

BUILDING A DATA PIPELINE

From Scratch

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@joecrobak

Tuesday, June 24, 2014
Axiom Lyceum - New York, NY

INTRODUCTION

Software Engineer @ Project Florida

Previously:

- Foursquare
- Adconion Media Group
- Joost

OVERVIEW

Why do we care?

Defining *Data Pipeline*

Events

System Architecture

DATA PIPELINES ARE EVERYWHERE

RECOMMENDATIONS

Continue Shopping: Customers Who Bought Items in Your Recent History Also Bought



New Balance Men's
ML574 Varsity...

★★★★★ (67)

\$37.98 - \$107.33 ✓ Prime

Some options are Prime eligible



New Balance Women's
WL574...

★★★★★ (5)

\$52.46 - \$79.99 ✓ Prime

Some options are Prime eligible



NuTone 23405ser
Ventilation Fan...

★★★★★ (12)

\$37.00

People You May Know



Jay Kreps, Principle Engineering Manger at LinkedIn



➕ Connect



Jeremy Gillick, Senior Web Developer at LinkedIn



➕ Connect



Albert Wang, User Experience Design at LinkedIn



➕ Connect

[See more »](#)

<http://blog.linkedin.com/2010/05/12/linkedin-pymk/>

RECOMMENDATIONS

Continue Shopping: Customers Who Bought Items in Your Recent History Also Bought



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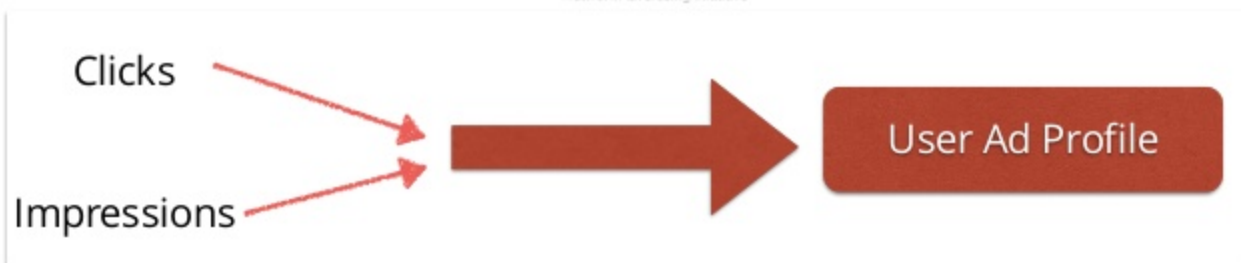
AD NETWORKS



AD NETWORKS



Advertise on Facebook



SEARCH



<http://lucene.apache.org/solr/>

Google

lyceum

[Web](#) [Images](#) [Maps](#) [Books](#) [Videos](#) [More ▾](#) [Search tools](#)

About 3,210,000 results (0.46 seconds)

Lyceum - Wikipedia, the free encyclopedia

en.wikipedia.org/wiki/Lyceum ▾ Wikipedia ▾

The **lyceum** is a category of educational institution defined within the education system of many countries, mainly in Europe. The definition varies between ...

[Lyceum \(Classical\)](#) - [Lyceum \(disambiguation\)](#) - [Lyceum of the Philippines](#)

Lyceum (Classical) - Wikipedia, the free encyclopedia

[en.wikipedia.org/wiki/Lyceum_\(Classical\)](http://en.wikipedia.org/wiki/Lyceum_(Classical)) ▾ Wikipedia ▾

The **Lyceum** (Ancient Greek: Λύκειον, "Lykeion") was a gymnasium and before that a public meeting place in a grove of trees in Classical Athens. The grove was ...

Lyceum on Broadway | The Shubert Organization

www.shubertorganization.com/theatres/lyceum.asp ▾

Lyceum on Broadway, owned by The Shubert Organization, Broadway's oldest theater-owner and producer of many Broadway shows. The Shubert Organization ...

Welcome to The Brooklyn Lyceum — Brooklyn Lyceum

www.brooklynlyceum.com/ ▾

The Brooklyn **Lyceum**(aka Public Bath #7) Summer SwampShop SwampTours SwampSupper Buster Keaton Shorts A Few Good Troupes Paleo Espresso ...

SEARCH

Google

lyceum



Page Rank



Search Rankings

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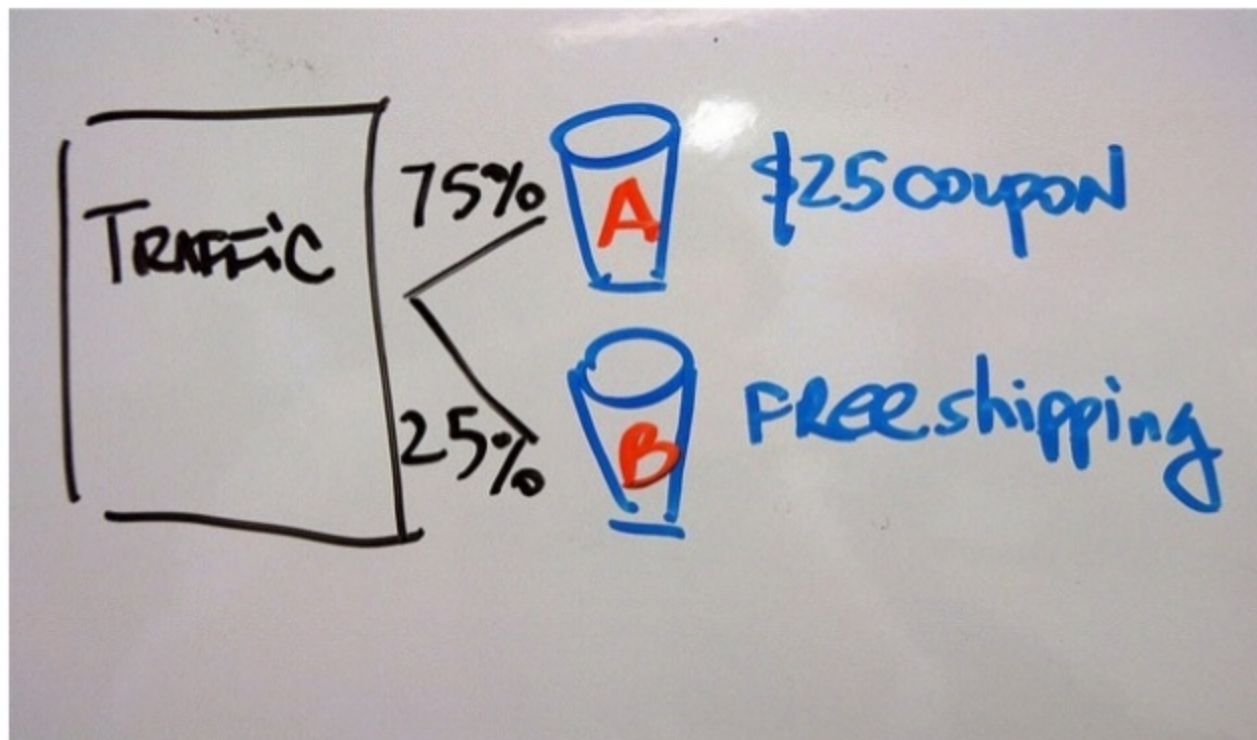
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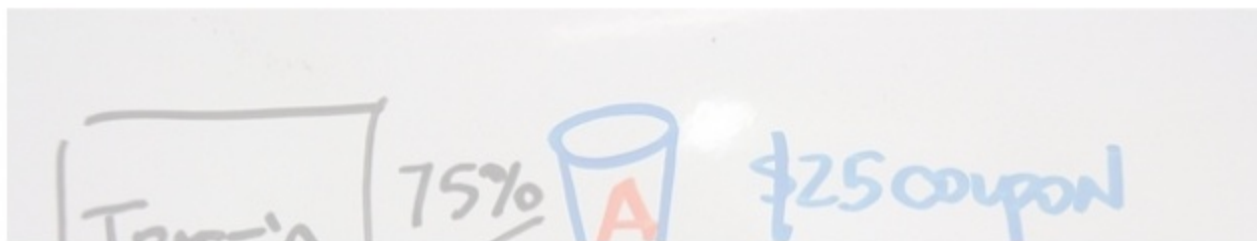
<http://www.jevans.com/pubnetmap.html>

A / B TESTING



<https://flic.kr/p/4ieVGa>

A / B TESTING



A conversions

B conversions



Experiment Analysis

DATA WAREHOUSING

Interest rate / Loan amount	3.750%	4.000%	4.250%	4.500%	4.750%
\$243,741	\$1,445	\$1,477	\$1,509	\$1,542	\$1,575
\$256,569	\$1,521	\$1,555	\$1,589	\$1,623	\$1,658
\$270,073	\$1,601	\$1,637	\$1,672	\$1,709	\$1,745
\$284,288	\$1,686	\$1,723	\$1,760	\$1,799	\$1,837
\$299,250	\$1,774	\$1,813	\$1,853	\$1,893	\$1,934
\$313,000	\$1,868	\$1,909	\$1,951	\$1,993	\$2,036
\$330,750	\$1,961	\$2,004	\$2,048	\$2,092	\$2,137
\$347,280	\$2,059	\$2,104	\$2,151	\$2,197	\$2,244
\$364,652	\$2,162	\$2,210	\$2,258	\$2,307	\$2,356
\$382,884	\$2,270	\$2,320	\$2,371	\$2,422	\$2,474
\$402,029	\$2,384	\$2,436	\$2,490	\$2,543	\$2,598



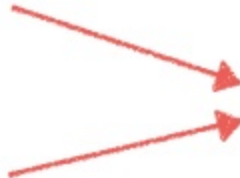
<http://gethue.com/hadoop-ui-hue-3-6-and-the-search-dashboards-are-out/>

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\$299,230					
\$313,000					
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\$382,604					
\$402,029					

key metrics

user events



Data Warehouse



<http://gethue.com/hadoop-ui-hue-3-6-and-the-search-dashboards-are-out/>

WHAT IS A DATA PIPELINE?

DATA PIPELINE

A **Data Pipeline** is a unified system for capturing events for **analysis** and **building products**.

DATA PIPELINE

click data
web visits
email sends
user events
...

- 
- Counting
 - Machine Learning
 - Extract Transform Load (ETL)

Data Warehouse

Product Features

Ad Hoc analysis

DATA PIPELINE

A Data Pipeline is a unified system for capturing **events** for analysis and building products.

EVENTS

EVENTS

Each of these **actions** can be thought of as an **event**.

COARSE-GRAINED EVENTS

- Events are captured as a **by-product**.
- Stored in **text logs** used primarily for debugging and secondarily for analysis.

COARSE-GRAINED EVENTS

- Events are captured as a
- Stored in
debugging and secondarily for analysis.

127.0.0.1 - - [17/Jun/2014:01:53:16 UTC] "GET / HTTP/1.1" 200 3969

IP Address

Timestamp

Action

Status

COARSE-GRAINED EVENTS

Implicit tracking—i.e. a “page load” event is a proxy for ≥ 1 other event.

e.g. event `GET /newsfeed` corresponds to:

- App Load (but only if this is the first time loaded this session)
- Timeline load, user is in “group A” of an A/B Test

These implementations details have to be known at analysis time.

FINE-GRAINED EVENTS

Record **events** like:

- app opened
- auto refresh
- user pull down refresh

Rather than:

- GET /newsfeed

FINE-GRAINED EVENTS

Annotate events with **contextual** information like:

- view the user was on
- which button was clicked

FINE-GRAINED EVENTS

Decouple logging and analysis. Create events for everything!

FINE-GRAINED EVENTS

A couple of **schema-less** formats are popular (e.g. JSON and CSV), but they have **drawbacks**.

- harder to change schemas
- inefficient
- require writing parsers

SCHEMA

Used to **describe data**, providing a contract about **fields** and their **types**.

Two schemas are compatible if you can read data written in schema 1 with schema 2.

SCHEMA

Facilities **automated analytics**—summary statistics, session/funnel analysis, a/b testing.

SCHEMA

Component	Description	Example
client	client application	web, iphone, android
page	page or functional grouping	home, profile, who_to_follow
section	tab or stream on a page	home, mentions, retweets, searches, suggestions
component	component, object, or objects	search_box, tweet
element	UI element within the component	button, avatar
action	actual user or application action	impression, click, hover

Table 1: Twitter schema for client events.

Facilities automated analytics—summary statistics, session/funnel analysis, a/b testing.

Field	Description
event_initiator	$\{\text{client, server}\} \times \{\text{user, app}\}$
event_name	event name
user_id	user id
session_id	session id
ip	user's IP address
timestamp	timestamp
event_details	event details

Table 2: Definition of a client event.

SCHEMA

Component	Description	Example
client	client application	web, iphone, android
page	page or functional grouping	home, profile, who_to_follow
section	tab or stream on a page	home, mentions, retweets, searches, suggestions
component	component, object, or objects	search_box, tweet
element	UI element within the component	button, avatar
action	actual user or application action	impression, click, hover

client:page:section:component:element:action e.g.:

`iphone:home:mentions:tweet:button:click`

Count iPhone users clicking from home page:

`iphone:home:*:*:*:click`

Count home clicks on buttons or avatars:

`*:home:*:*:{button,avatar}:click`

KEY COMPONENTS

EVENT FRAMEWORK

For **easily generating events** from your applications

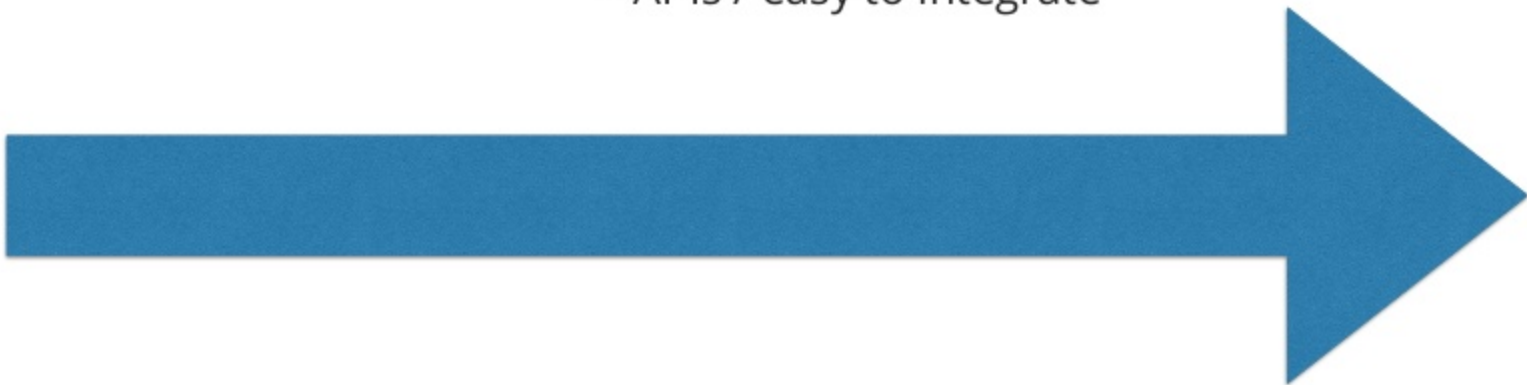
EVENT FRAMEWORK

```
1 val event = Event(...)  
2  
3 EventLog.log(Topic.UserActions, event)
```

For
applications

BIG MESSAGE BUS

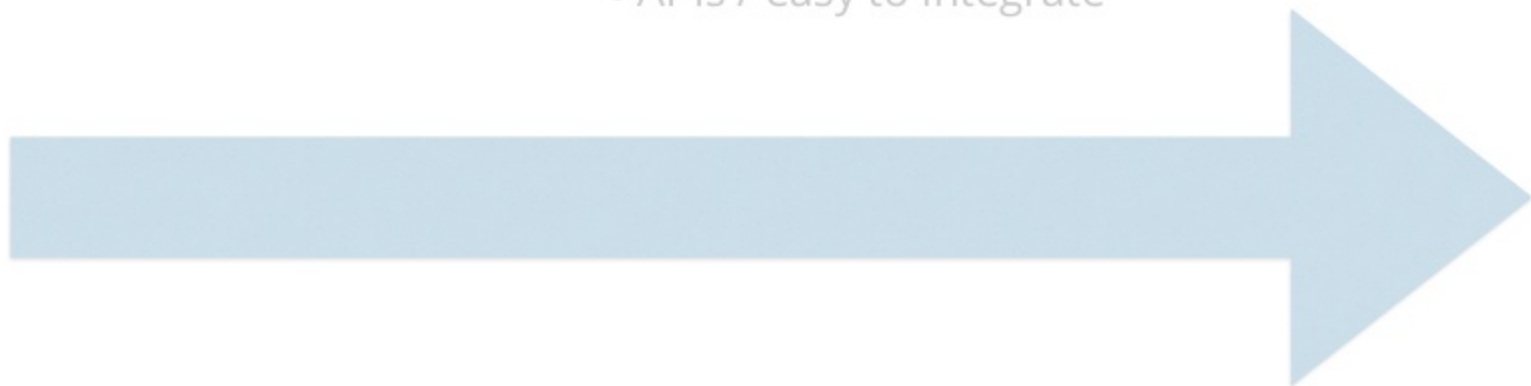
- Horizontally scalable
- Redundant
- APIs / easy to integrate



BIG MESSAGE BUS

- Scribe (Facebook)
- Apache Chukwa
- Apache Flume
- Apache Kafka*

- Horizontally scalable
- Redundant
- APIs / easy to integrate



* My recommendation

DATA PERSISTENCE

For **storing** your **events** in files for batch processing

DATA PERSISTENCE



For
processing

Kite Software Development Kit

<http://kitesdk.org/>

Spring Hadoop

<http://projects.spring.io/spring-hadoop/>

WORKFLOW MANAGEMENT

For **coordinating** the tasks in your data pipeline

WORKFLOW MANAGEMENT



... or your own system written
in your own language of choice.

For
pipeline

SERIALIZATION FRAMEWORK

Used for **converting** an Event to **bytes on disk**. Provides **efficient**, cross-language framework for serializing/deserializing data.

SERIALIZATION FRAMEWORK

- Apache Avro*
- Apache Thrift
- Protocol Buffers (google)

Used for

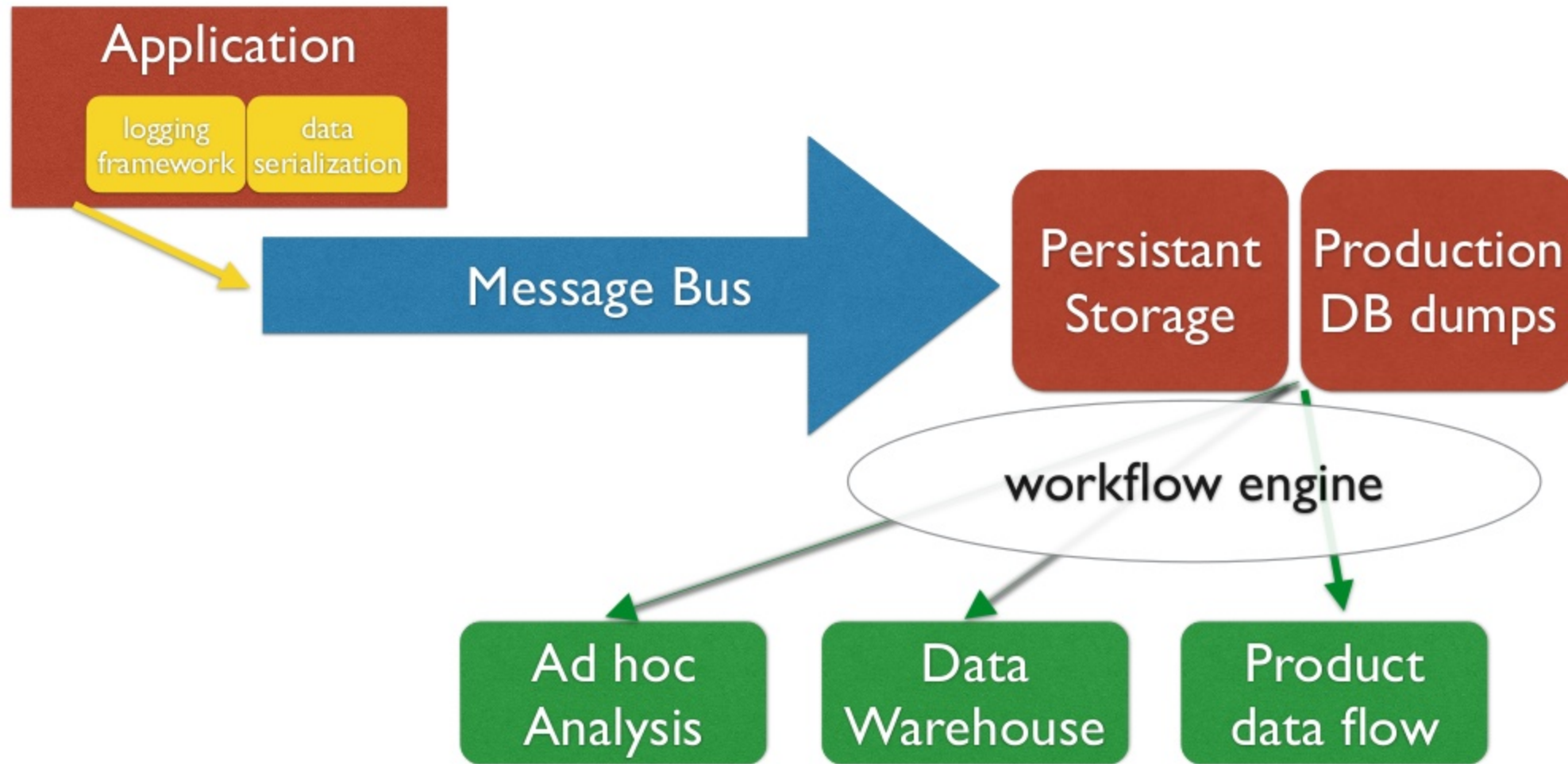
disk

framework for serializing/deserializing data.

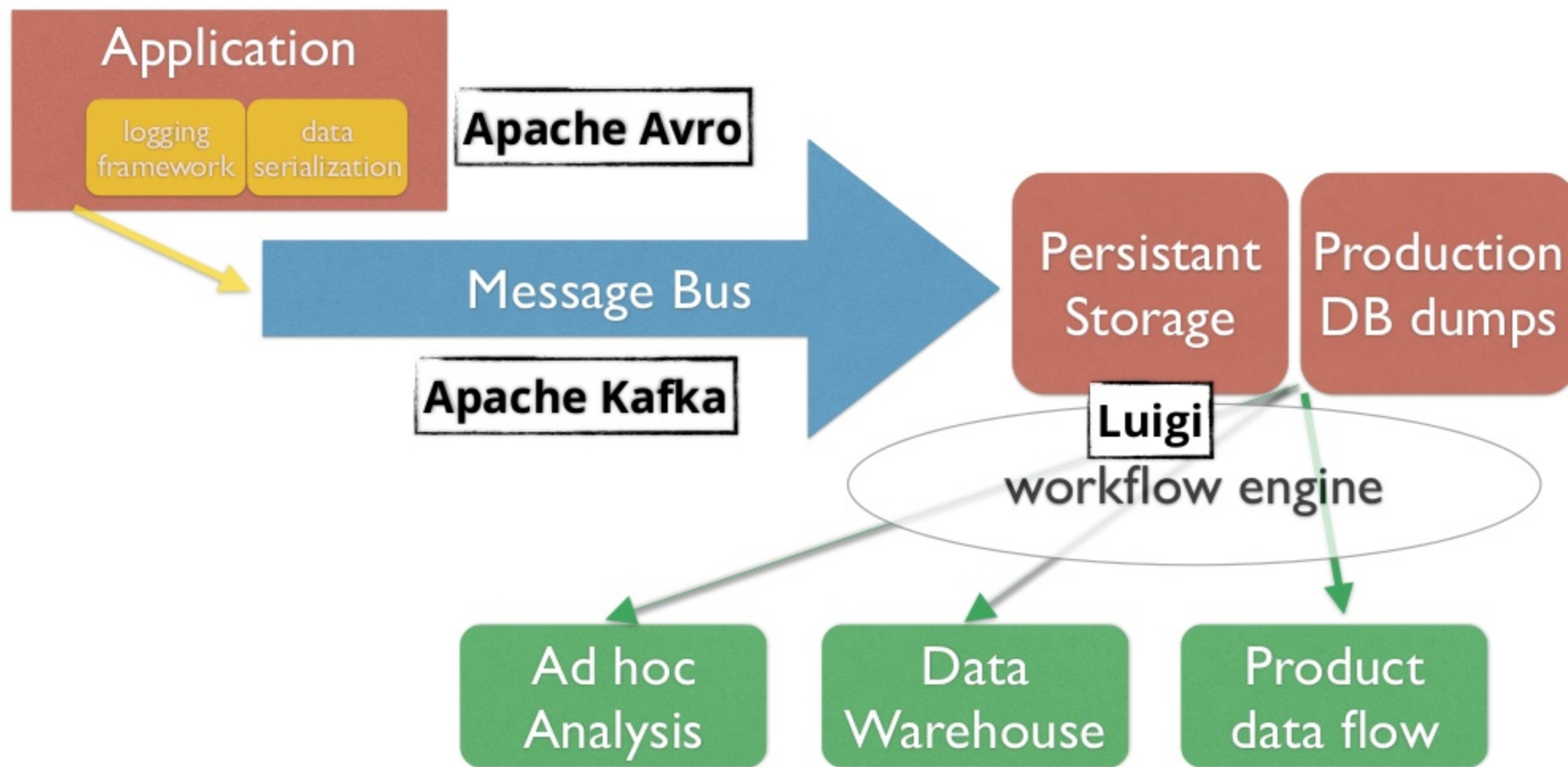
BATCH PROCESSING AND AD HOC ANALYSIS

- Apache Hadoop (MapReduce)
- Apache Hive (or other SQL-on-Hadoop)
- Apache Spark

SYSTEM OVERVIEW



SYSTEM OVERVIEW (OPINIONATED)



NEXT STEPS

This architecture opens up a lot of possibilities

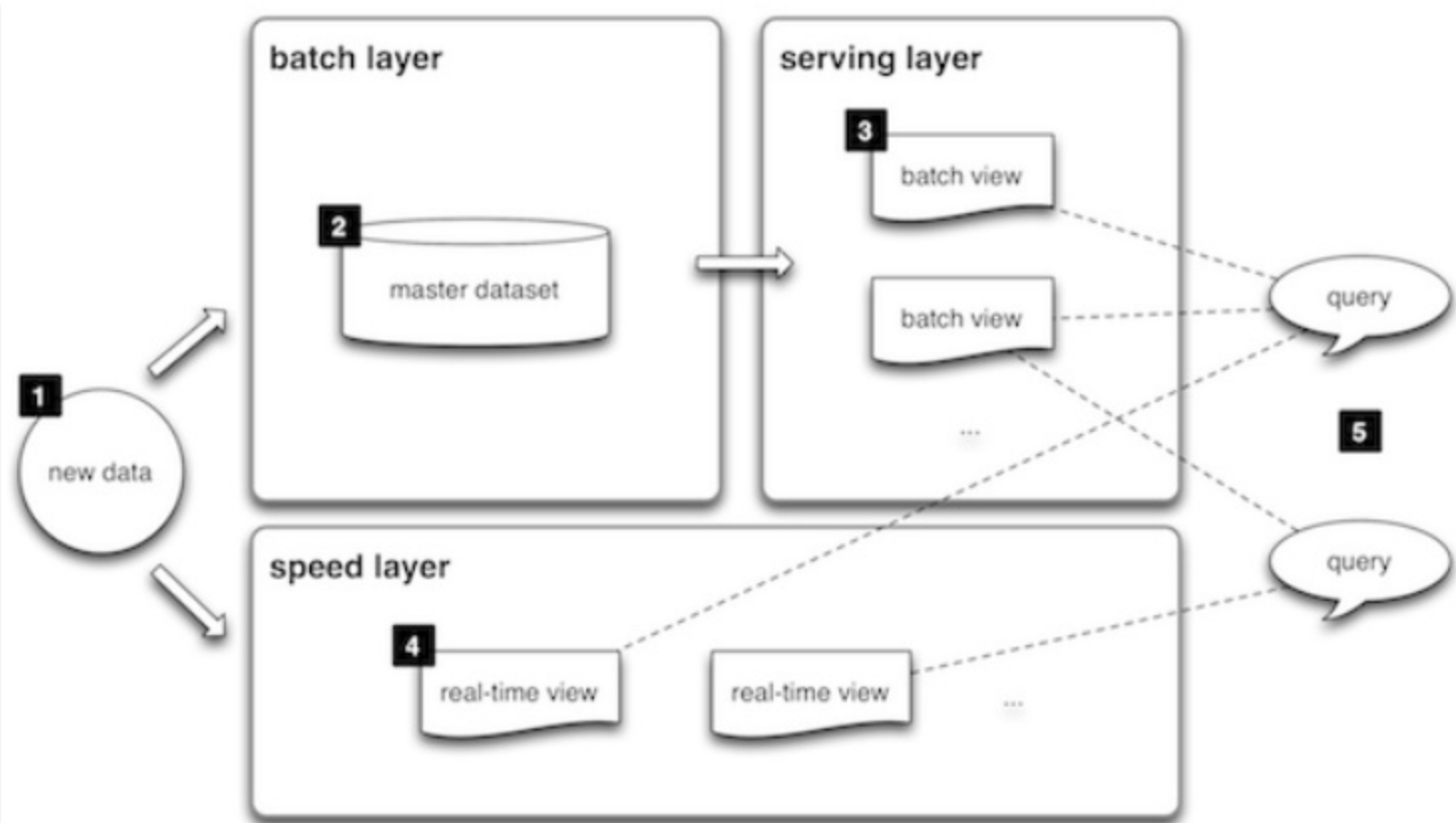
- **Near-real time computation**—Apache Storm, Apache Samza (incubating), Apache Spark streaming.
- **Sharing information** between services asynchronously—e.g. to augment user profile information.
- **Cross-datacenter** replication
- **Columnar storage**

LAMBDA ARCHITECTURE

Term coined by Nathan Marz (creator of Apache Storm) for **hybrid batch** and **real-time** processing.

Batch processing is treated as source of truth, and real-time updates models/insights between batches.

LAMBDA ARCHITECTURE



SUMMARY

- Data Pipelines are **everywhere**.
- Useful to think of data as **events**.
- A **unified** data pipeline is very powerful.
- Plethora of **open-source tools** to build data pipeline.

FURTHER READING

[The Unified Logging Infrastructure for Data Analytics at Twitter](#)

[The Log: What every software engineer should know about real-time data's unifying abstraction \(Jay Kreps, LinkedIn\)](#)

[Big Data by Nathan Marz and James Warren](#)

[Implementing Microservice Architectures](#)

THANK YOU

Questions?

Shameless plug: www.hadoopweekly.com

EXTRA SLIDES

WHY KAFKA?

- <https://kafka.apache.org/documentation.html#design>
- Pull model works well
- Easy to configure and deploy
- Good JVM support
- Well-integrated with the LinkedIn stack

WHY LUIGI?

- Scripting language (you'll end up writing scripts anyway)
- Simplicity (low learning curve)
- Idempotency
- Easy to deploy

WHY AVRO?

- Self-describing files
- Integrated with nearly everything in the ecosystem
- CLI tools for dumping to JSON, CSV