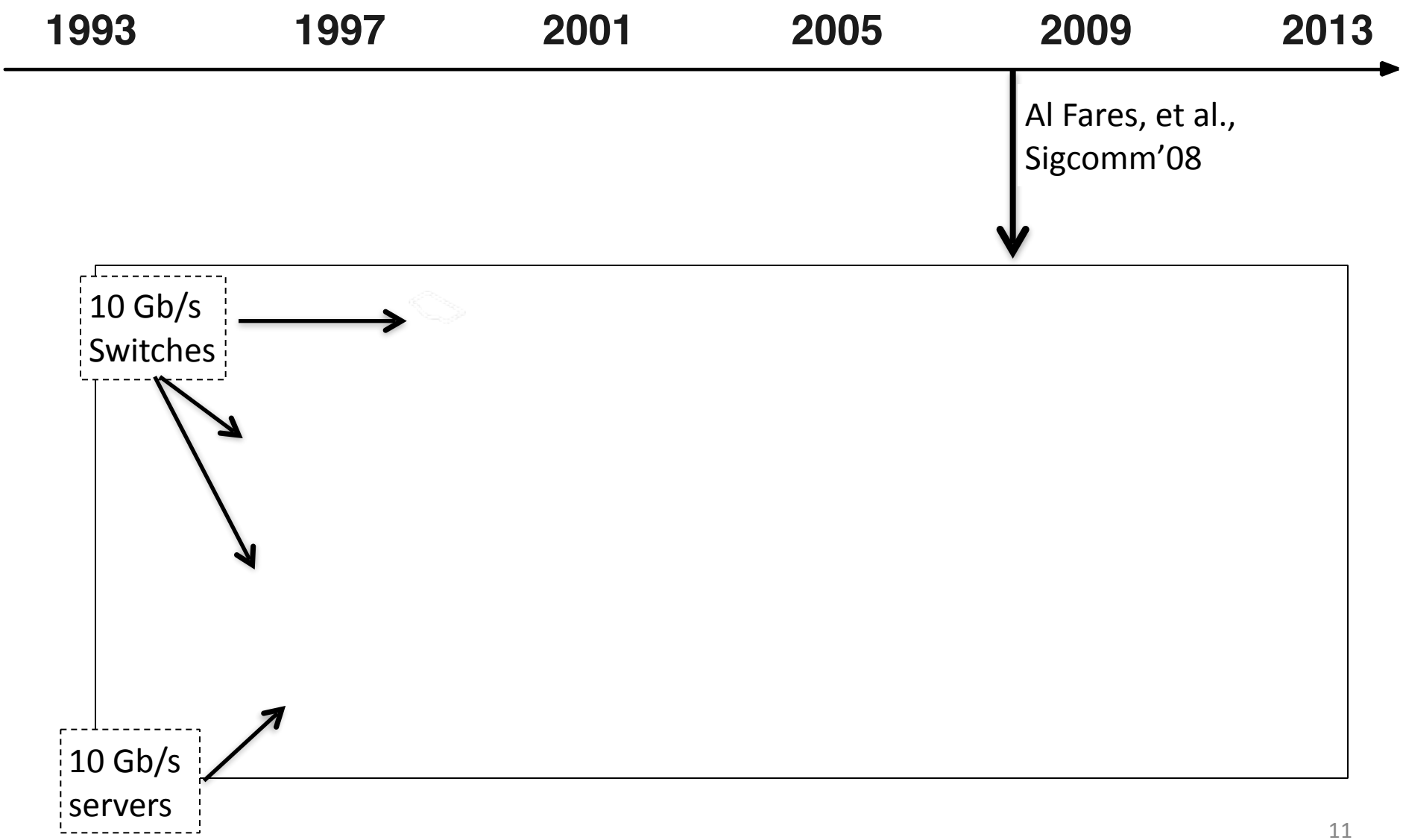

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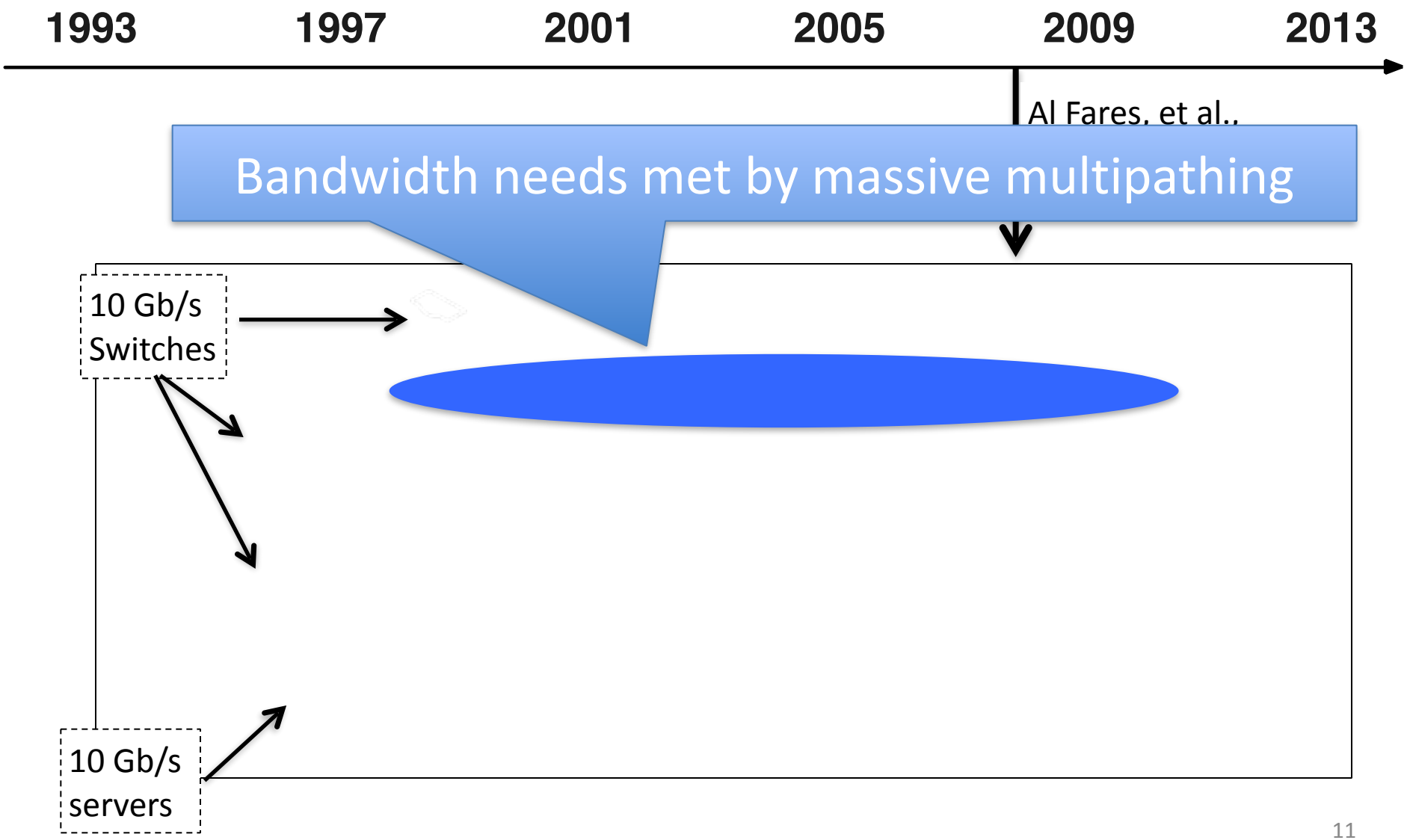

Paper previews: Topologies

- *Jupiter Rising: A Decade of Clos Topologies and Centralized Control in Google's Datacenter Network (Singh et al.)*
  - Tu 5pm-6:15pm Session 3.2: Experience Track: 2
  - 10 year retrospective on Google's experiences building large-scale networks

- *Condor: Better Topologies through Declarative Design (Schlinker et al.)*
  - Th 8:50am - 10:30am Session 8: Data center networking
  - Describing and reasoning about the network structure

Paper previews: Measurement

Network measurement

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- Measuring the Internet:
  - No central vantage point, only indirect access to certain portions, multiple ASes hiding information…

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- Measuring the Internet:
  - No central vantage point, only indirect access to certain portions, multiple ASes hiding information…
- Measuring data centers:
  - Need low latency
  - Need fine-grained precision (milli- or microsecond)
  - An enormous amount of data to collect
  - Hard to publish findings (proprietary data sets)

Paper previews: Measurement (1/2)

- *Inside the Social Network's (Datacenter) Network (Roy et al.)*
  - Tu 4pm-4:50pm Session 3.1: Experience Track 1
  - Measurement study of Facebook's data center
- *Pingmesh: A Large-Scale System for Data Center Network Latency Measurement and Analysis (Guo et al.)*
  - Tu 4pm-4:50pm Session 3.1: Experience Track 1
  - Experience paper on Microsoft's system for collecting inter-server ping times at scale

Paper previews: Measurement (2/2)

- *Packet-Level Telemetry in Large Datacenter Networks (Zhu et al.)*
  - Th 8:50am - 10:30am Session 8: Data center networking
  - Packet tracing system deployed at Microsoft designed for finding network faults

Paper previews: Packet/flow handling

Packet and flow handling

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- Internet service model:
  - Best-effort, “end-to-end principle”, generally just one path to a destination

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- Internet service model:
  - Best-effort, “end-to-end principle”, generally just one path to a destination
- Data center networks:
  - *Load balancing*: how to effectively use all the many paths to a given destination?
  - *Better than best-effort*: how to prioritize, rate-limit, adjust relative sending rates…

Paper previews: Packet/flow handling

- *Presto: Edge-based Load Balancing for Fast Datacenter Networks (He et al.)*
  - Th 8:50am - 10:30am Session 8: Data center networking
  - Choosing paths for packets with help from endhosts

- *Enabling End-Host Network Functions (Ballani et al.)*
  - Th 8:50am - 10:30am Session 8: Data center networking
  - Providing better than best-effort handling of packets with help from endhosts

In closing

- DCN is an exciting, fun research area
- While many papers are from Microsoft, Google, Facebook, …
  - YOU have the ability to have enormous impact
  - Many projects are open-source
    - E.g., http://opencompute.org
- Rethink the entire network stack!
  - Hardware, software, protocols, OS, NIC, …