6.S897 Large-Scale Systems

Instructor: Matei Zaharia
Fall 2015, TR 2:30-4, 34-301

bit.ly/6-s897

Outline

What this course is about

Logistics

Datacenter environment

What this Course is About

Large-scale computer systems

- **Web applications:** Facebook, Gmail, etc
- **Big data:** one computation on many machines
- **Clouds:** software or infrastructure as a service

"Systems that run on hundreds of nodes"

Why Study Large-Scale Systems?

Increasingly run “most” computer applications

One of the more likely areas for impact

Rich systems & algorithmic problems

Trends Behind Large-Scale Systems

1. Growth of workloads (users, data) relative to machine speeds
2. Faster Internet
3. Economics
   - Benefits of software and infra as a service
   - Economies of scale for providers

1. Growth of Workloads

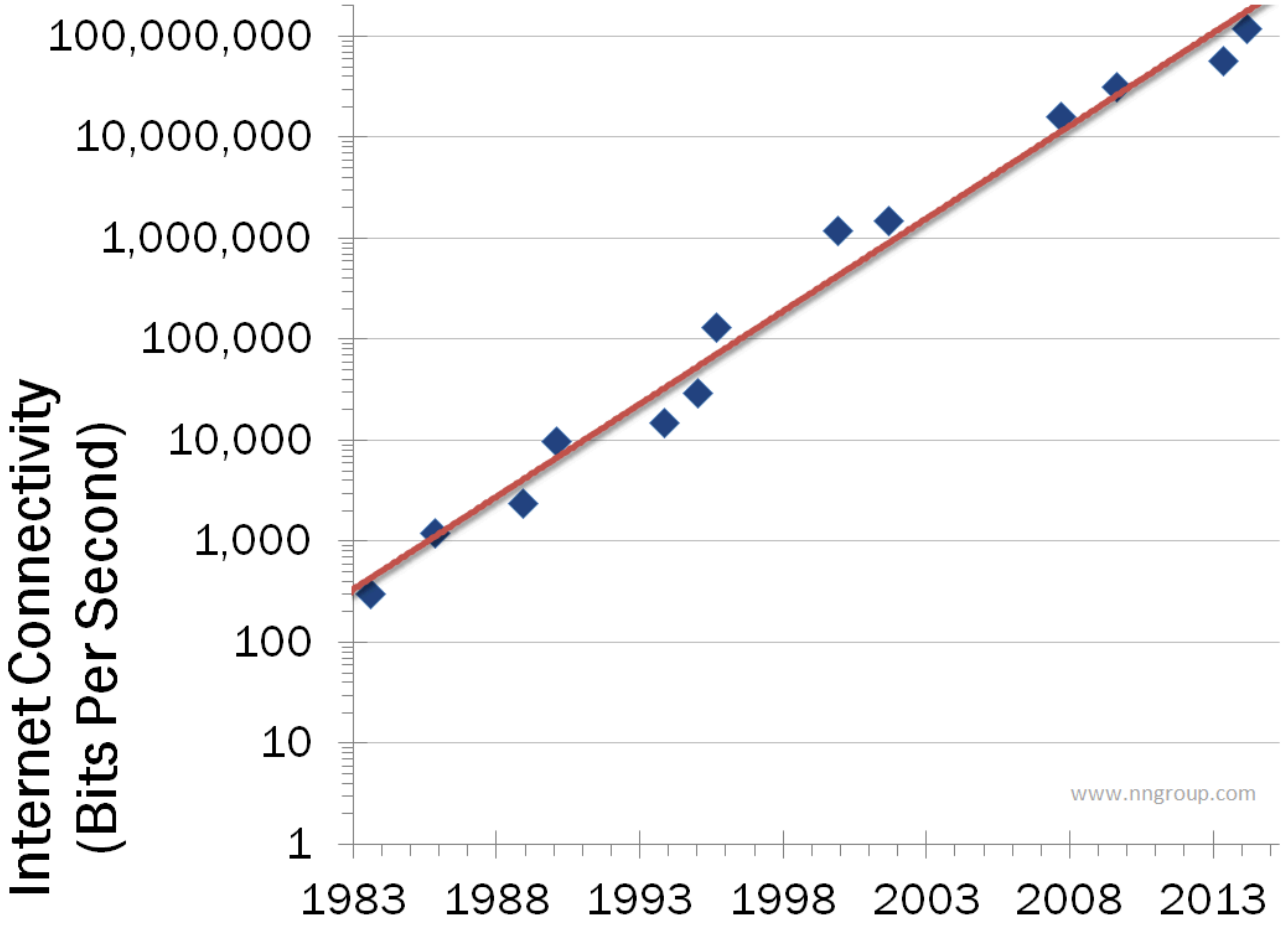
Growing # of Internet users

Growth of data w.r.t. computation speeds

– Mostly from machines: sensors, images, IoT, etc

2. Faster Internet

Speed of a high-end residential connection



3. Economics

Benefits of software as a service:

- For vendors: single deployment target, visibility
- For users: easier to manage

Benefits of infrastructure as a service:

- Elastic scaling, pay-as-you-go

Economies of scale (lower costs in bulk)

This Course

Papers & readings on influential systems

- File systems, databases, coordination, processing frameworks, resource managers, networks, performance, programming tools

Guest talks from 4 speakers

Focus on what's widely deployed

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Readings

2-3 per class

Each has summary questions

- Email answers to 6.s897staff@gmail.com

Each student will present 1 paper in class

- 15 minute talk; see website

Projects

Ideally in groups of 2-3

Term-long mini research project of your choice

- Can be related to your research
- Matei will list some ideas

Report + poster session at end of term

Project Timeline

Oct 2	Form groups, run idea by Matei
Oct 9	Initial proposal (1-2 pages)
Nov 10	Mid-term review
Dec 10	Poster session
Dec 15	Final writeup (10-12 pages)

Grading

70% project

15% paper presentation

15% summary questions + participation

Course Staff

Instructor: Matei Zaharia

– Office hours TBD, likely Tuesday at 4

TA: Rohan Mahajan

– Will help with summary questions & logistics

Other Notes

The course is 12 units!

I have some EC2 credits for the projects

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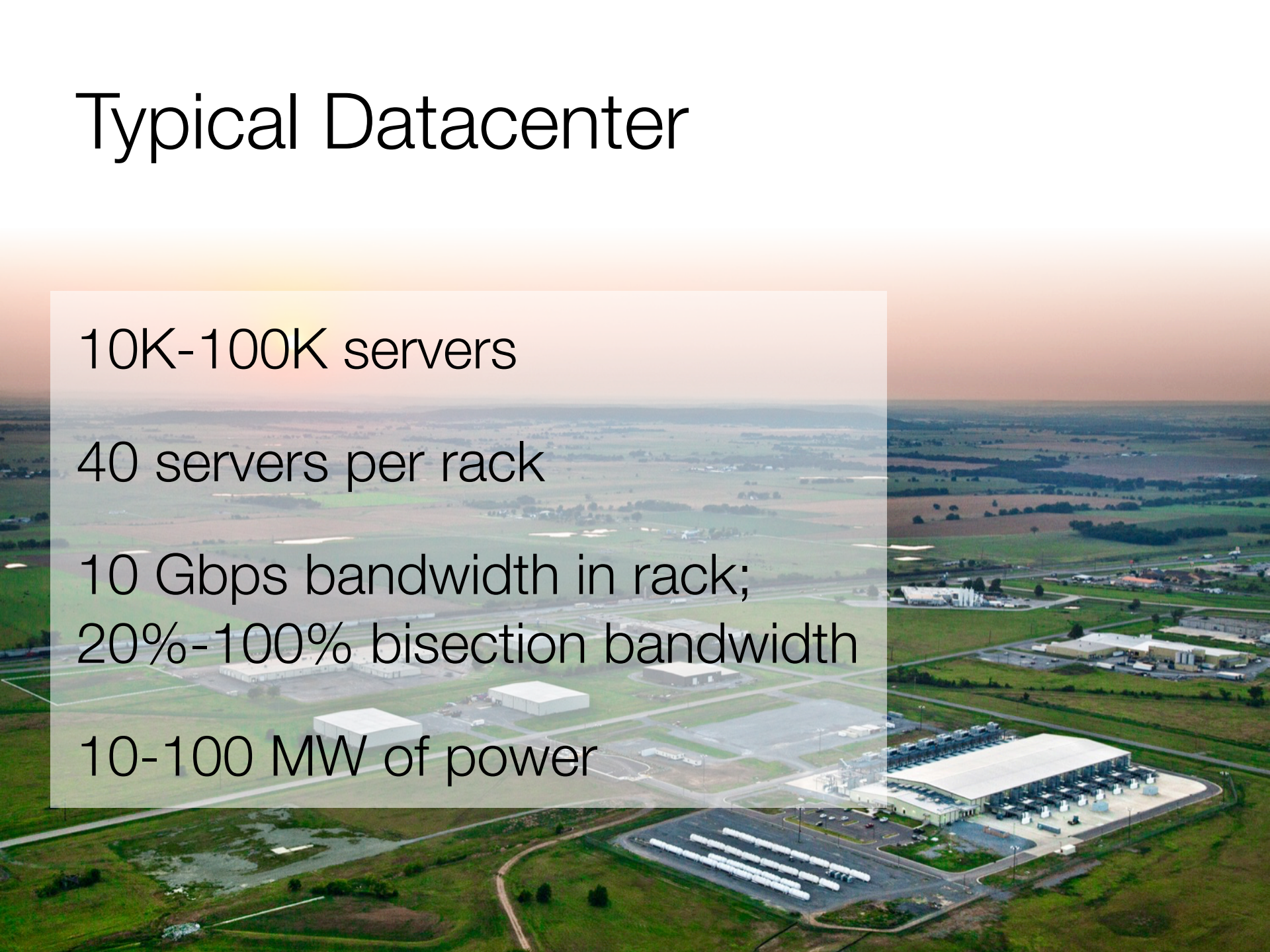
Typical Datacenter

Typical Datacenter



10K-100K servers

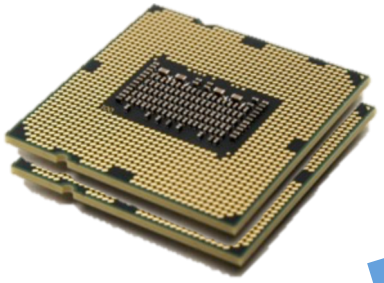
40 servers per rack

10 Gbps bandwidth in rack;
20%-100% bisection bandwidth

10-100 MW of power

Typical Server

CPUs:
16-32 cores



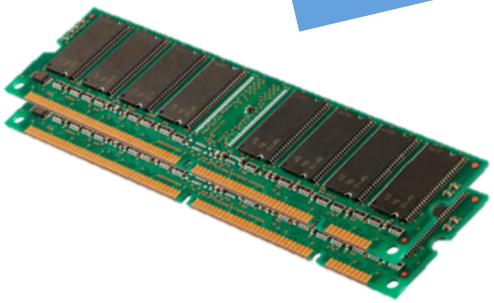
1 GB/s

NIC: 10 Gbps

50 GB/s

0.1 GB/s each

1 GB/s each



DRAM: 64-256 GB

HDDs: 2-40 TB

SSDs?

Recent Hardware Changes

Node bandwidth: 1 Gbps ➔ 10 Gbps

Embrace of SSDs (flash)

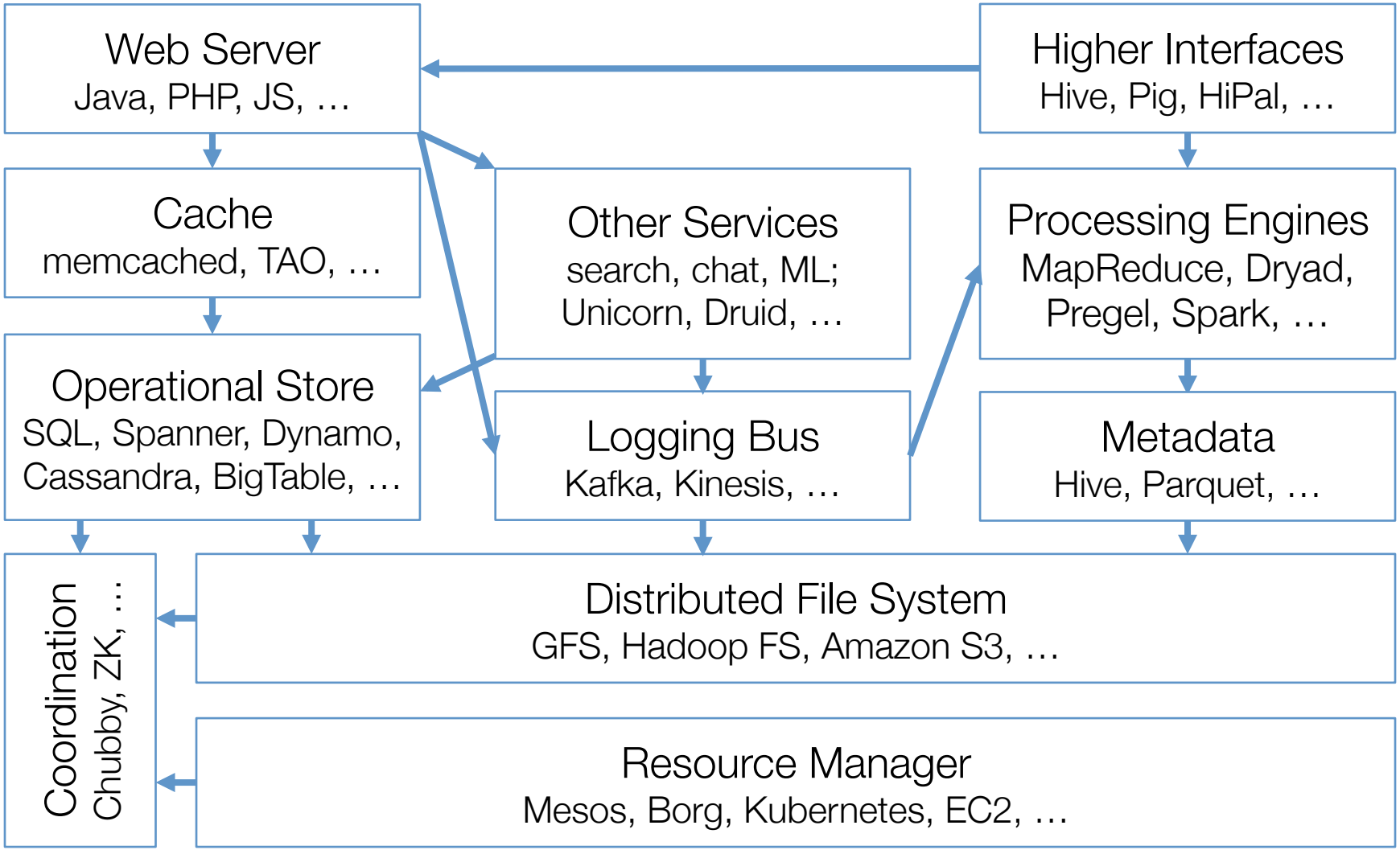
- Almost a given for transactional workloads
- “Soon” may be competitive for capacity / $

Better I/O virtualization

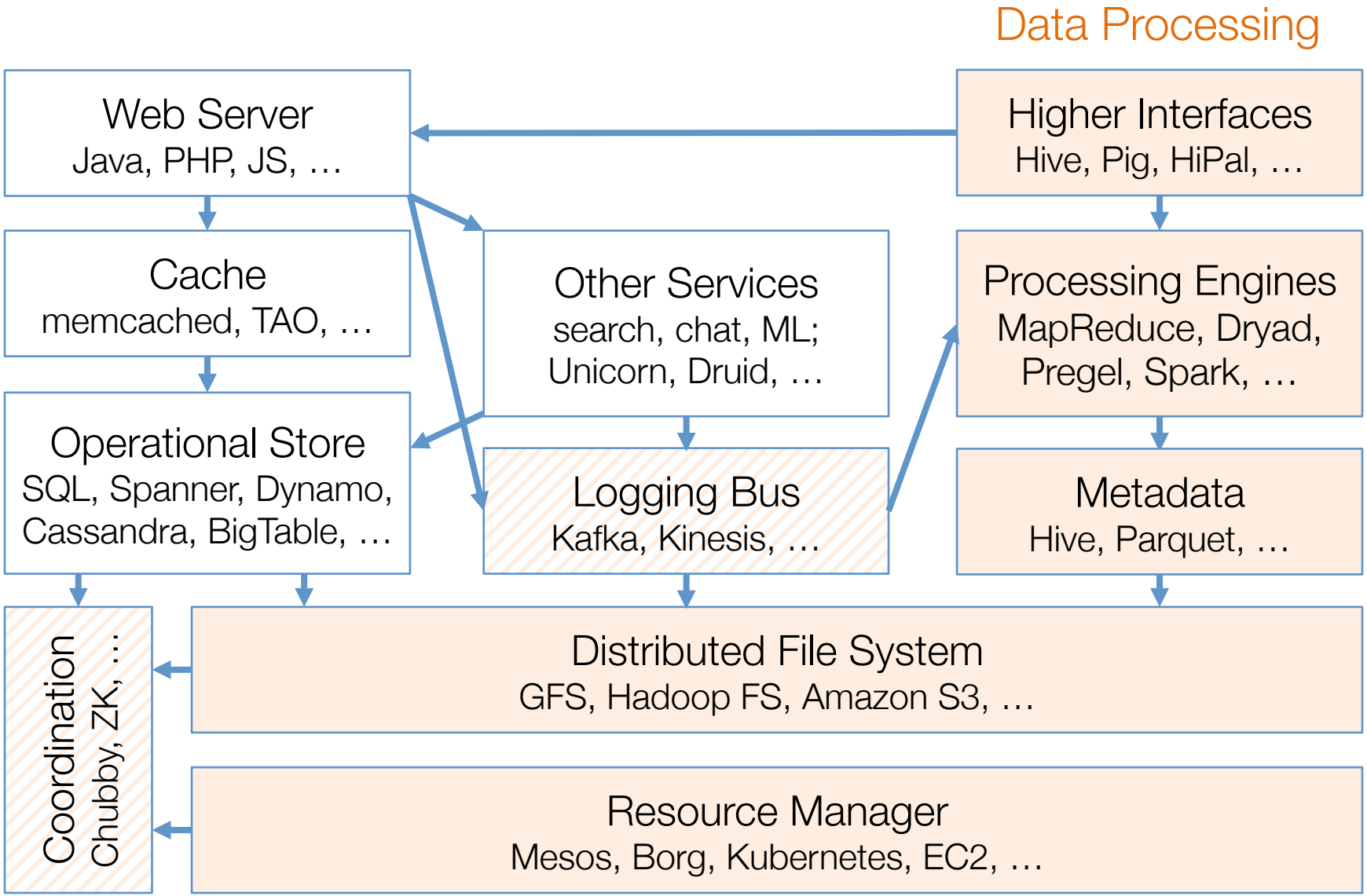
Types of Applications

1. Single big computation (e.g. big data)
2. Hosted apps for many tenants (e.g. Gmail, web hosting, cloud)
3. Single big multi-user app (e.g. Facebook)

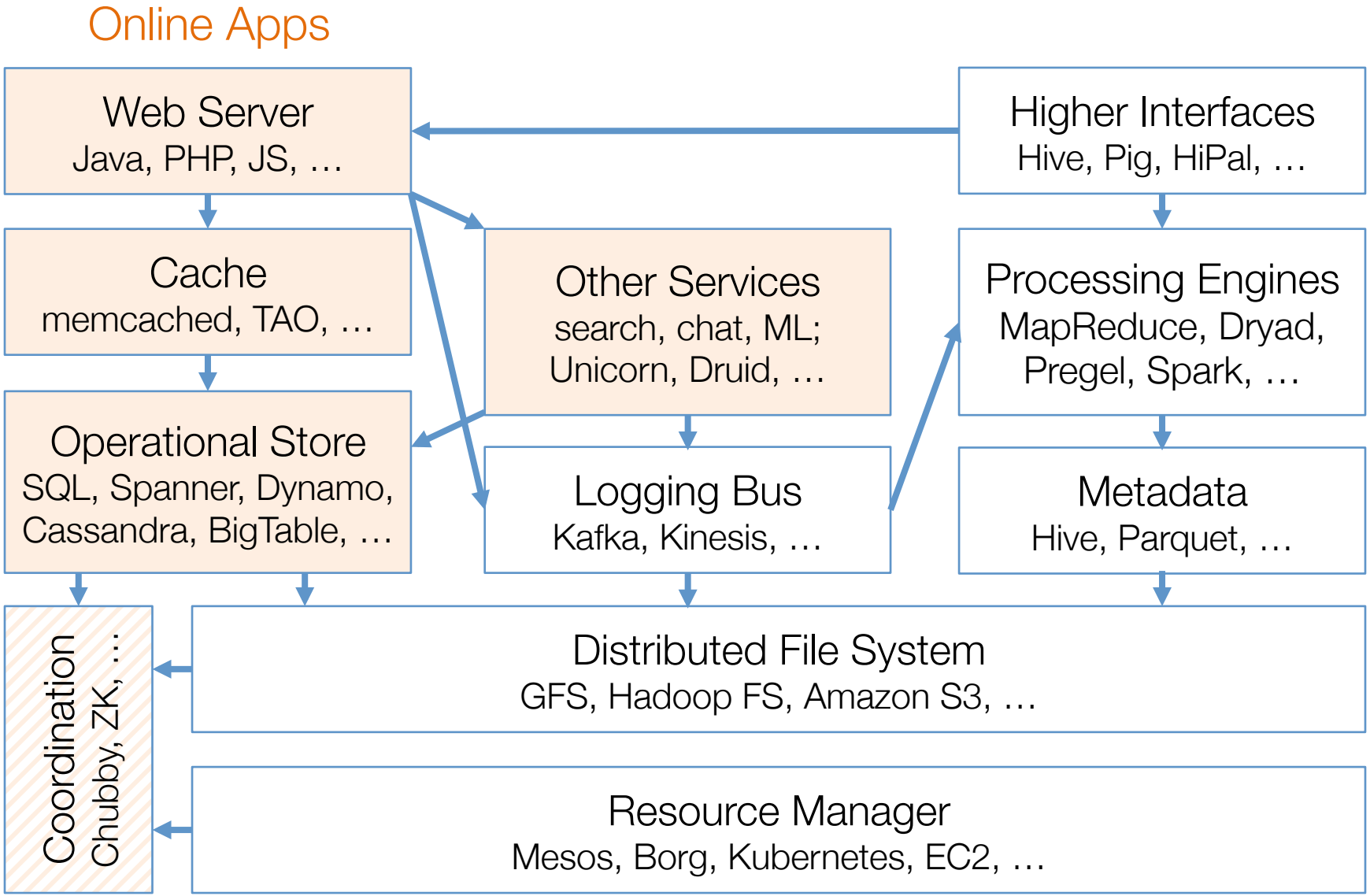
Software Stack



Software Stack



Software Stack



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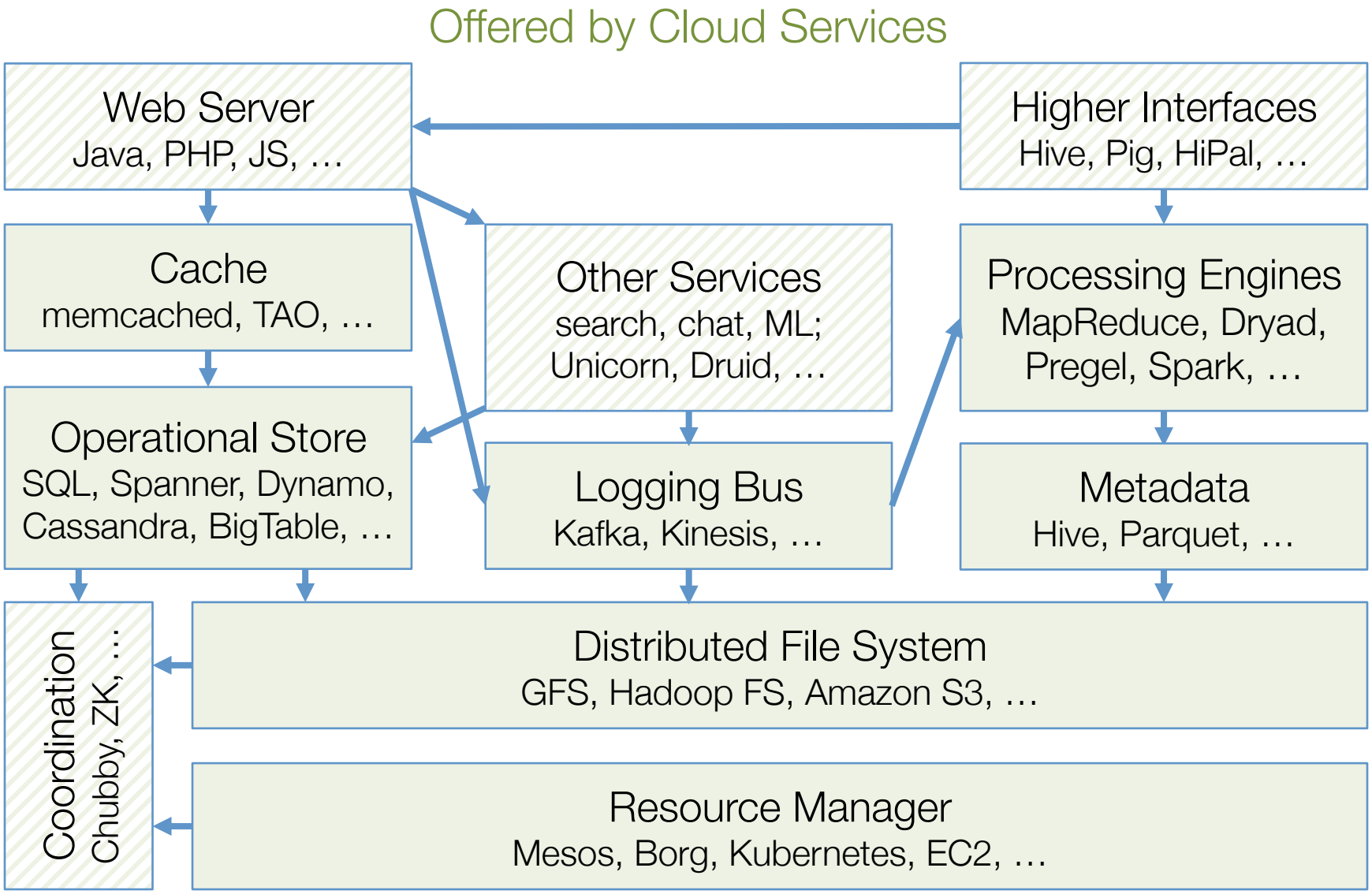

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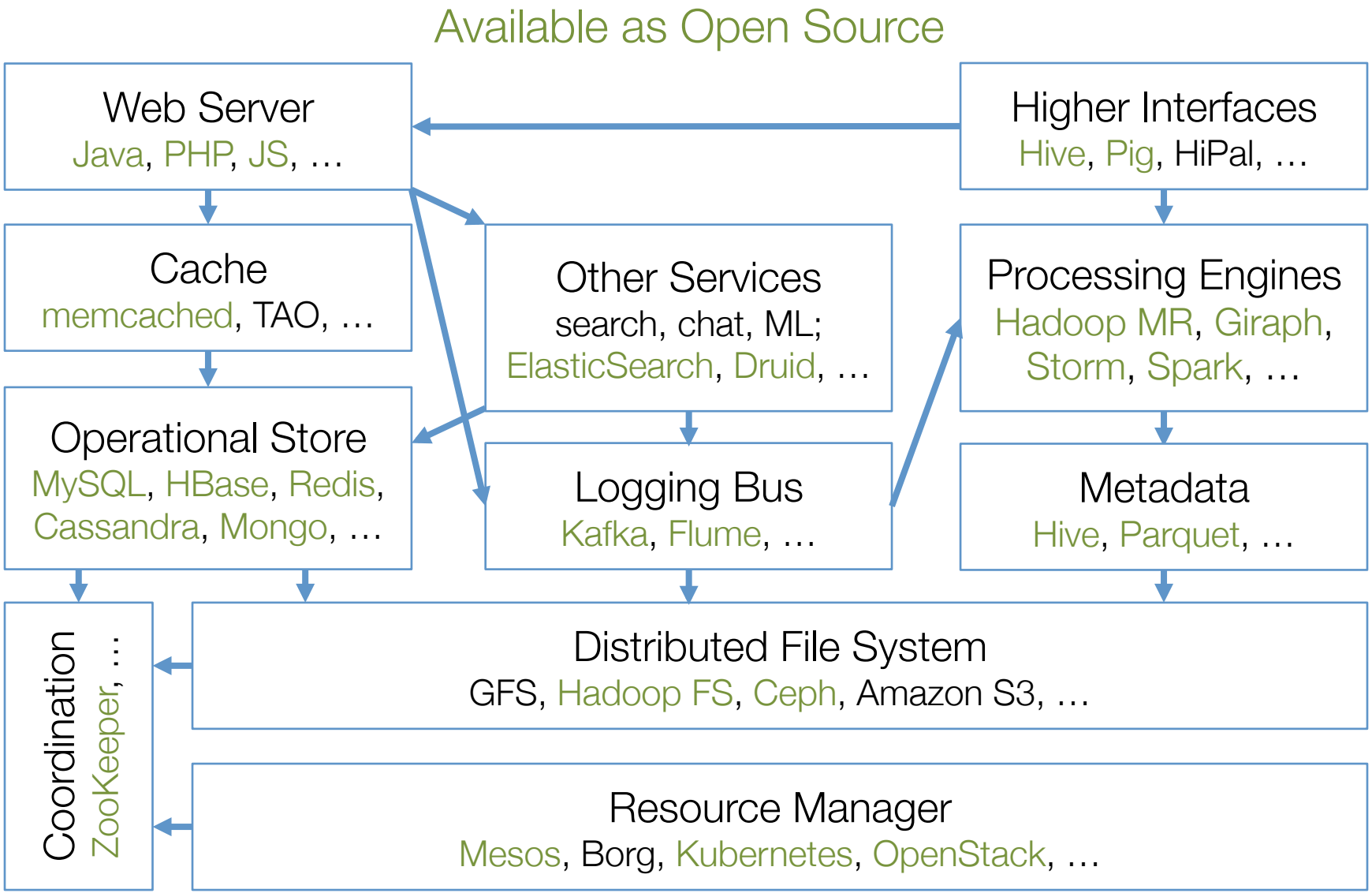

Coverage in This Course

Broad overview + a few “hot” areas

- Streaming, performance, complex analytics

Focus on what people actually *do*

Meant to drive new ideas / research

Key Themes

1. Cost of people vs software/hardware
   - Everyone works to lower development time, operations time, and time-to-answer
2. Simple, reusable abstractions
3. Statistical effects of scale
4. Moving target of efficiency
   - New hardware, app needs, multitenancy, …

Next Week

Tuesday: 3 intro readings (cloud computing and two readings from Facebook)

Volunteers for these?

Thursday: talk by Ali Ghodsi (Databricks) on big data processing as a service