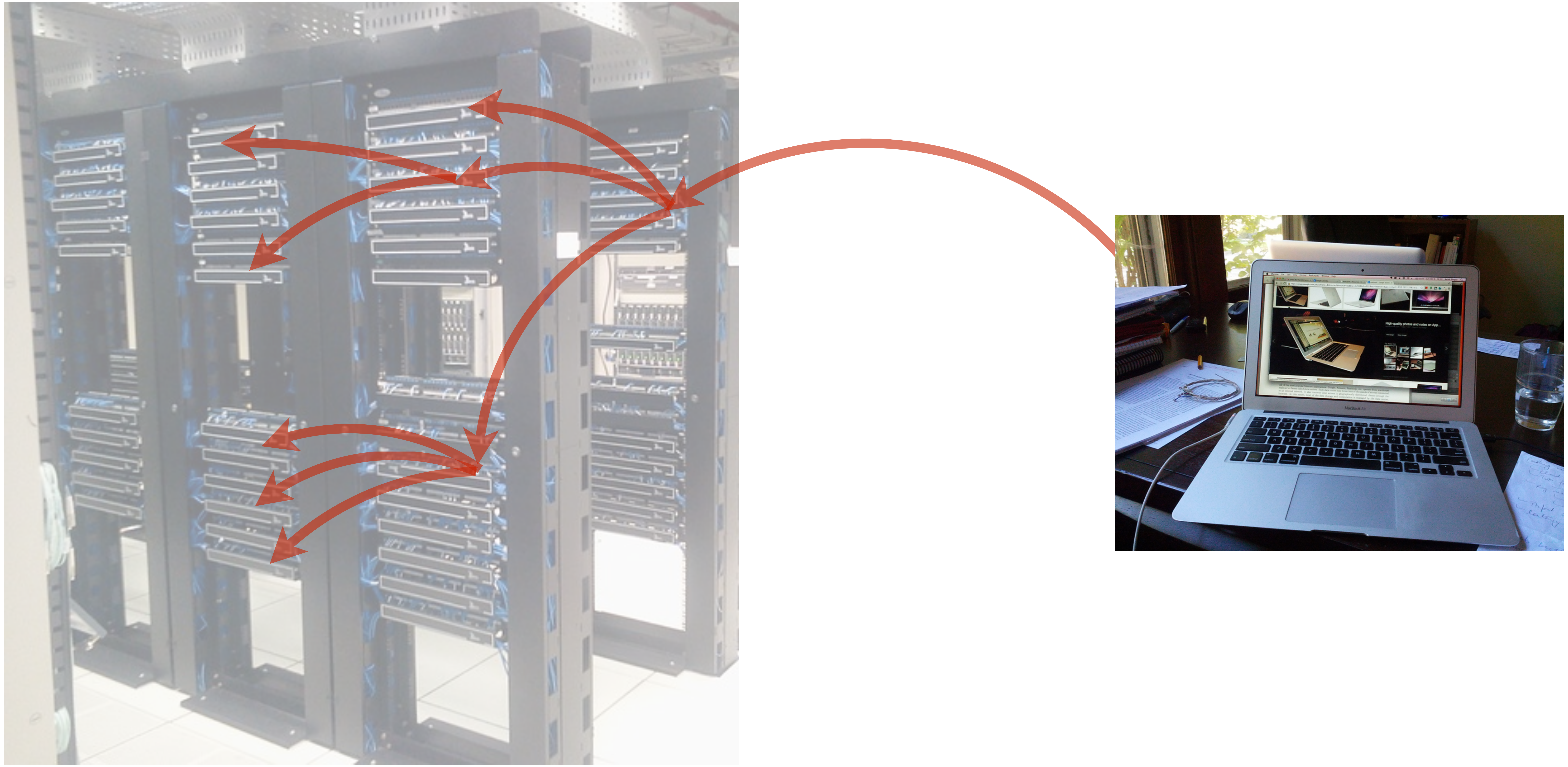
Applications and network traffic

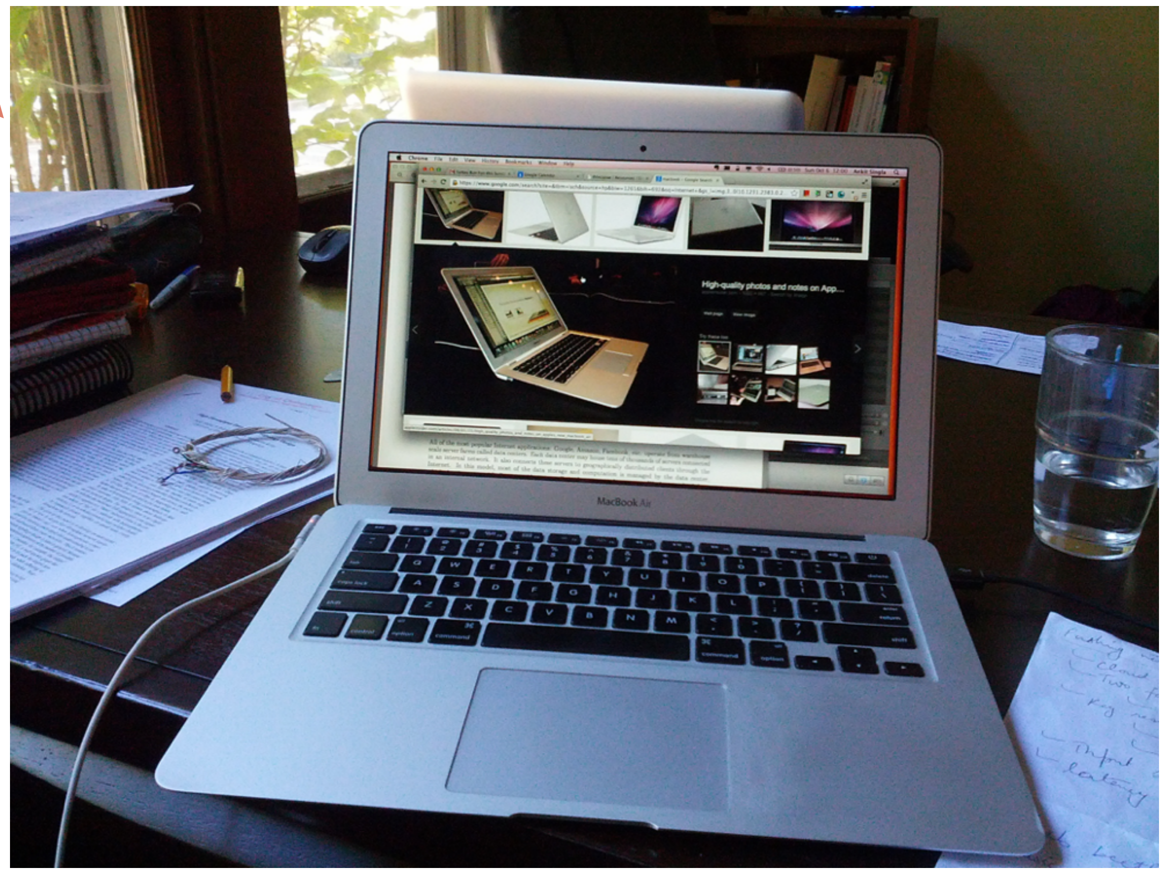
[Image: NASA/Goddard/UMBC]

How a Web search works

How a Web search works



Scatter-gather traffic pattern



Extremely short response deadlines for each server — 10ms

"Up to 150 stages, degree of 40, path lengths of 10 or more"

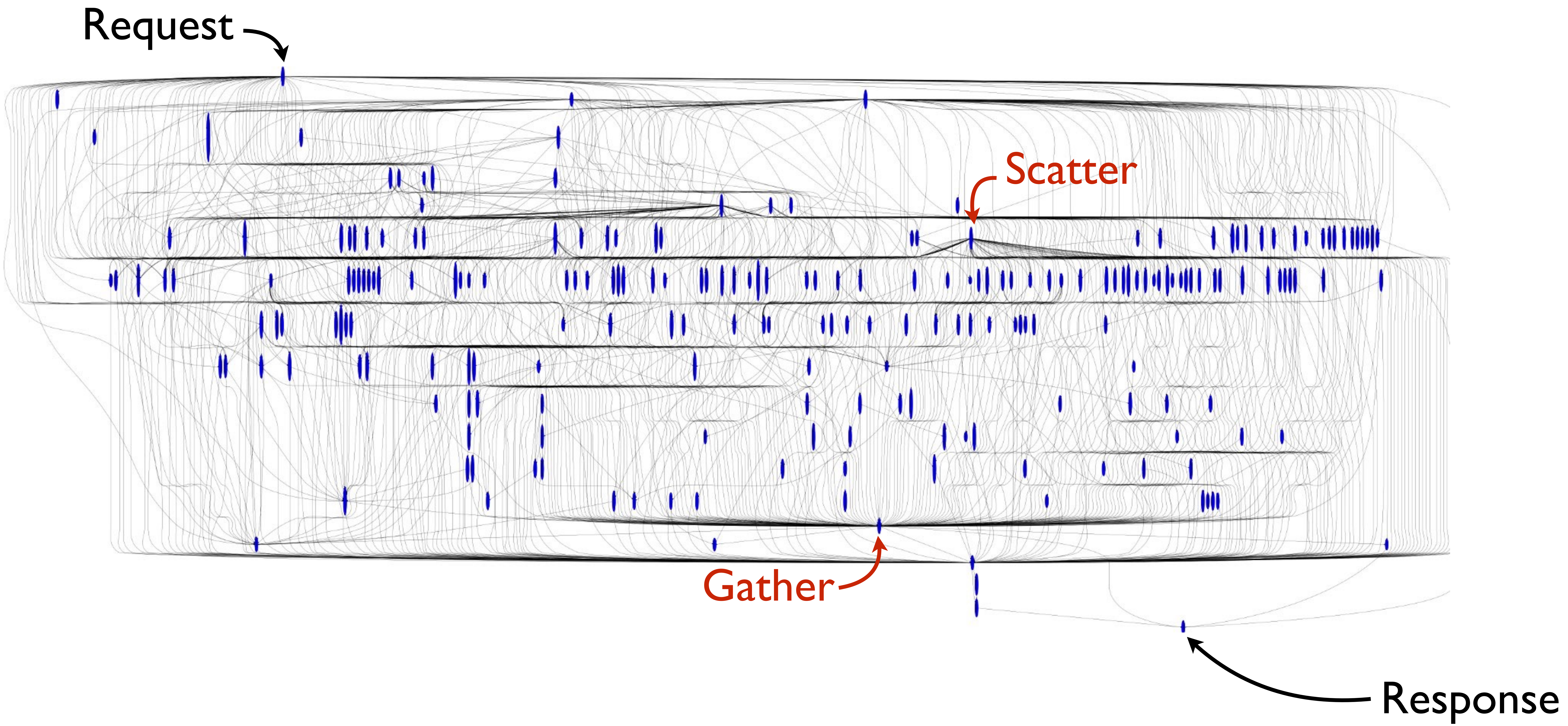


Image source: Talk on "Speeding up Distributed Request-Response Workflows" by Virajith Jalaparti at ACM SIGCOMM'13

Other Web application traffic

USENIX NSDI, 2013

Scaling Memcache at Facebook

Rajesh Nishtala, Hans Fugal, Steven Grimm, Marc Kwiatkowski, Herman Lee, Harry C. Li,
Ryan McElroy, Mike Paleczny, Daniel Peek, Paul Saab, David Stafford, Tony Tung,
Venkateshwaran Venkataramani
{rajeshn,hans}@fb.com, {sgrimm, marc}@facebook.com, {herman, hcli, rm, mpal, dpeek, ps, dstaff, ttung, veeve}@fb.com
Facebook Inc.

One popular page loaded ⇒ average of **521** distinct `memcache` fetches

95th percentile: **1740** distinct `memcache` fetches

Big data analytics

Hadoop

Spark

Dryad

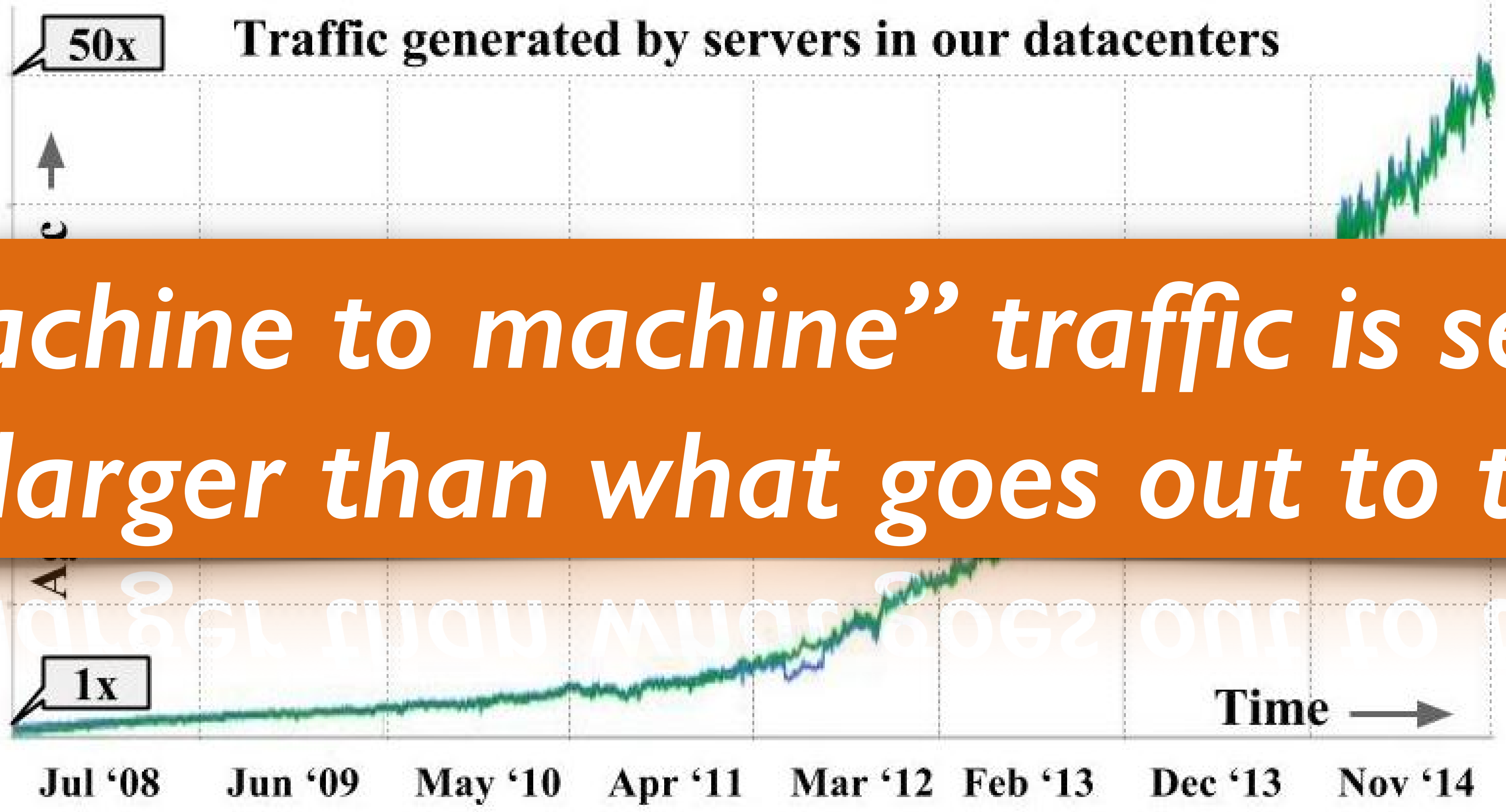
Database *joins*

⋮

What does data center traffic look like?

It depends … on applications, scale, network design, …

Traffic characteristics: growing volume



Facebook: *"machine to machine" traffic is several orders of magnitude larger than what goes out to the Internet*

"Jupiter Rising: A Decade of Clos Topologies and Centralized Control in Google's Datacenter Network", Arjun Singh et al. @ Google, ACM SIGCOMM'15

Traffic characteristics: rack locality

Facebook

"Inside the Social Network's (Datacenter) Network"
Arjun Roy et al., ACM SIGCOMM'15

Locality	All	Hadoop	FE	Svc.	Cache	DB
Rack	12.9	13.3	2.7	12.1	0.2	0
Cluster	57.5	80.9	81.3	56.3	13.0	30.7
DC	11.9	3.3	7.3	15.7	40.7	34.5
Inter-DC	17.7	2.5	8.6	15.9	16.1	34.8
Percentage		23.7	21.5	18.0	10.2	5.2

Google

"Jupiter Rising: A Decade of Clos Topologies and Centralized Control in Google's Datacenter Network"
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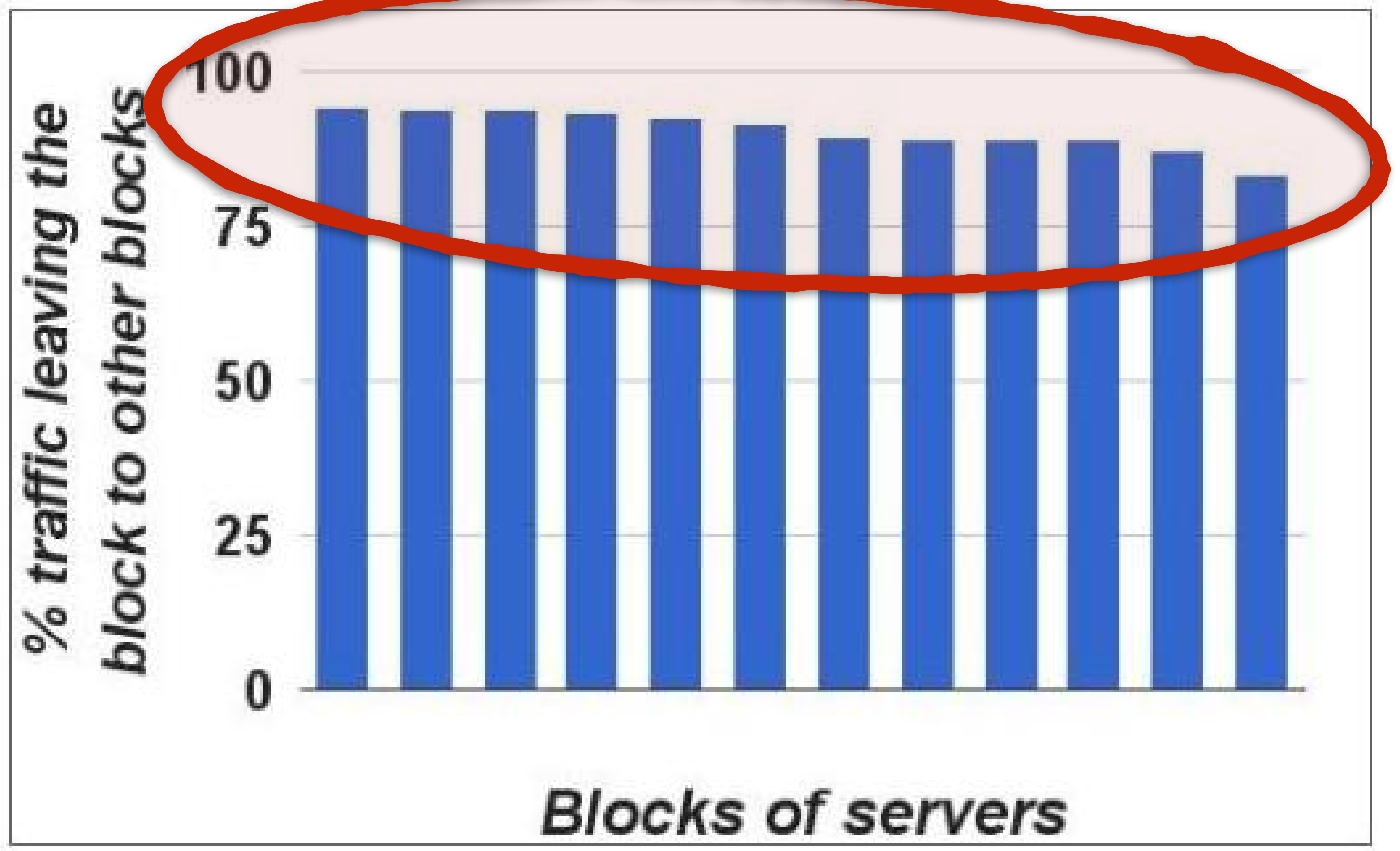
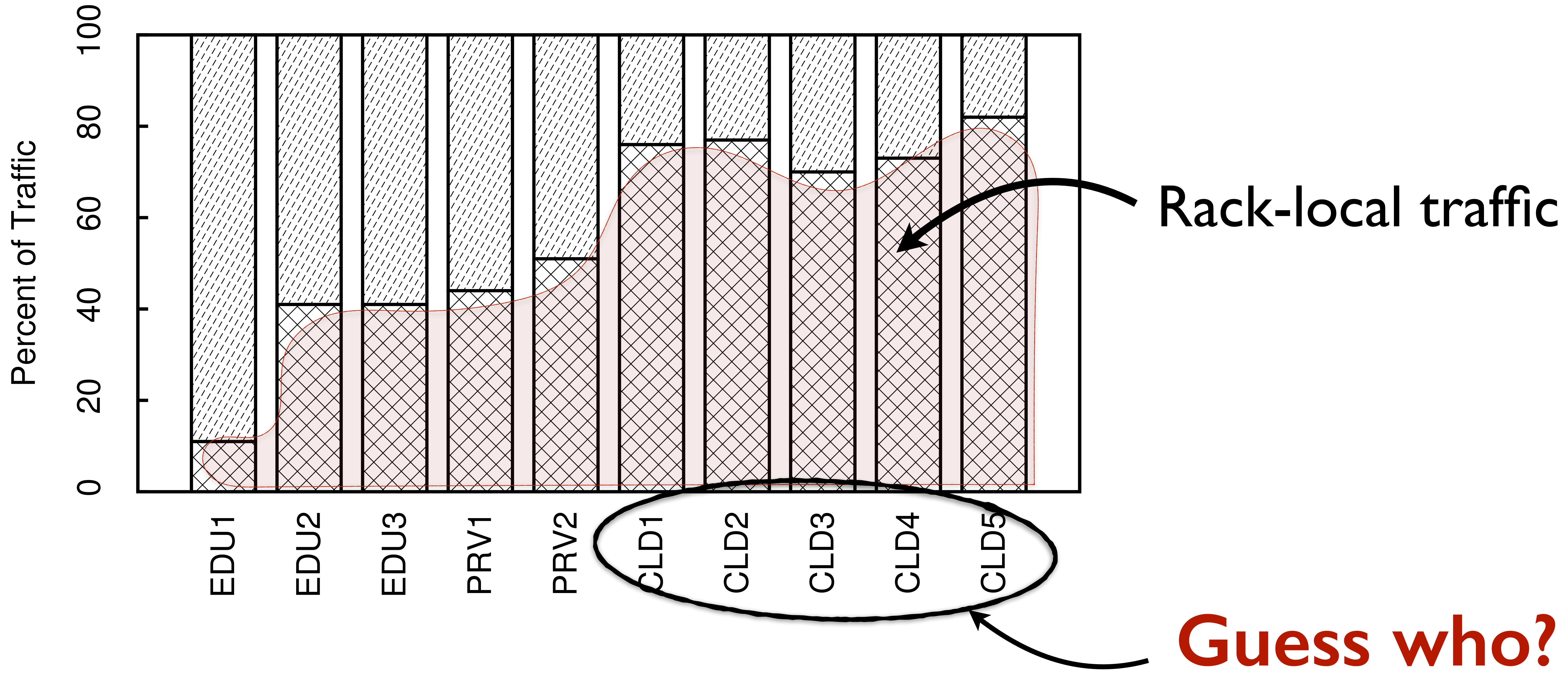
Job Category	B/w (%)
Storage	49.3
Search Serving	26.2
Mail	7.4
Ad Stats	3.8
Rest of traffic	13.3



Traffic characteristics: rack locality



"Network Traffic Characteristics of Data Centers in the Wild"
Theophilus Benson et al., ACM IMC'10

Traffic characteristics: concurrent flows

Facebook

"Inside the Social Network's (Datacenter) Network"
Arjun Roy et al., ACM SIGCOMM'15

*"Web servers and cache hosts have **100s to 1000s** of concurrent connections"*

*"Hadoop nodes have approximately **25** concurrent connections on average."*

1500 server cluster @ ??

"The Nature of Datacenter Traffic: Measurements & Analysis"
Srikanth Kandula et al. (Microsoft Research), ACM IMC'09

"median numbers of correspondents for a server are two (other) servers within its rack and four servers outside the rack"

Traffic characteristics: flow arrival rate

Facebook

"Inside the Social Network's (Datacenter) Network"
Arjun Roy et al., ACM SIGCOMM'15

"median inter-arrival times of approximately 2ms"

1500 server cluster @ ??

"The Nature of Datacenter Traffic: Measurements & Analysis"
Srikanth Kandula et al. (Microsoft Research), ACM IMC'09

< 0.1x Facebook's rate

Traffic characteristics: flow sizes

Facebook

"Inside the Social Network's (Datacenter) Network"
Arjun Roy et al., ACM SIGCOMM'15

Hadoop: median flow <1KB
<5% exceed 1MB or 100sec

Caching: most flows are long-lived
… but bursty internally

Heavy-hitters ≈ median flow, not persistent

1500 server cluster @ ??

"The Nature of Datacenter Traffic: Measurements & Analysis"
Srikanth Kandula et al. (Microsoft Research), ACM IMC'09

> 80% of the flows last <10sec

> 50% bytes are in flows lasting less <25sec

What does data center traffic look like?

It depends … on applications, scale, network design, …

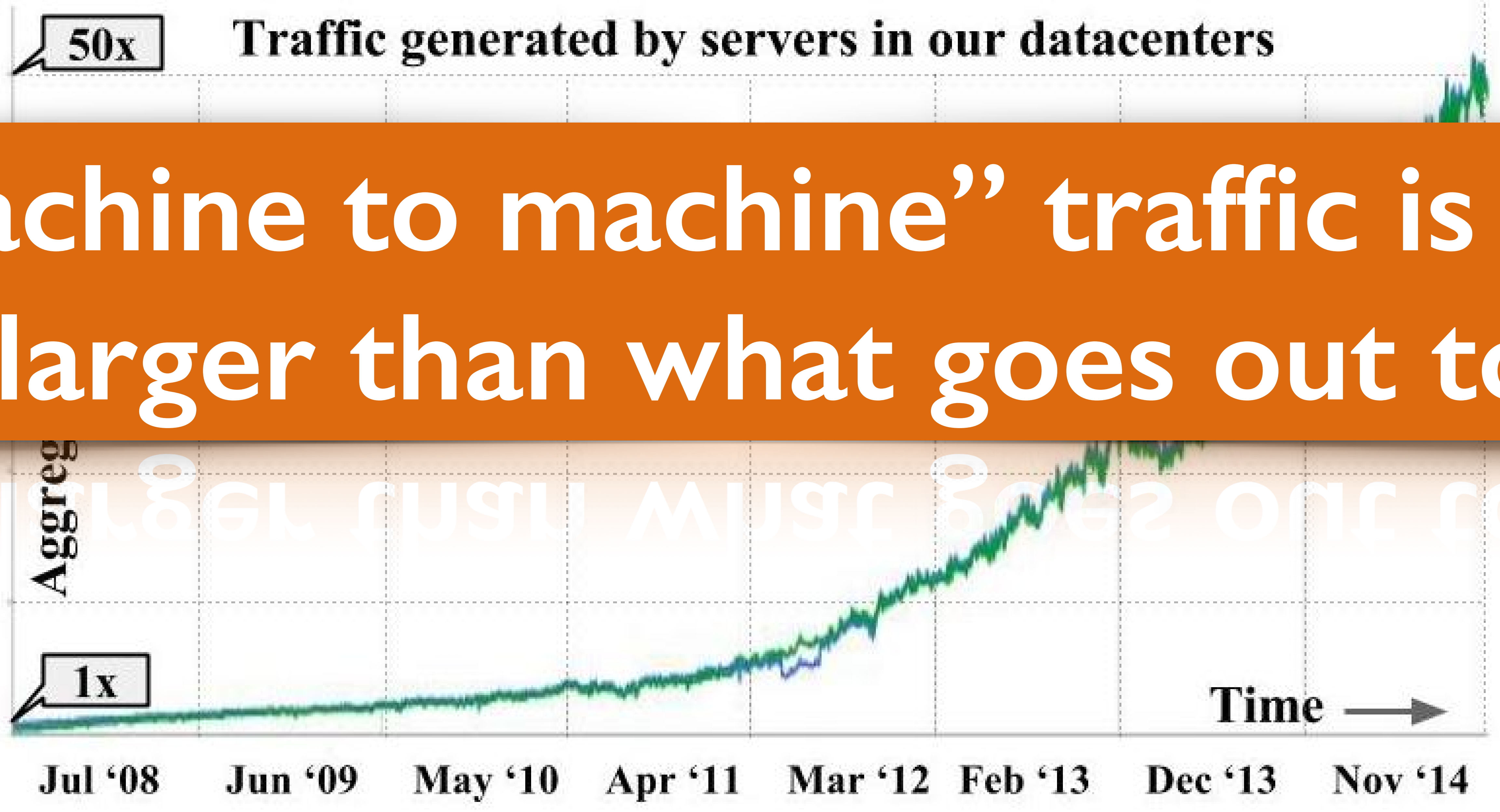
… and right now, not a whole lot of data is available.

Implications for networking

1. Data center internal traffic is BIG
2. Tight deadlines for network I/O
3. Congestion and TCP incast
4. Need for isolation across applications
5. Centralized control at the flow level may be difficult

Implications for networking

1 Data center internal traffic is BIG



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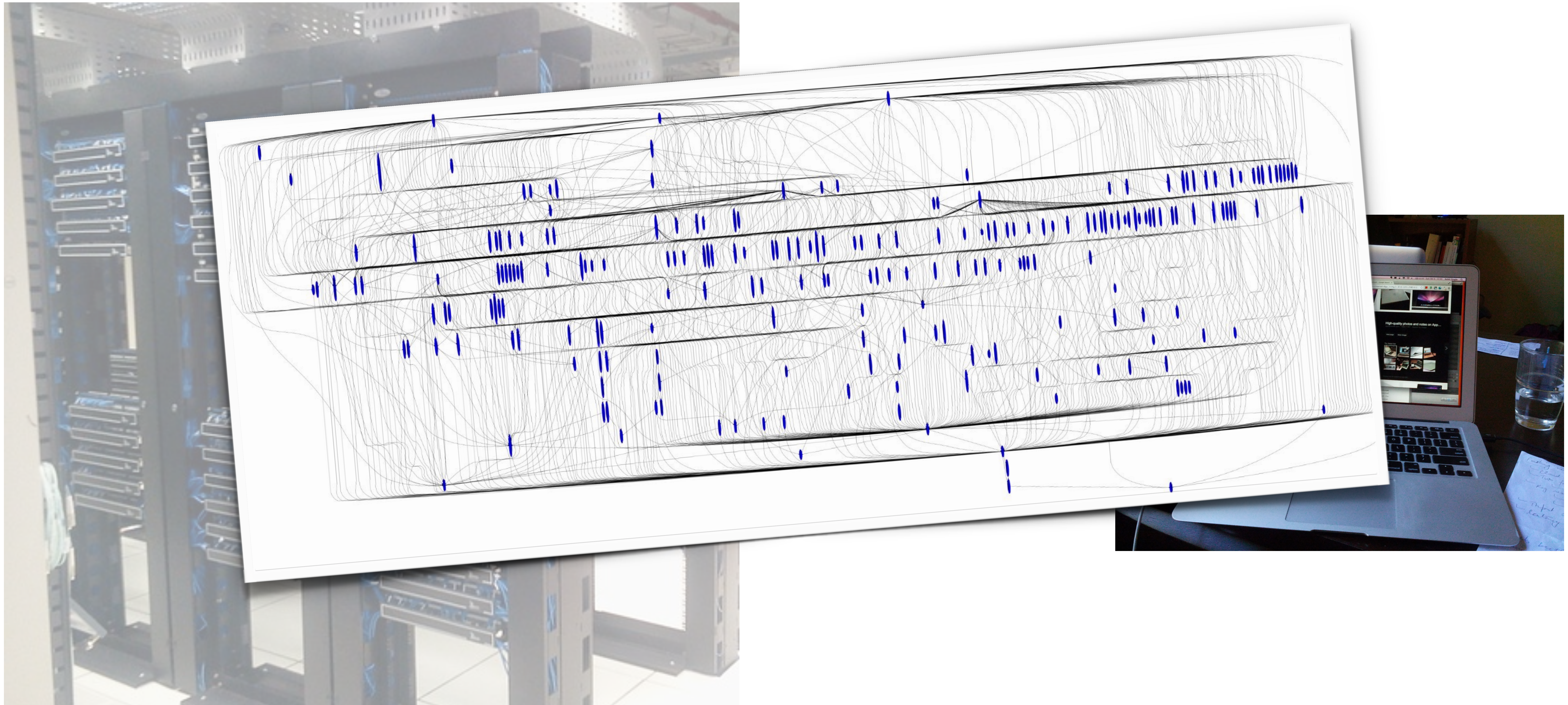
"Jupiter Rising: A Decade of Clos Topologies and Centralized Control in Google's Datacenter Network", Arjun Singh et al. @ **Google**, ACM SIGCOMM'15

Implications for networking

2 Tight deadlines for network I/O



Implications for networking

2 Tight deadlines for network I/O

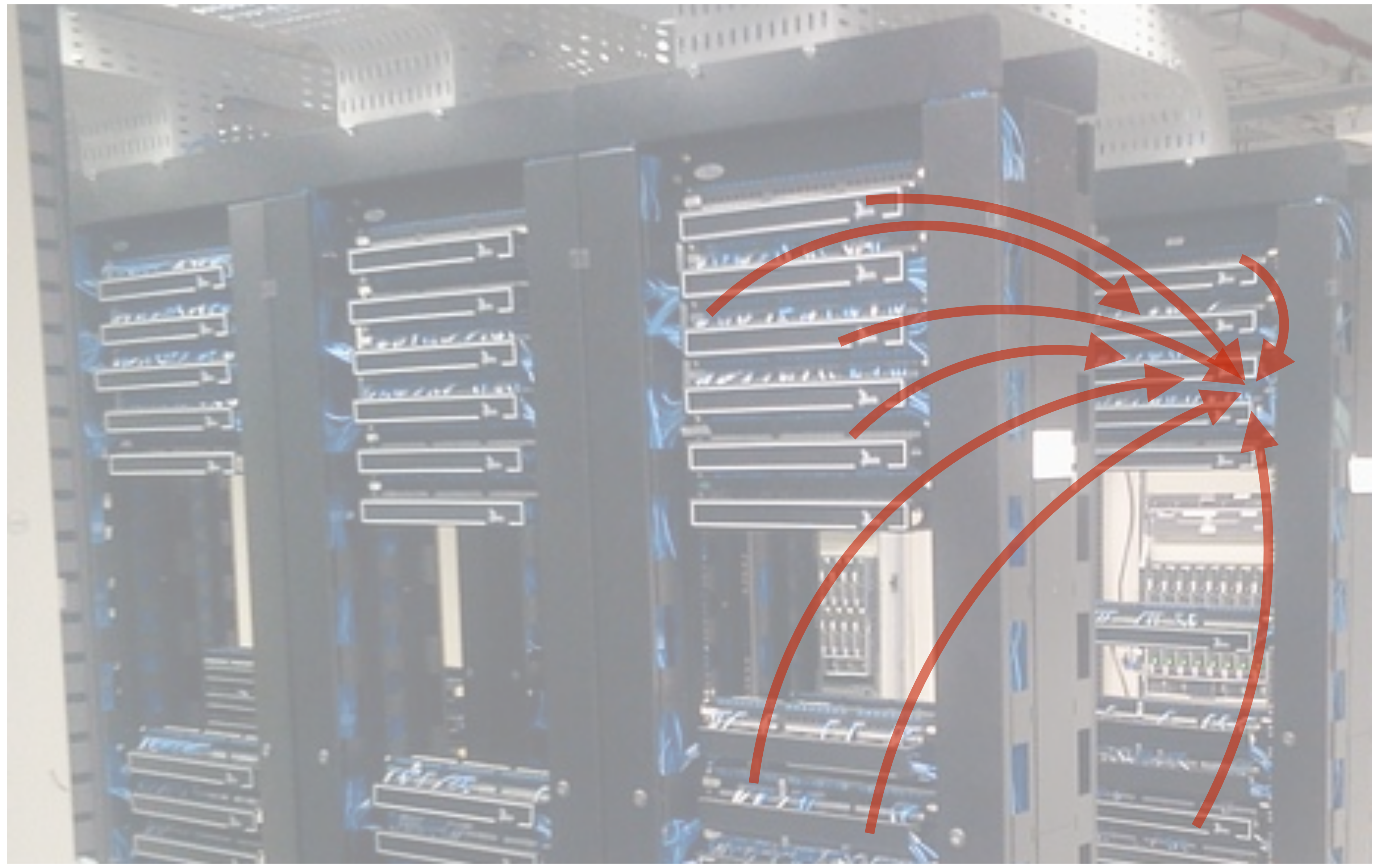
Suppose: server response-time is 10ms for 99% of requests; 1s for 1%

#Servers	Requests 1s or slower
1	1%
100	63%

Need to reduce variability and tolerate *some* variation

Implications for networking

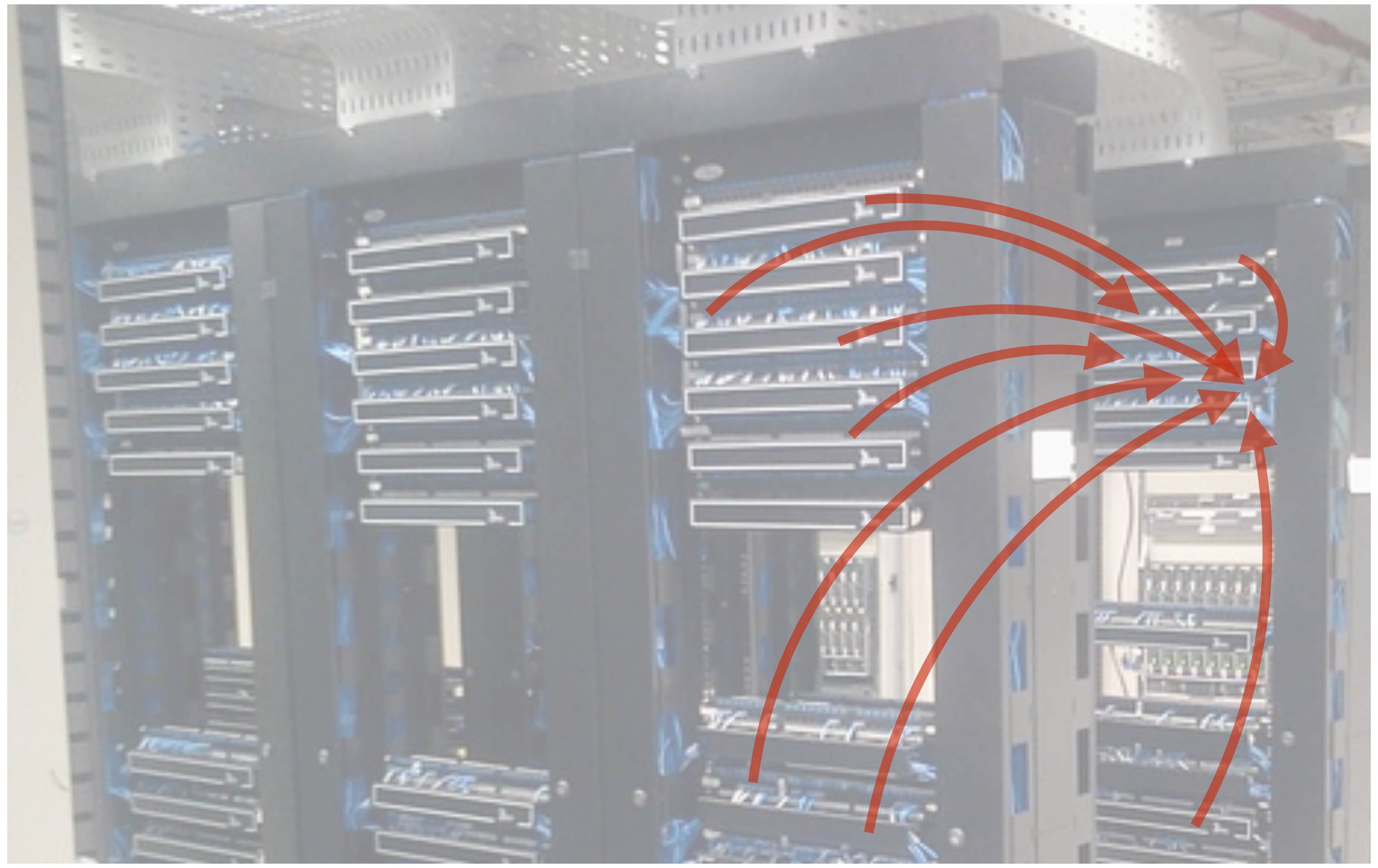
3 Congestion and TCP incast

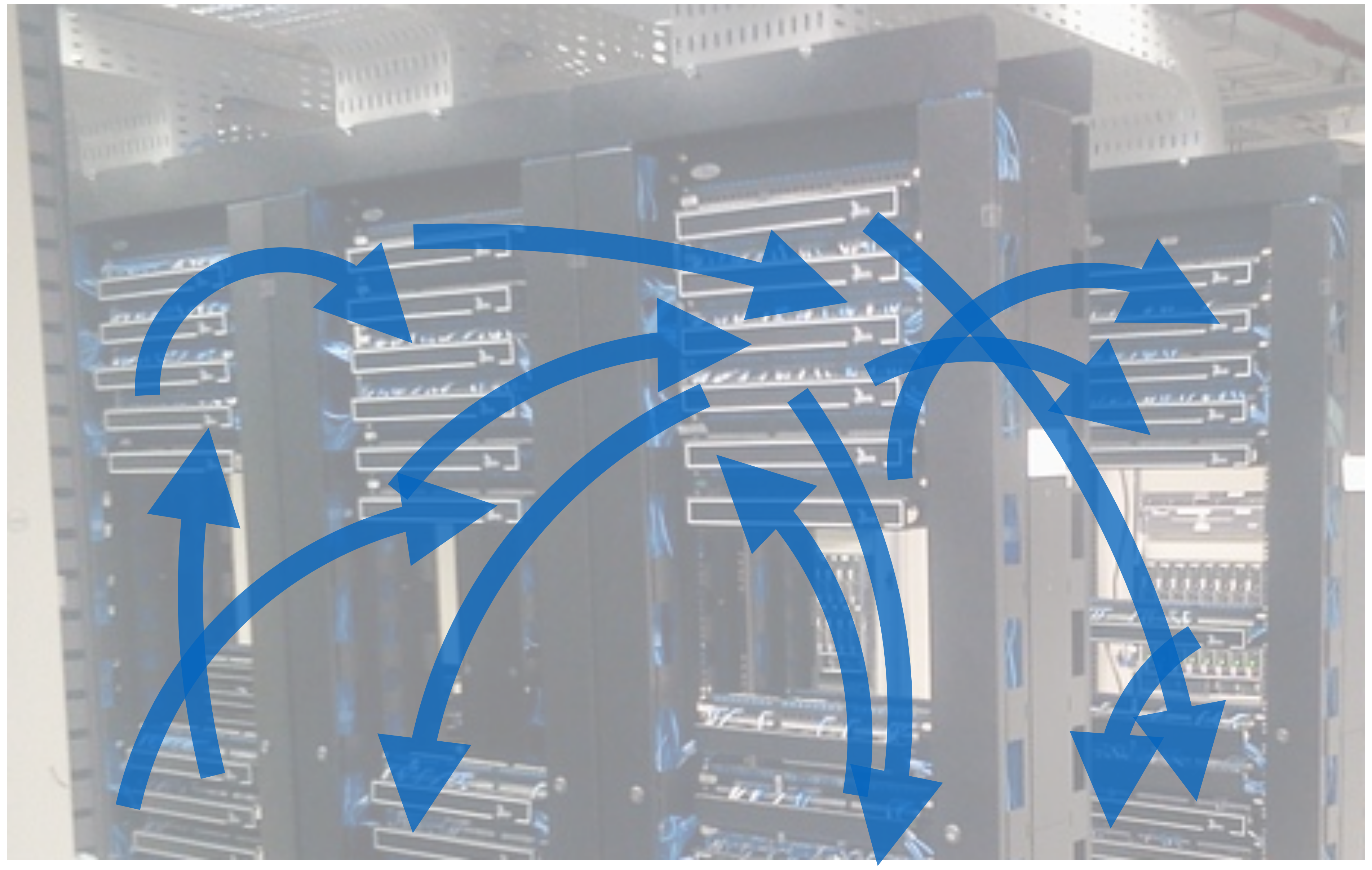


TCP does not work very well

Implications for networking

4 Need for isolation across applications

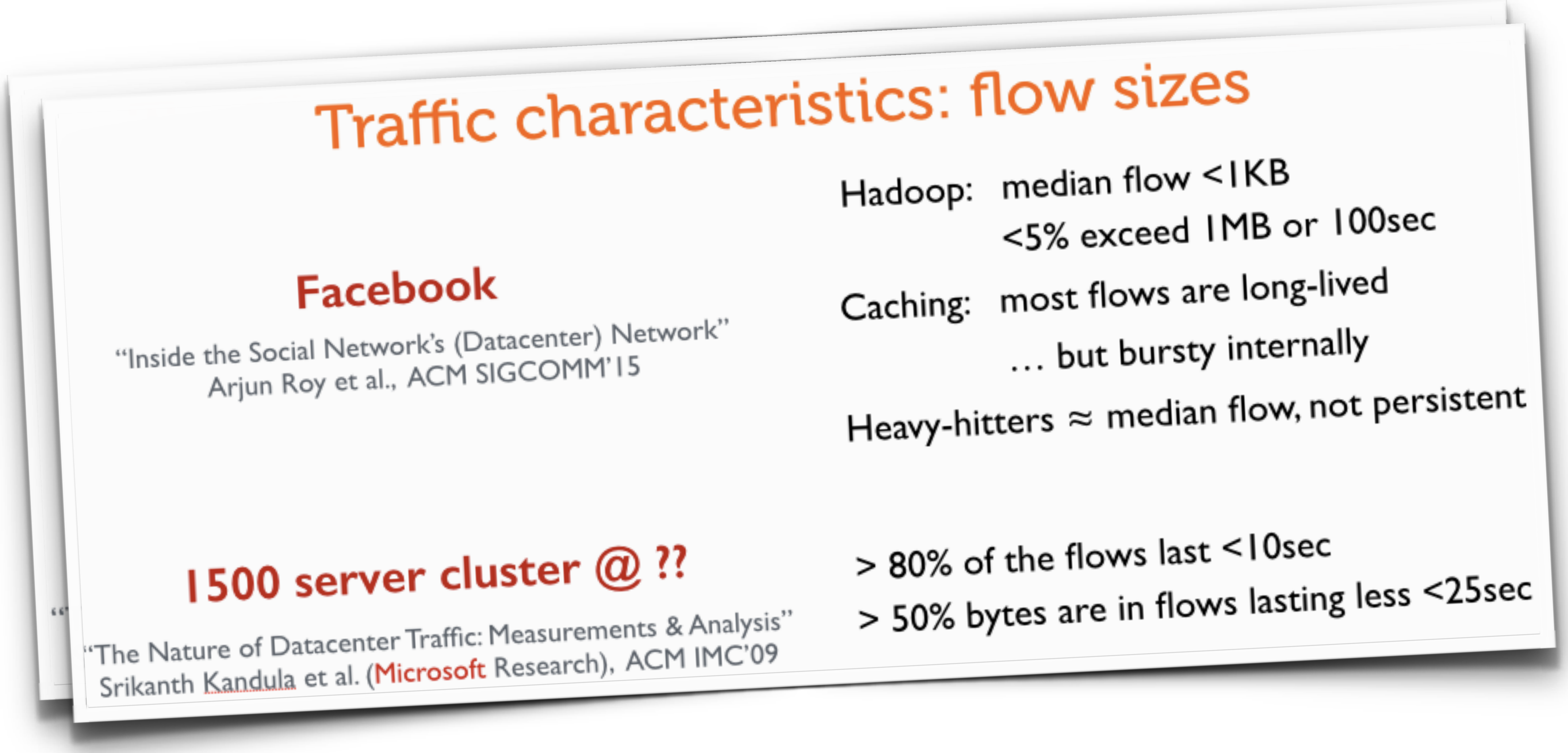




Applications with different objectives sharing the network

Implications for networking

5 Centralized control at the flow level may be difficult



Distributed control, perhaps with some centralized tinkering