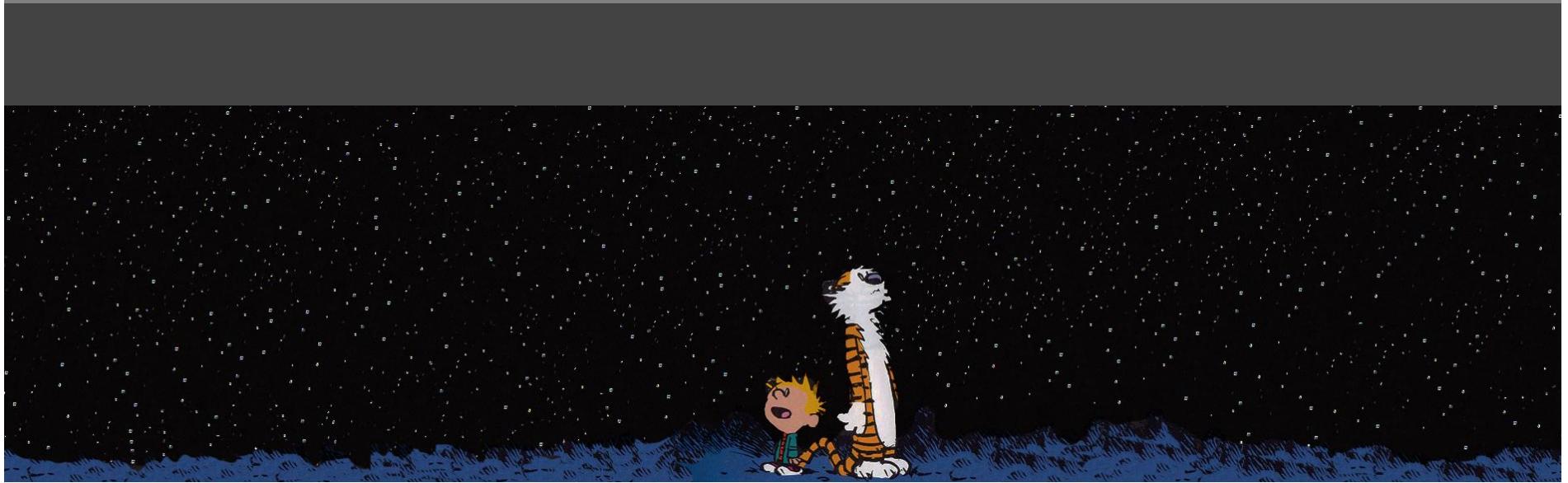


simplifying Big Data.
Everywhere.





Large

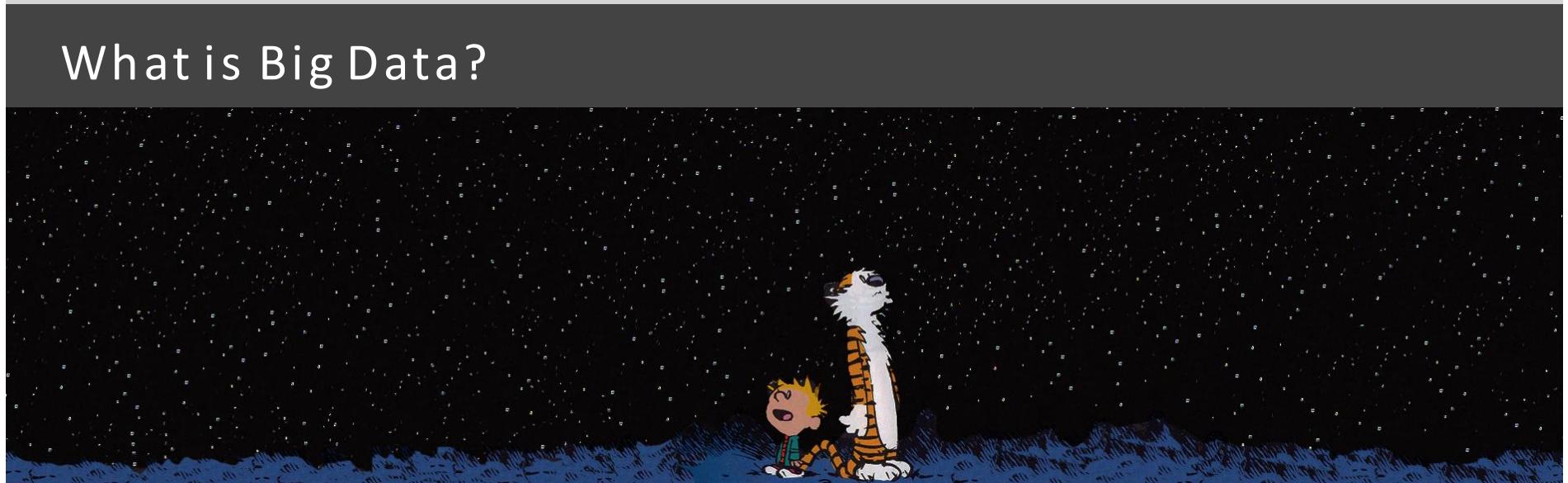


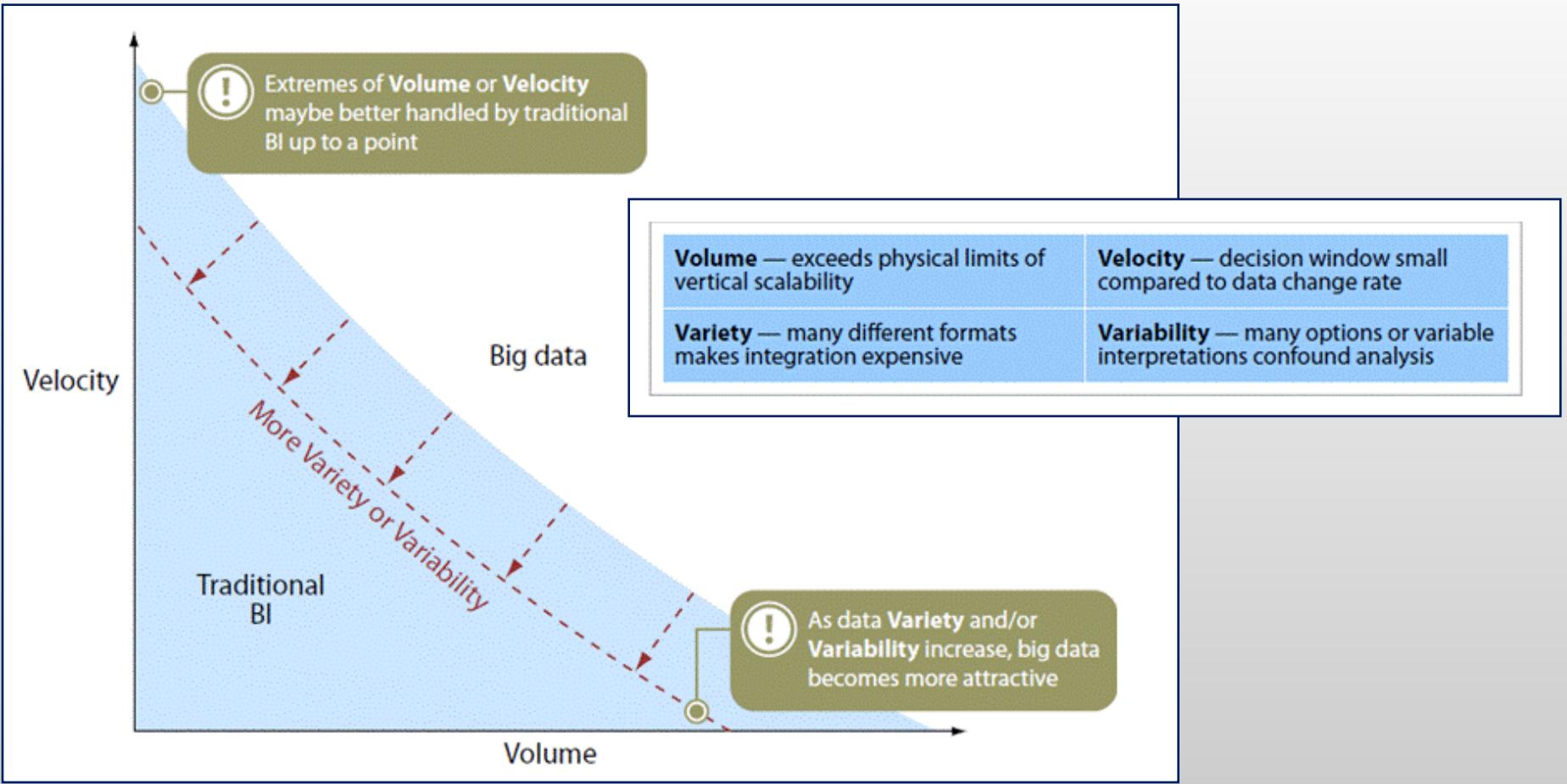
Complex



Unstructured

What is Big Data?





A Definition of Big Data - 4Vs: volume, velocity, variability, variety

Big data: techniques and technologies that make handling data at extreme scale economical.



Scale Up!

With the power of the Hubble telescope, we can take amazing pictures 45M light years away

Amazing image of the Antennae Galaxies (NGC 4038-4039)

Analogous with scale up:

- non-commodity
- specialized equipment
- single point of failure*





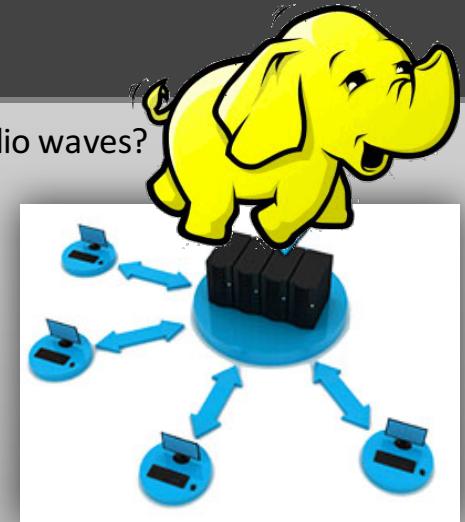
Scale Out | Commoditized Distribution

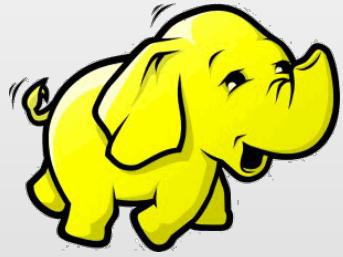
Hubble can provide an amazing view Giant Galactic Nebula (NGC 3503) but how about radio waves?

- Not just from one area but from *all areas viewed* by observatories
- SETI @ Home: 5.2M participants, 10^{21} floating point operations¹, 769 teraFLOPS²

Analogous with commoditized distributed computing

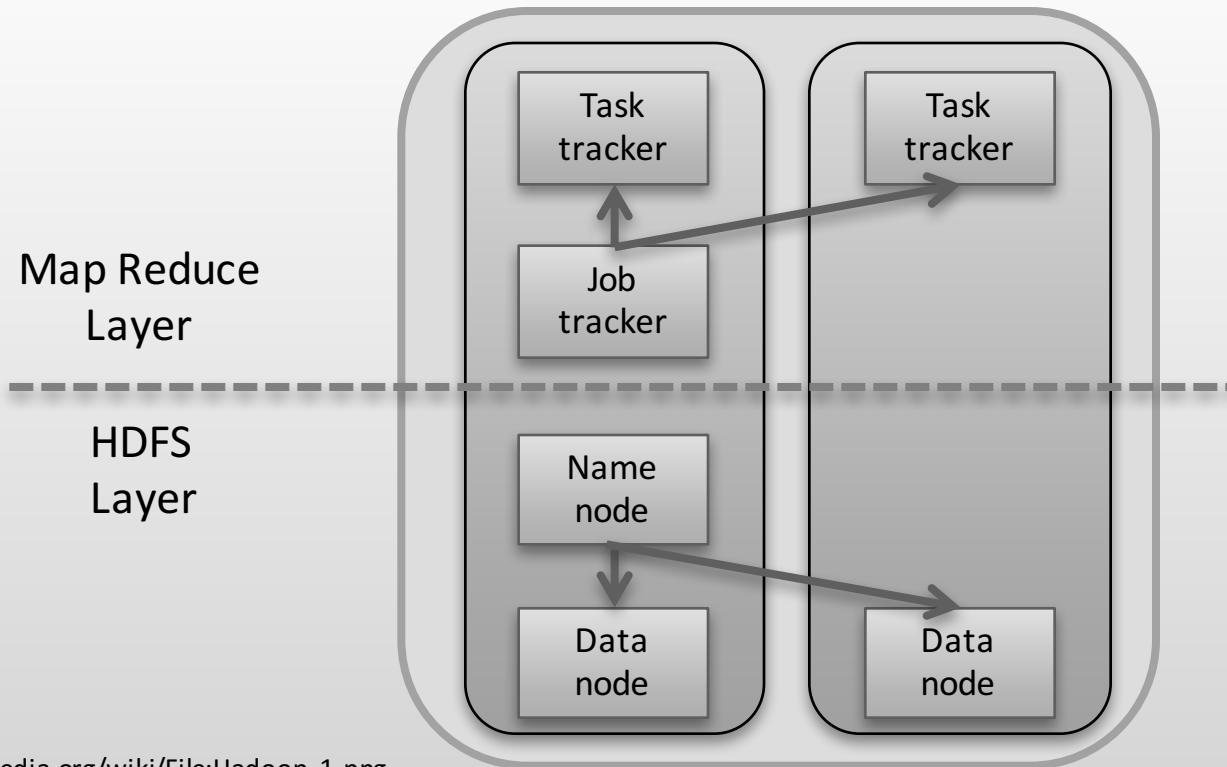
- Distributed and calculated locally
- Engage with hundreds, thousands, + machines
- Many points of failure, auto-replication prevents this from being a problem





Map Reduce
Layer

HDFS
Layer



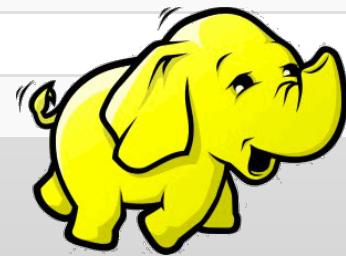
Reference: http://en.wikipedia.org/wiki/File:Hadoop_1.png

What is Hadoop?

- Synonymous with the Big Data movement
- Infrastructure to automatically distribute and replicate data across multiple nodes and execute and track map reduce jobs across all of those nodes
- Inspired by Google's Map Reduce and GFS papers
- Components are: Hadoop Distributed File System (HDFS), Map Reduce, Job Tracker, and Task Tracker
- *Based on the Yahoo! "Nutch" project in 2003, became Hadoop in 2005 named after Doug Cutting's son's toy elephant*

	Traditional RDBMS	MapReduce
Data Size	Gigabytes (<i>Terabytes</i>)	Petabytes (<i>Hexabytes</i>)
Access	Interactive and Batch	Batch
Updates	Read / Write many times	Write once, Read many times
Structure	Static Schema	Dynamic Schema
Integrity	High (ACID)	Low (BASE)
Scaling	Nonlinear	Linear
DBA Ratio	1:40	1:3000

Reference: Tom White's *Hadoop: The Definitive Guide*



Comparing RDBMS and MapReduce



demo

Isotope / Hadoop in action

- WordCount demo
- Map/Reduce
- HiveQL on a weblog sample

Sample Java MapReduce WordCount Function

```
// Map Reduce is broken out into a Map function and reduce function
// -----
//
// Sample Map function: tokenizes string and establishes the tokens
// e.g. "a b\tc\n" is now an key value pairs representing [a, b, c, d]

public void map(Object key, Text value, Context context
                  ) throws IOException, InterruptedException {
    StringTokenizer itr = new StringTokenizer(value.toString());
    while (itr.hasMoreTokens()) {
        word.set(itr.nextToken());
        context.write(word, one);
    }
}

// Sample Reduce function: does the count of these key value pairs

public void reduce(Text key, Iterable<IntWritable> values,
                     Context context
                     ) throws IOException,
                           InterruptedException {
    int sum = 0;
    for (IntWritable val : values) {
        sum += val.get();
    }
    result.set(sum);
    context.write(key, result);
}
```

Executing WordCount against sample file

The **Project** Gutenberg EBook of The Notebooks of Leonardo Da Vinci, Complete
by Leonardo Da Vinci
(#3 in our series by Leonardo Da Vinci)

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**Welcome To The World of Free Plain
**eBooks Readable By Both Humans and
*****These eBooks Were Prepared By T

Title: The Notebooks of Leonardo Da

Author: Leonardo Da Vinci

...

Code to execute:

```
hadoop jar AcmeWordCount.jar AcmeWordCount  
/test/davinci.txt /test/davinci_wordcount
```

Purpose: To perform count of number of words
within the said davinci.txt

laws	2
Project	5

...

Query a Sample WebLog using HiveQL

// Sample Generated Log

```
588.891.552.388,-,08/05/2011,11:00:02,W3SVC1,CTSSVR14,-,-,0,-  
,200,-,GET,/c.gif,Mozilla/5.0 (Windows NT 6.1; rv:5.0)  
Gecko/20100101 Firefox/5.0,http://foo.live.com/cid-  
4985109174710/blah?fdkjafdf,[GUID],-,MSFT,  
&PageID=1234&Region=89191&IsoCy=BR&Lang=1046&Referrer=hotmail.c  
om&ag=2385105&Campaign=&Event=12034
```



GUID	PUID	Parameters
[GUID]	[PUID]	&PageID=1234&Region=89191&IsoCy=BR&Lang=104 6&Referrer=hotmail.com&ag=2385105&Campaign= &Event=12034



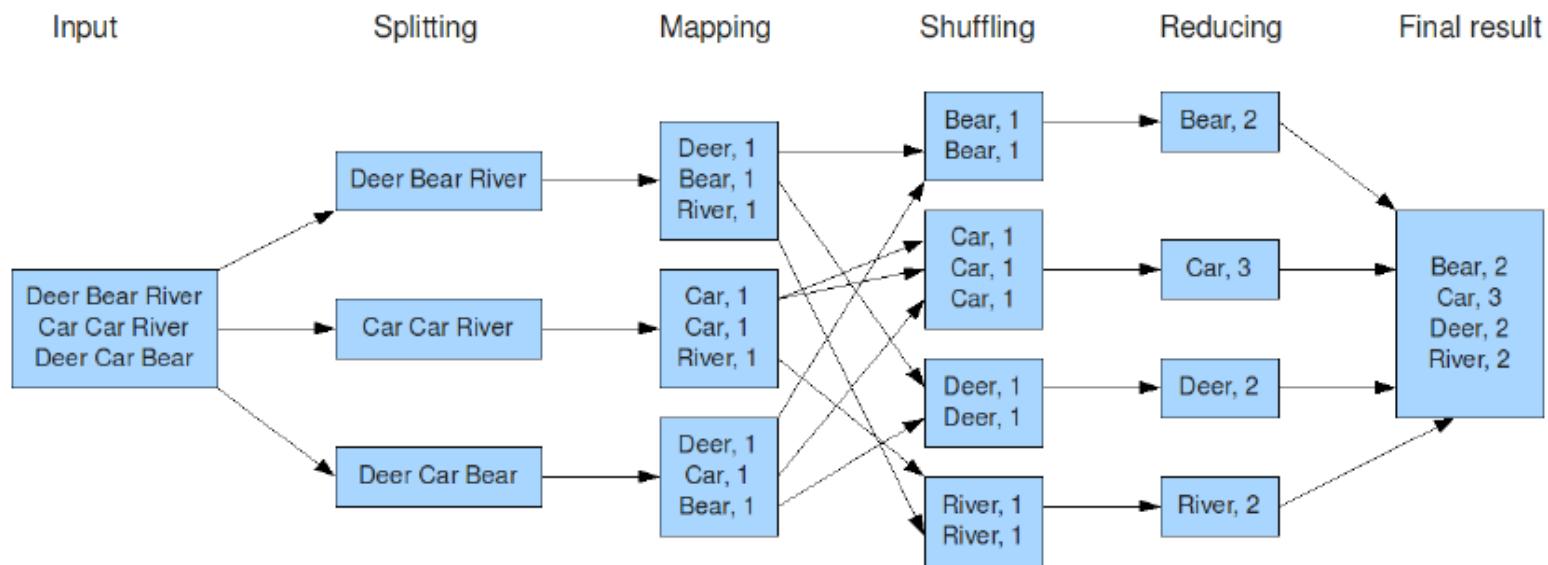
```
select  
    GUID,  
    str_to_map("param", "&", "=") [ "IsoCy" ],  
    str_to_map("param", "&", "=") [ "Lang" ]  
from  
    weblog;
```

HiveQL: SQL-like language

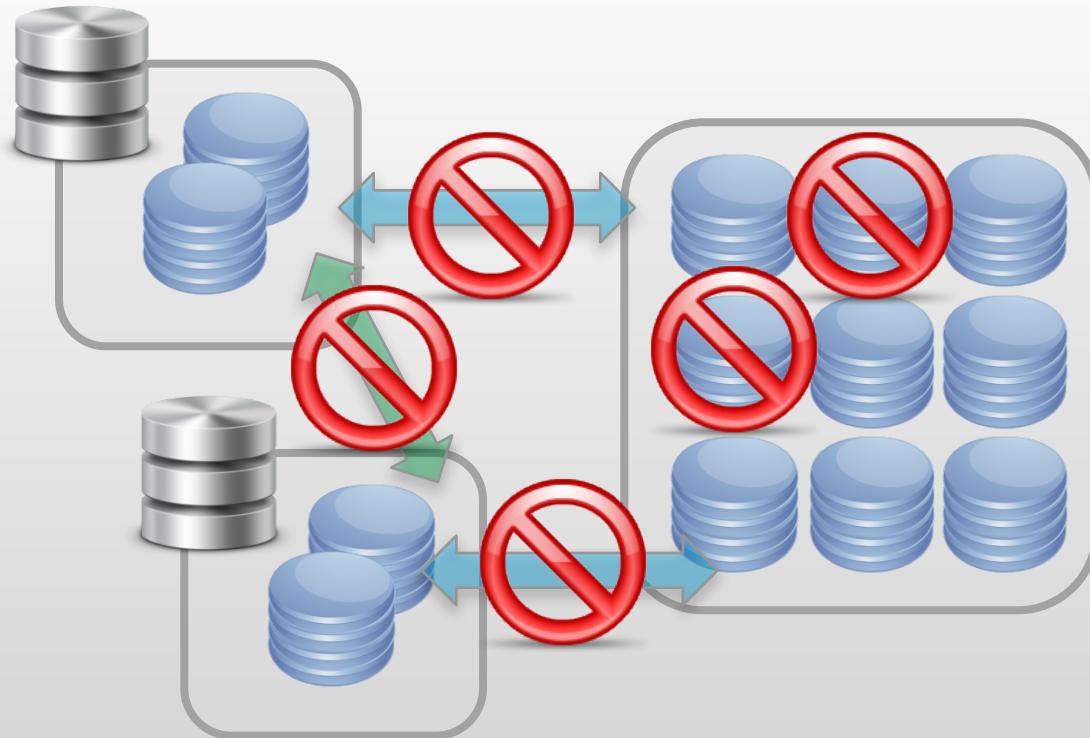
- Write SQL-like query which becomes MapReduce functions
- Includes functions like **str_to_map** so one can perform parsing functions in HiveQL

Map Reduce Tutorial

The overall MapReduce word count process



A great Map Reduce Tutorial can be found at:
http://hci.stanford.edu/courses/cs448g/a2/files/map_reduce_tutorial.pdf



Traditional RDBMS: Move Data to Compute

As you process more and more data, and you want interactive response

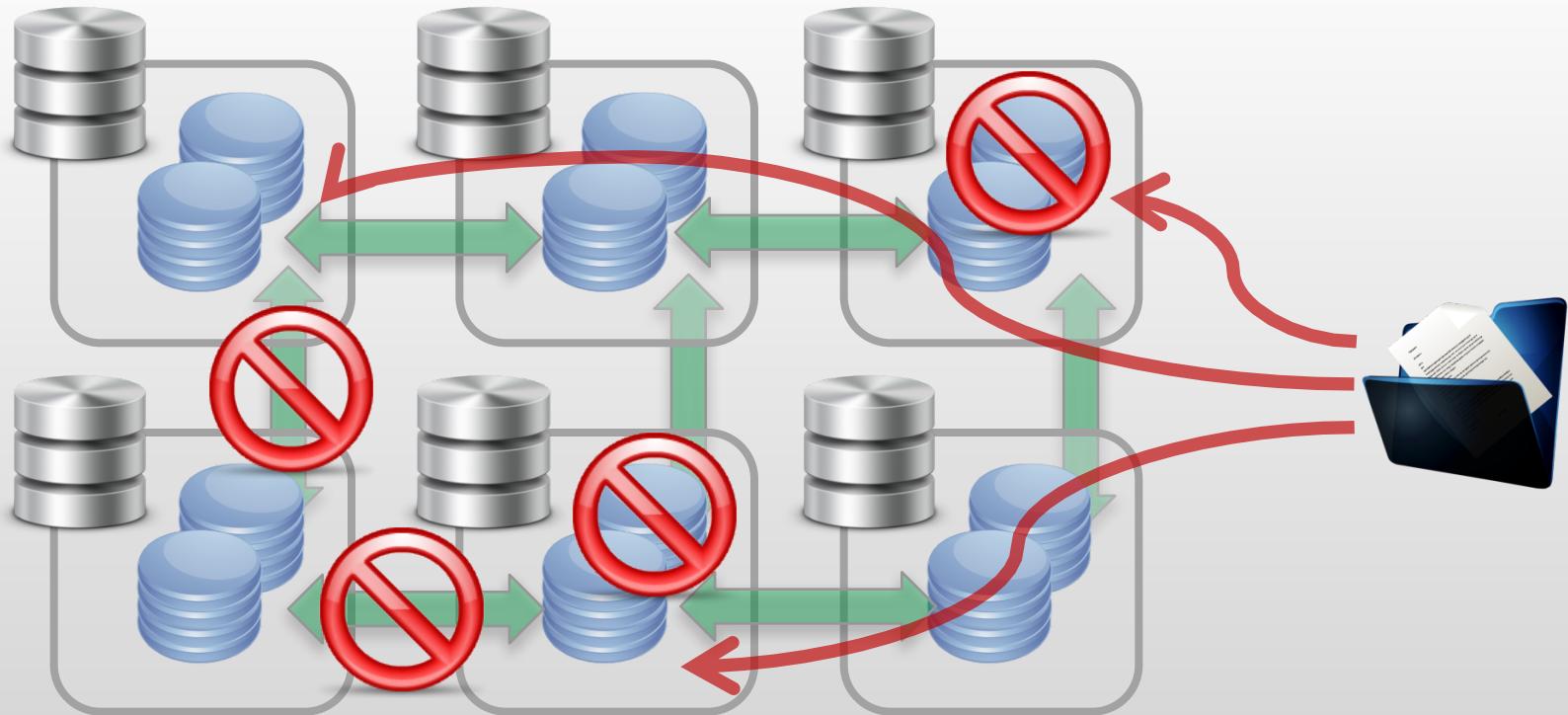
- Typically need more expensive hardware
- Failures at the points of disk and network can be quite problematic

It's all about ACID: atomicity, consistency, isolation, durability

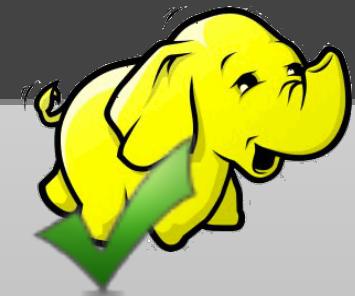
Can work around this problem with more expensive HW and systems

- Though distribution problem becomes harder to do





Hadoop / NoSQL: Move Compute to the Data

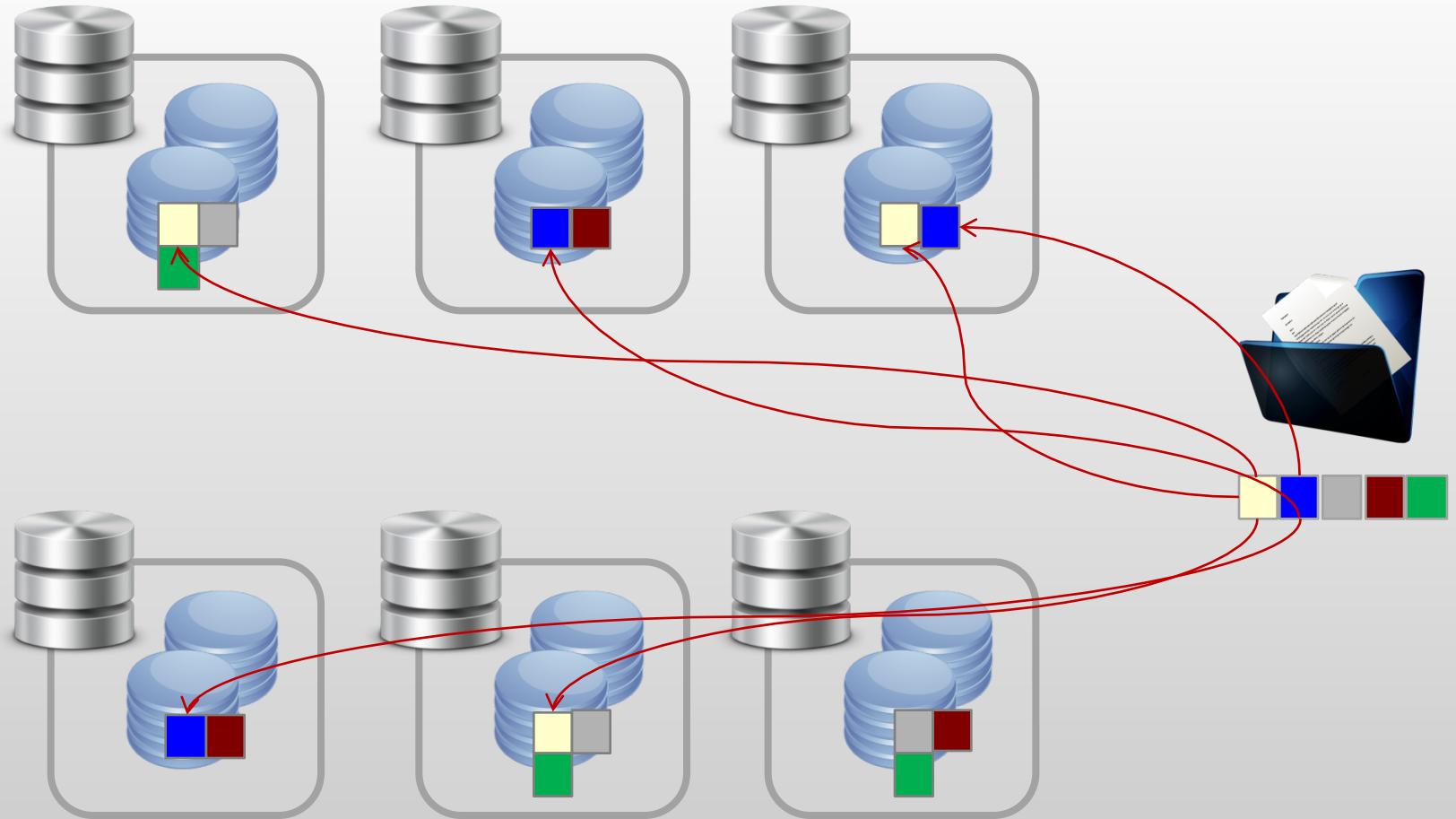


Hadoop (and NoSQL in general) follows the Map Reduce framework

- Developed initially by Google -> Map Reduce and Google File system
- Embraced by community to develop MapReduce algorithms that are very robust
- Built Hadoop Distributed File System (HDFS) to auto-replicate data to multiple nodes
- And execute a single MR task on all/many nodes available on HDFS

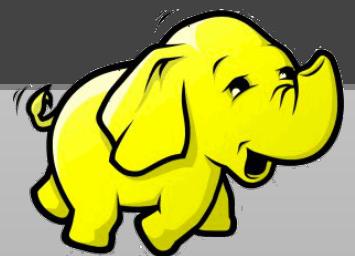
Use commodity HW: no need for specialized and expensive network and disk

Not so much ACID, but BASE (basically available, soft state, eventually consistent)

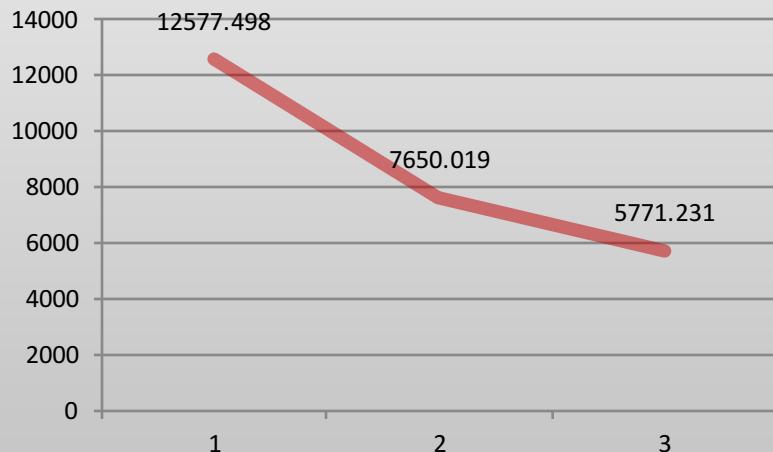


Hadoop: Auto-replication

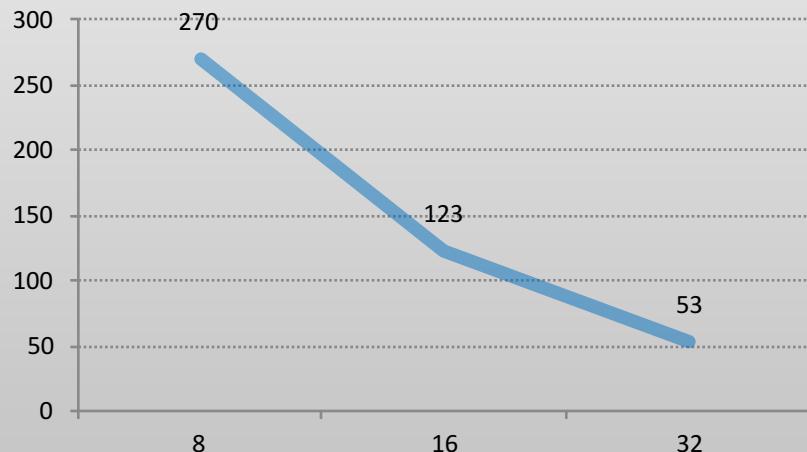
- Hadoop processes data in 64MB chunks and then replicates to different servers
- Replication value set at the hdfs-site.xml, dfs.replication node



HiveQL Query



TeraSort



Distribution, Linear Scalability

- Key facet is that as more nodes are added, the more can be calculated, faster (*minus overhead*)
- Designed for Batch systems (though this will change in the near future)
- Roughly linear scalability for HiveQL query as well as TeraSort



Cassandra
Hive
Scribe
Hadoop



Hadoop
Oozie
Pig (-latin)



BackType
Hadoop
Pig / Hbase
Cassandra



MR/GFS
Bigtable
Dremel
...



SimpleDB
Dynamo
EC2 / S3
...



Isotope | Azure | Excel | BI | SQL DW | PDW | F# | Viola James

NoSQL ecosystem | open source, commodity

Mahout | Scalable machine learning and data mining

MongoDB | Document-oriented database (C++)

Couchbase | CouchDB (doc dB) + Membase (memcache protocol)

Hbase | Hadoop column-store database

R | Statistical computing and graphics

Pegasus | Peta-scale graph mining system

Lucene | full-featured text search engine library

15 out of 17

sectors in the US have more data stored per company than the US Library of Congress

140,000-190,000

more deep analytical talent positions

1.5 million

more data saavy managers
in the US alone

50-60%

increase in the number of Hadoop developers
within organizations already using Hadoop
within a year

€250 billion

Potential annual value to
Europe's public sector

\$300 billion

Potential annual value to US healthcare

NoSQL ecosystem | business value



How Facebook moved 30 petabytes of Hadoop data.

... the migration proved that disaster recovery is possible with Hadoop clusters.

This could be an important capability for organizations considering relying on Hadoop (by running Hive atop the Hadoop Distributed File System) as a data warehouse, like Facebook does. As Yang notes, "Unlike a traditional warehouse using SAN/NAS storage, HDFS-based warehouses lack built-in data-recovery functionality. We showed that it was possible to efficiently keep an active multi-petabyte cluster properly replicated, with only a small amount of lag."



This illustrates a new thesis or collective wisdom emerging from the Valley: If a technology is not your core value-add, it should be open-sourced because then others can improve it, and potential future employees can learn it. This rising tide has lifted all boats, and is just getting started.

Kovas Boguta: [Hadoop & Startups: Where Open Source Meets Business Data.](#)



Hadoop on Windows and Azure (Code Name: Isotope)

“The next frontier is all about uniting the power of the cloud
with the power of data to gain insights that simply weren’t
possible even just a few years ago”

Ted Kummert, CVP Business Platforms
SQL PASS, October 2011

“We are excited to work with Microsoft to help make Apache Hadoop a compelling platform for storing and processing data. Hortonworks welcomes Microsoft to the Hadoop ecosystem and looks forward to lending our deep domain expertise to help accelerate the delivery of Microsoft’s Apache Hadoop-based solution for Windows Server and service for Windows Azure.”

Eric Baldeschwieler

CEO



GIVING BACK AND PARTICIPATING IN THE HADOOP COMMUNITY

Microsoft will be working with the community to contribute back significant code to the Apache Foundation
Microsoft has announced a partnership with Hortonworks to help accelerate our open source support



Azure + Hadoop = Tier-1 in the Cloud

In short, Hadoop has the potential to make the enterprise compatible with the entire rest of the open-source and startup world...

Kovas Boguta: [Hadoop & Startups: Where Open Source Meets Business Data.](#)

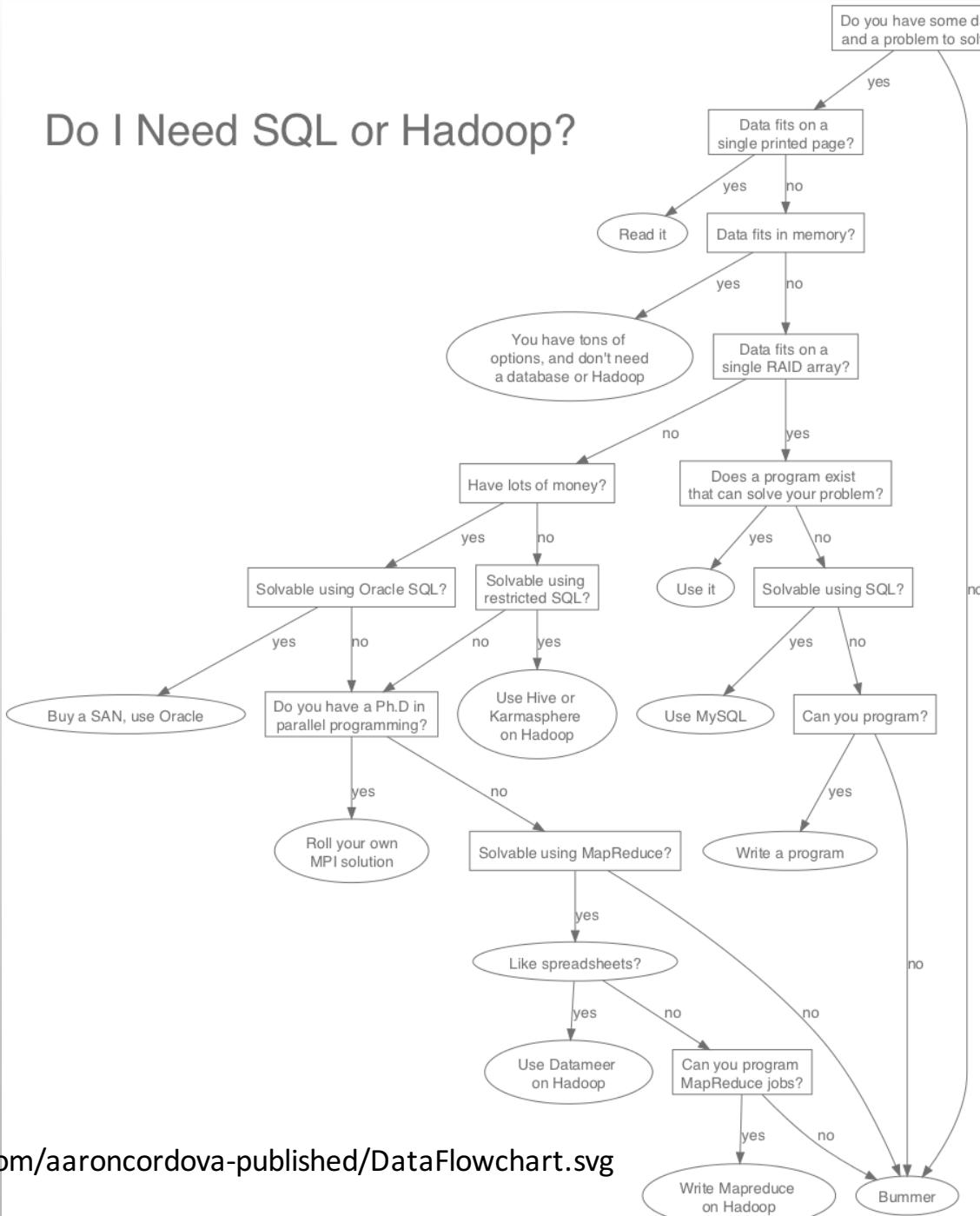


BI + Tier-1 Big Data = Above the Cloud

*"The sun always shines
above the clouds."*
— Paul F. Davis

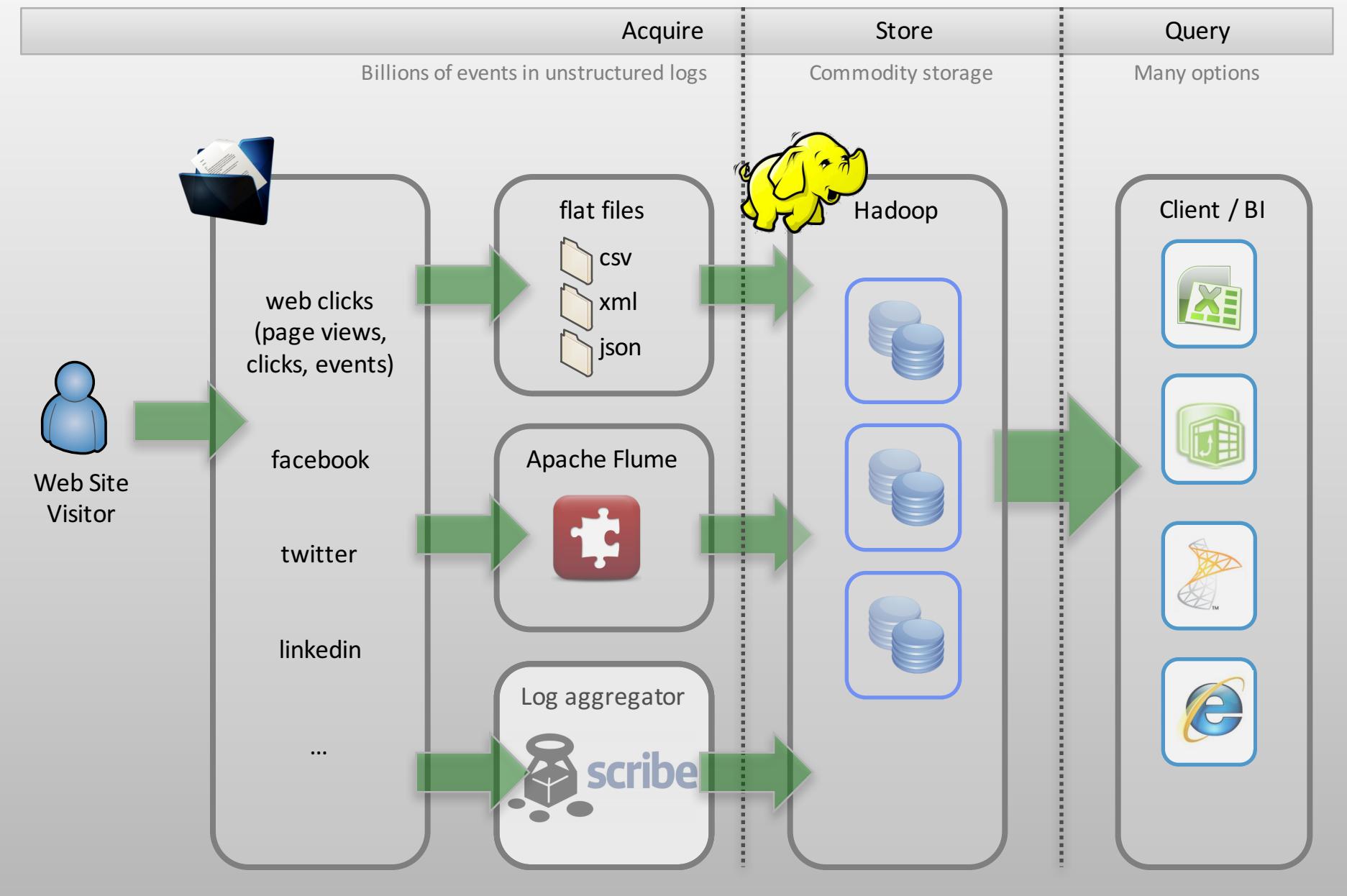
SCENARIOS

Do I Need SQL or Hadoop?

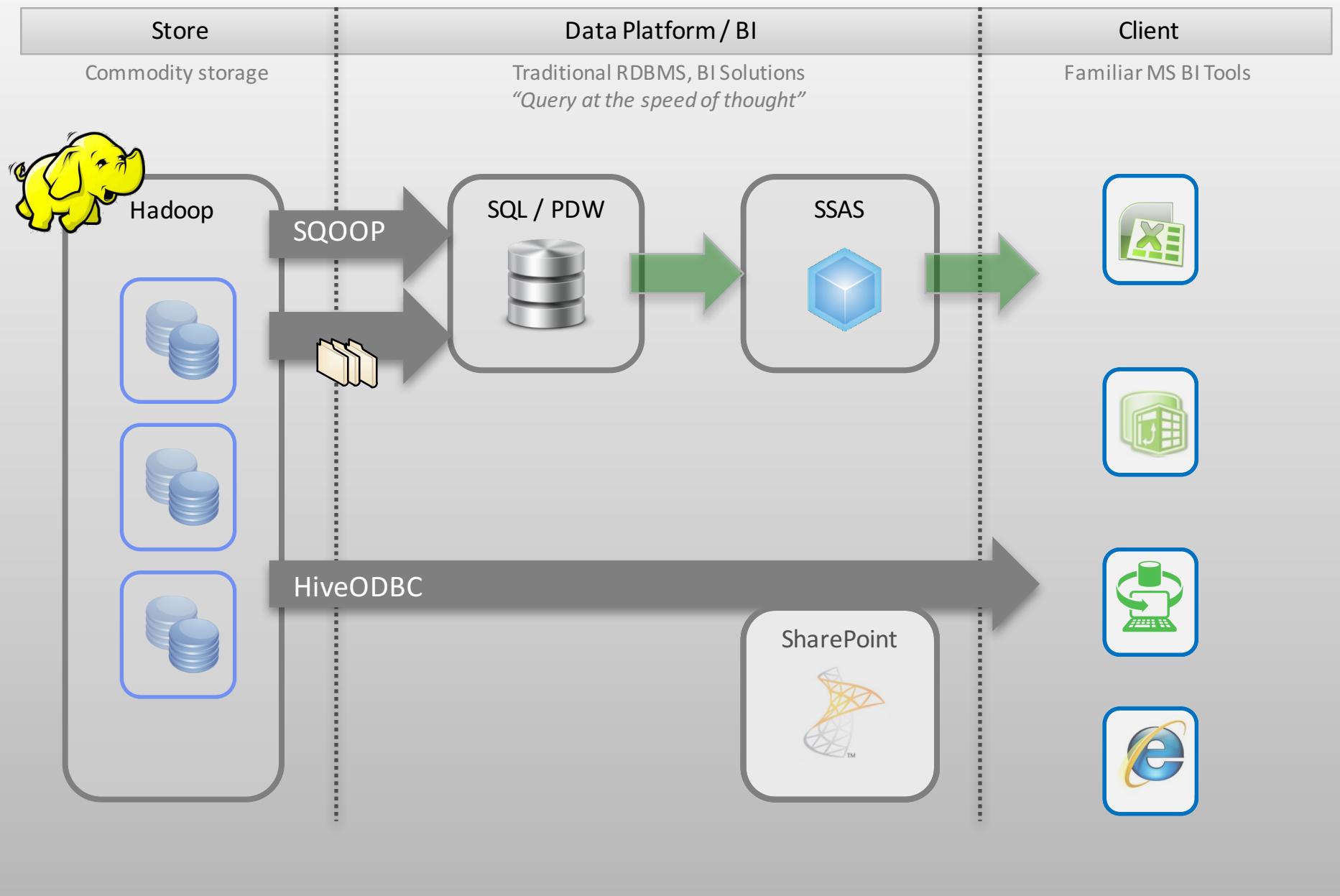


<https://s3.amazonaws.com/aaroncordova-published/DataFlowchart.svg>

Acquire, Store, Query: Web / Social

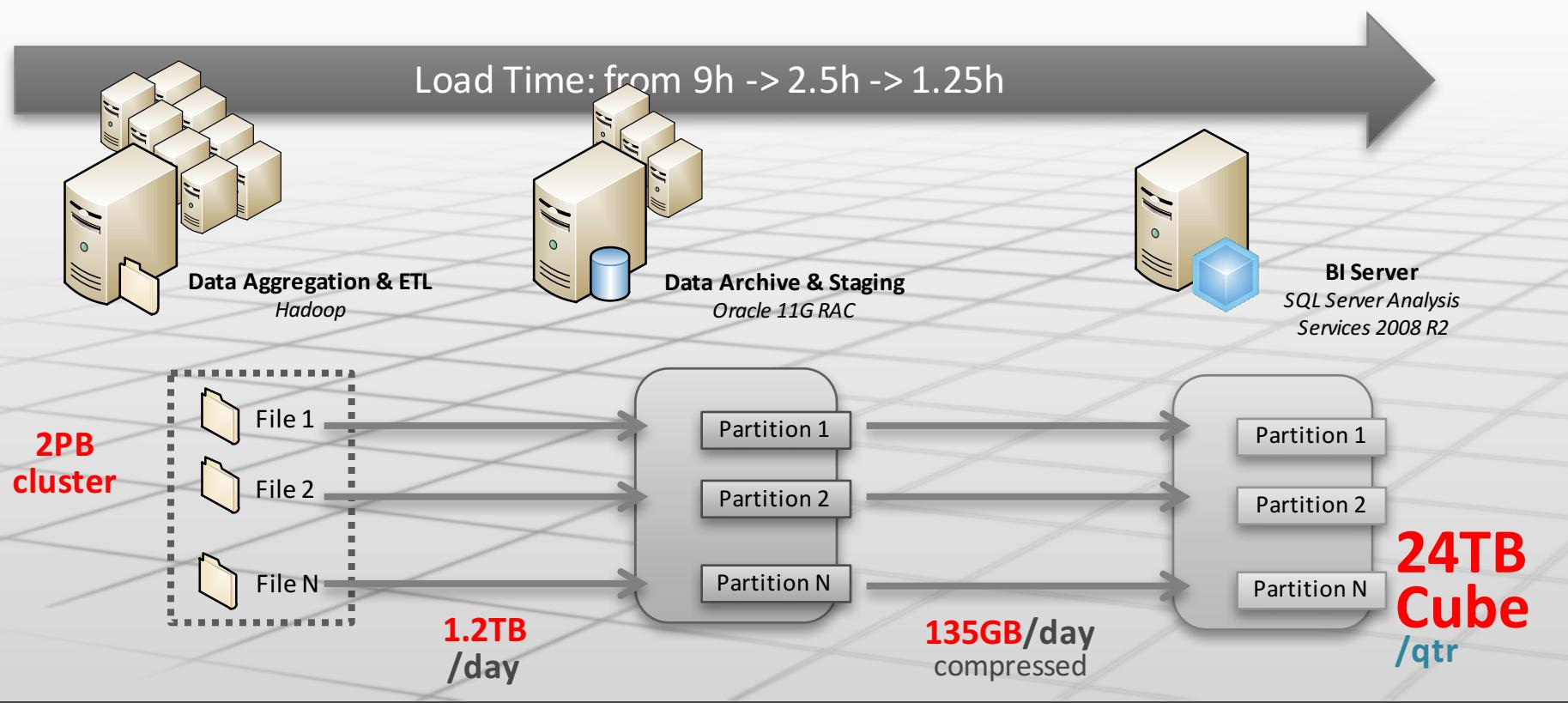


Query: Common BI / ETL





YAHOO!



Yahoo! TAO Platform: BI to Big Data

Visitors to Yahoo! Branded Sites: **680,000,000**

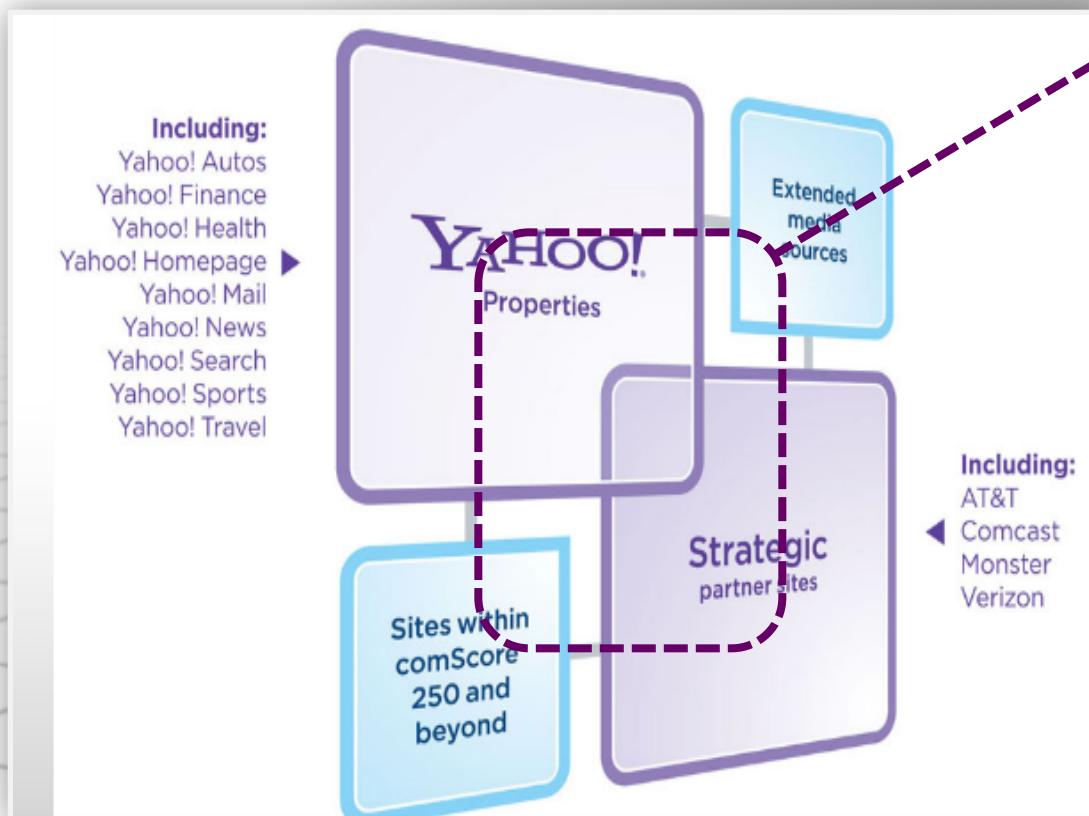
Ad Impressions: **3,500,000,000** (per day)

Rows Loaded: **464,000,000,000** (per qtr)

Refresh Frequency: **Hourly**

Average Query Time: **<10s**

YAHOO! TAO BUSINESS CHALLENGE



Yahoo! manages a ***powerful scalable advertising exchange*** that includes publishers and advertisers

YAHOO! TAO BUSINESS CHALLENGE

The screenshot shows the Yahoo homepage from April 10, 2011. At the top, there's a navigation bar with links for Web, Images, Video, Local, Shopping, and More. Below the navigation is a search bar with a yellow "Web Search" button and a link to "See Y! Search Direct^{BETA}". The main content area features a large image of a sunken plane underwater. Headlines include "Rare underwater find has experts stunned" and "Ref crepted out on the ice". To the right is a "TRENDING NOW" box listing topics like Hulk Hogan, Kristen Stewart, and the Federal budget. A purple dashed circle highlights a promotional banner for "SEATTLE 1-DAY RESTAURANT DEALS" from livingsocial, featuring a photo of fries and a "GET DEALS!" button.

Advertisers want to get the best bang for their buck by reaching their **targeted audiences** effectively and efficiently

YAHOO! TAO BUSINESS CHALLENGE

The screenshot shows the Yahoo! homepage with a search bar containing "Rare underwater find has experts". Below the search bar, there's a "Web Search" button and a link to "See Y! Search Direct^{BETA}". The main content area displays a news article titled "Rare underwater find has experts" with a thumbnail image of a sunken plane. To the left is a sidebar titled "YAHOO! SITES" with links to various services like Mail, Autos, Dating, Finance, Games, Health, Horoscopes, Jobs, Messenger, Movies, omg!, Real Estate, Shine, Shopping, Sports, and Travel. At the bottom, there are news tabs for NEWS, WORLD, LOCAL, and FINANCE, along with a "2011 Tax Center" link.

Yahoo! needs visibility into how consumers are responding to ads along **many dimensions:** web sites, creatives, time of day, gender, age, location to make the exchange **work as efficiently and effectively** as possible

Yahoo! TAO Technical Requirements

Visitors to Yahoo! Branded sites:

680,000,000

Ad Impressions:

3,500,000,000 (per day)

Rows Loaded:

464,000,000,000 (per qtr)

Refresh Frequency:

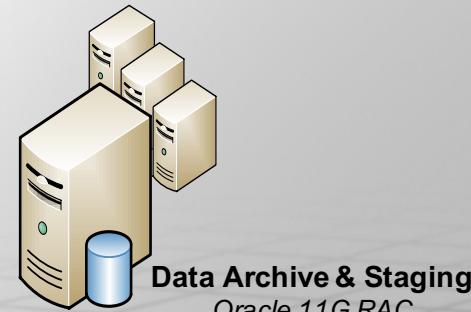
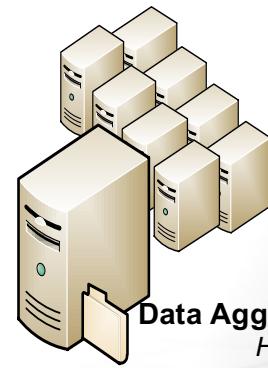
Hourly

Average Query Time:

<10 seconds

Yahoo! TAO Platform Architecture

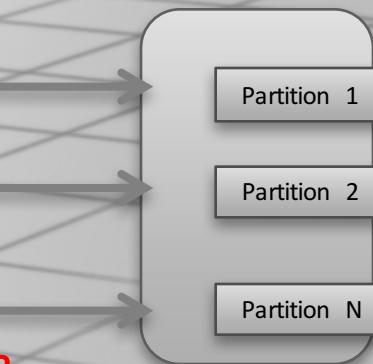
How did we load so much so quickly?



2PB
cluster



1.2TB
/day

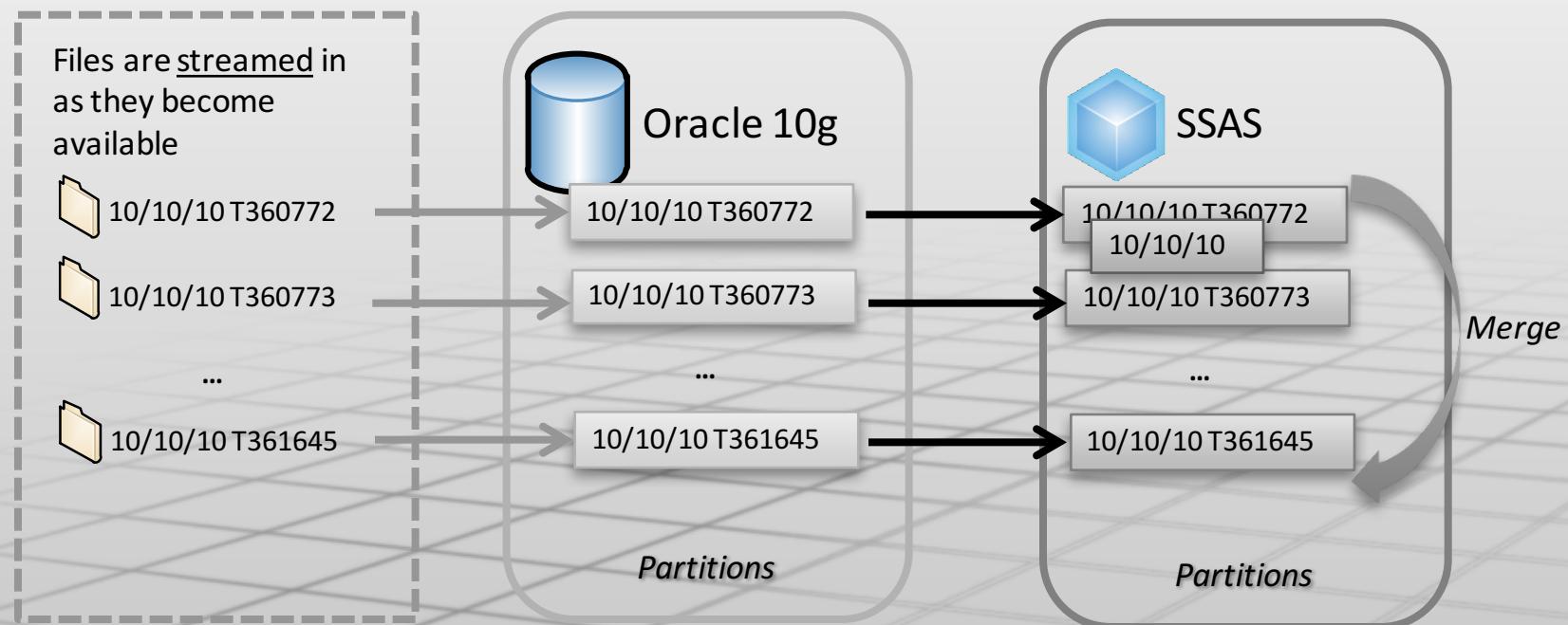


135GB/day
compressed



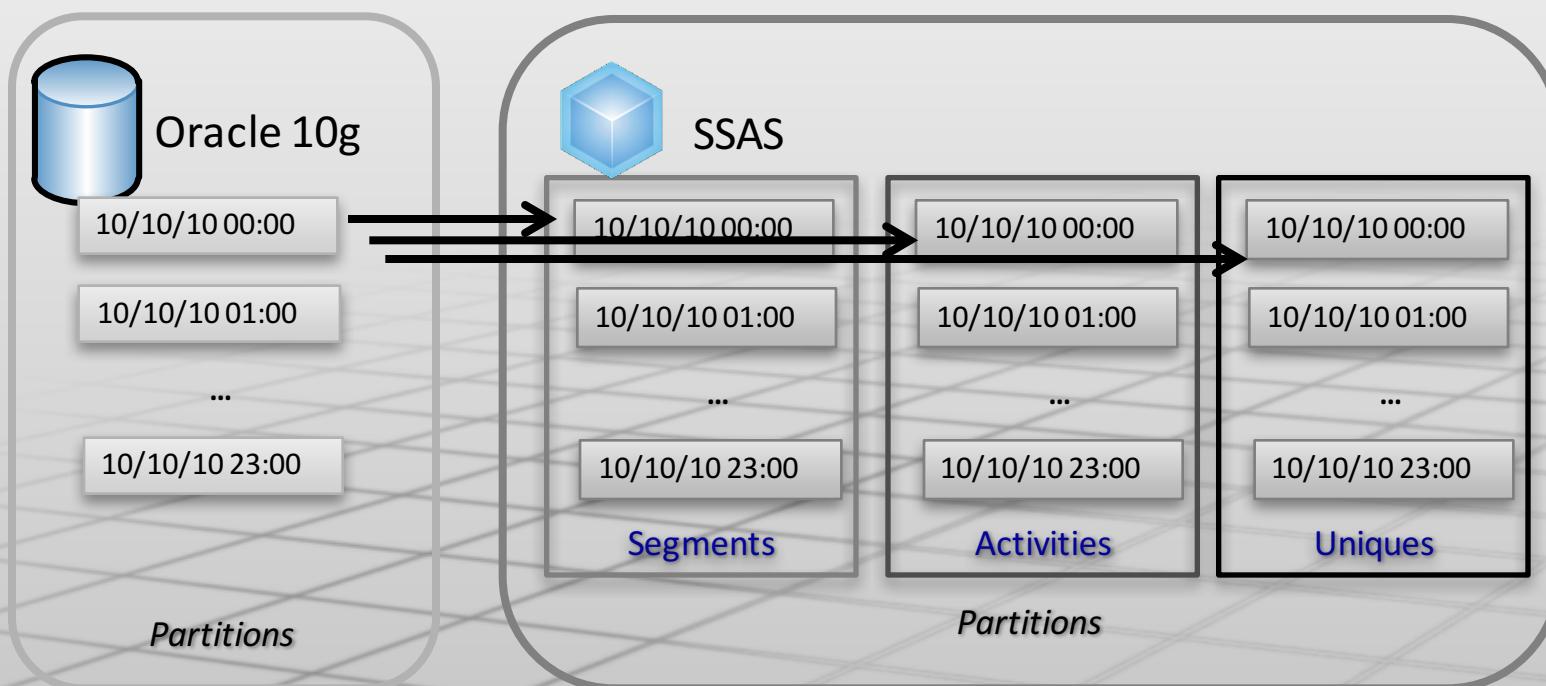
24TB
Cube
/qtr

YAHOO! EXAMPLE – “FAST” LOAD



- Data is streamed in to Oracle to files
- To get max processing, 30 threads are fired because all T (temp) partitions are processed concurrently
- Super fast data loads
- Problem is that it requires constant merging of partitions

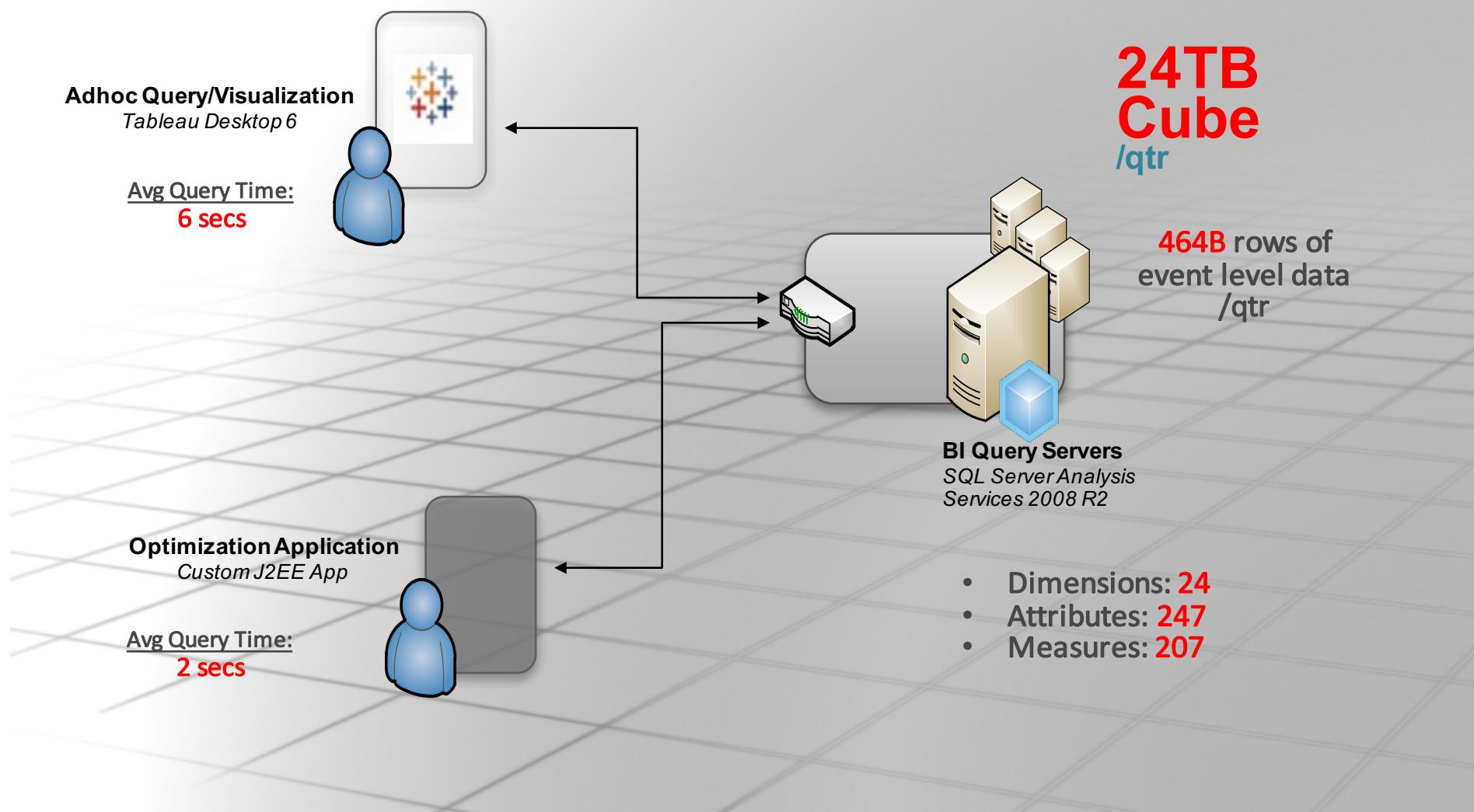
PARTITIONS – DIRECTLY MERGING



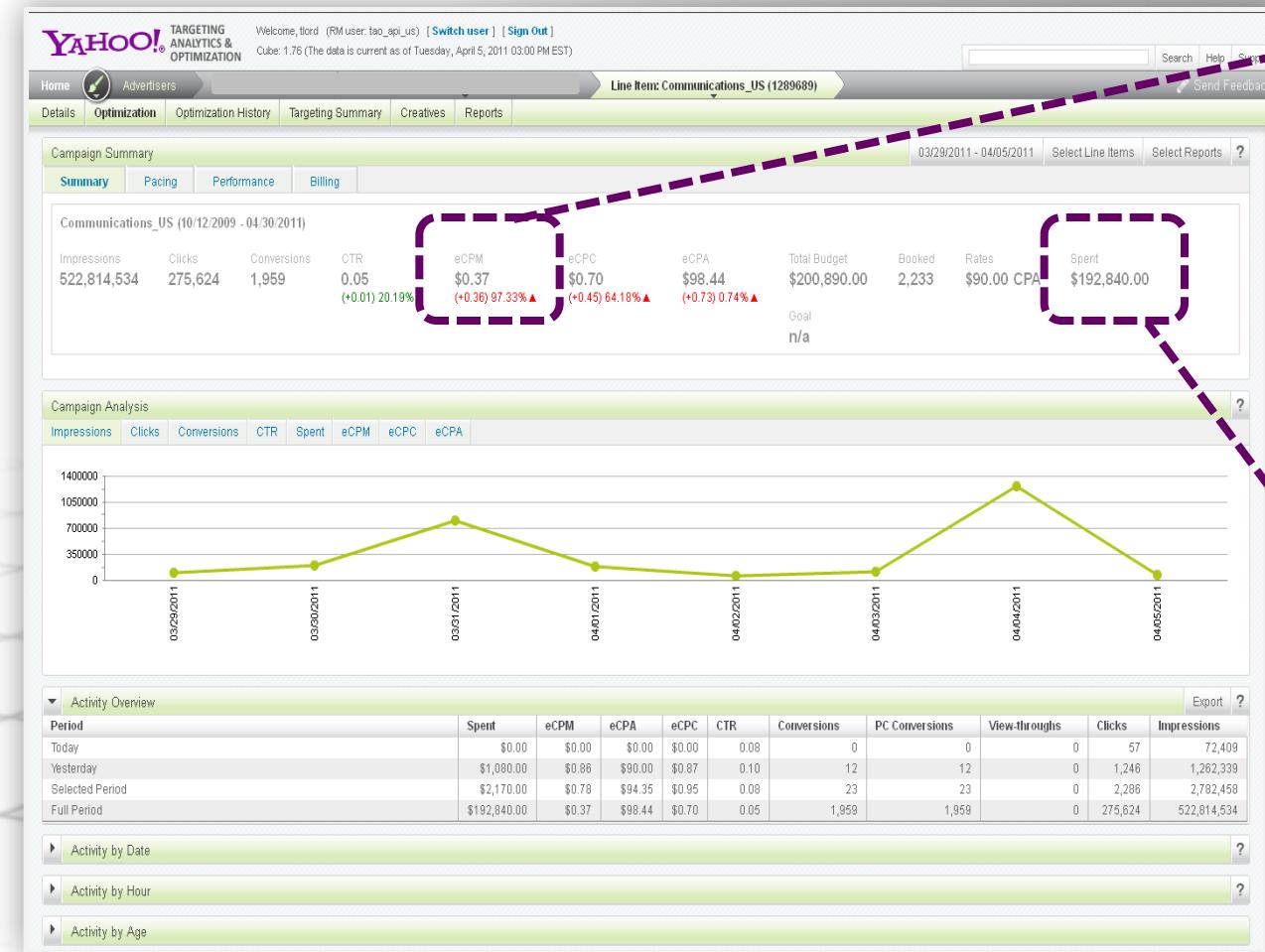
- New model allows for set hourly partitions
- No more streaming data but with hourly partitions, cannot have as many threads for fast data loads, unless...
- Process multiple cubes or measure groups in parallel

Yahoo! TAO Platform Architecture

Queries at the “speed of thought”



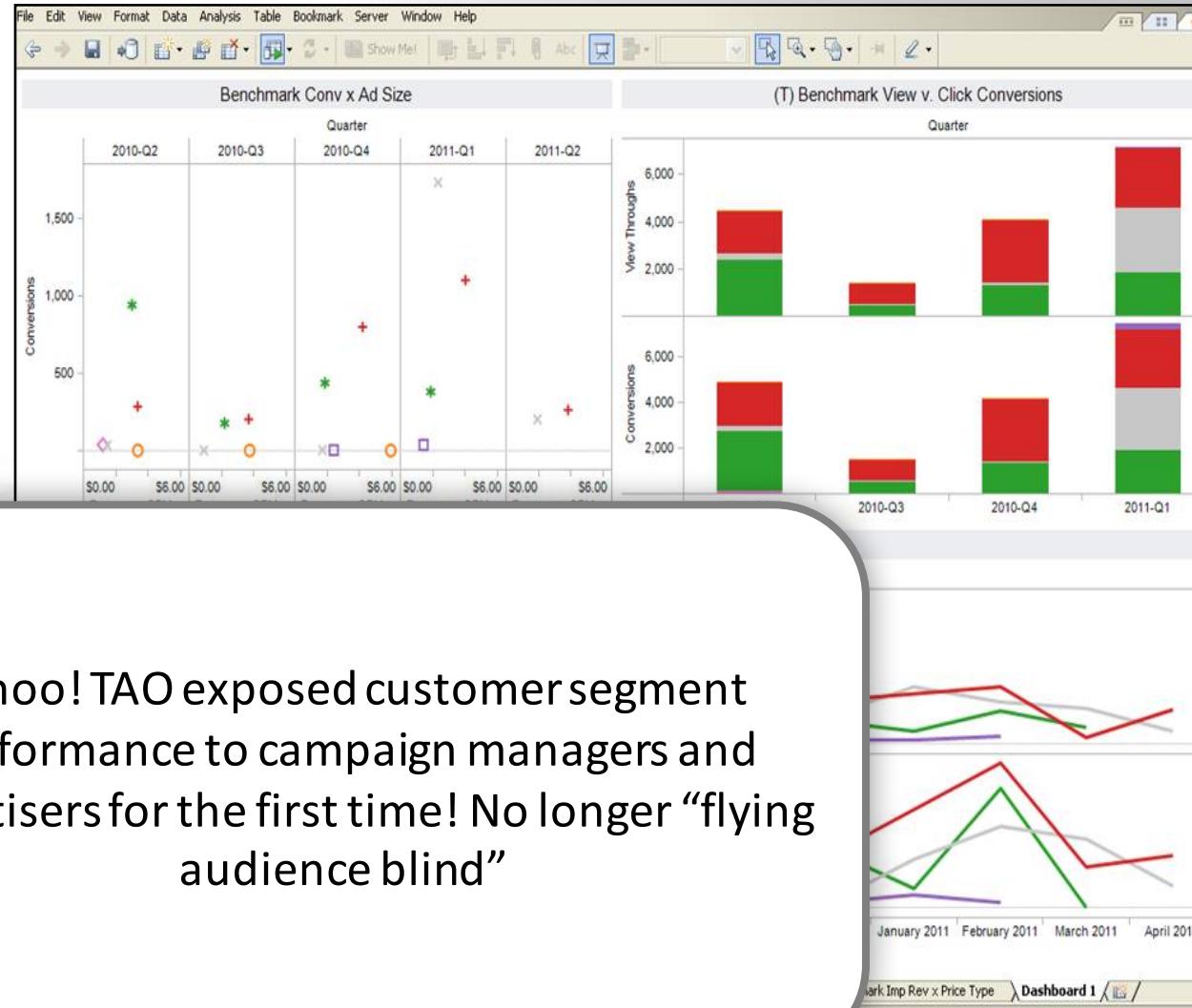
Yahoo! TAO Return on Investment



For campaigns optimized using TAO, **eCPMs (revenue) has more than doubled!**

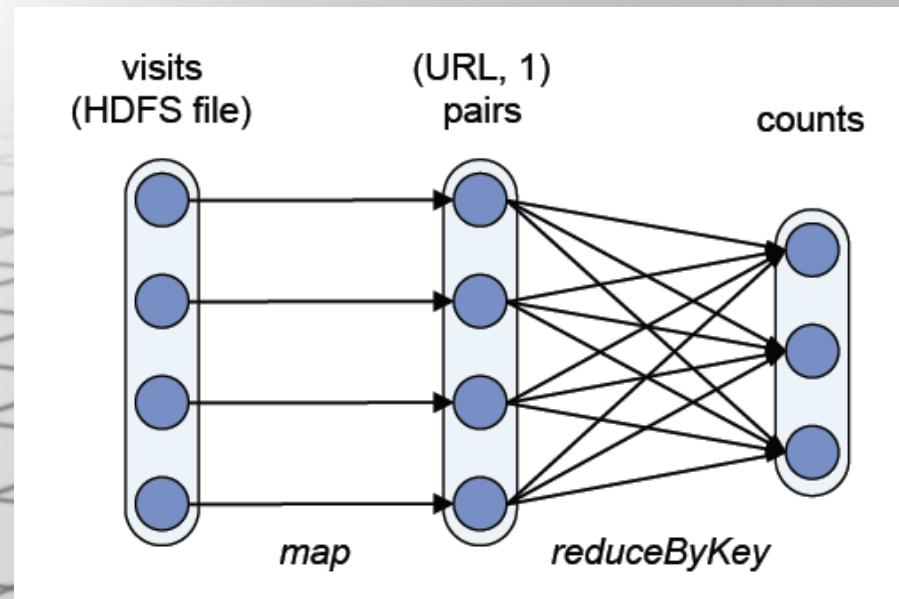
For campaigns optimized using TAO, **advertisers spent 15% more** with Yahoo! than before

Yahoo! TAO Return on Investment



Yahoo! TAO Future Direction

SPARK: SWISS ARMY KNIFE OF BIG DATA ANALYTICS





KLOUT

Klout: Social Score

53

+K

Denny Lee

SPECIALIST

dork, scribe, geek, Microsoft data dork, ultimate frisbee fan, mountain climber (barely!)... occasionally awake
Seattle

Influences 1K others

SQL CAT 29 14 10

tweet • share • see more...

Influential about 16 topics

Big Data
Business Intelligence
Nosql

tweet • share • see all...

SCORE ANALYSIS

TOPICS
INFLUENCERS
LISTS
KLOUT STYLE
PERKS
ACHIEVEMENTS

Score Analysis

You create content that is spread throughout your network and drives discussions

53

52

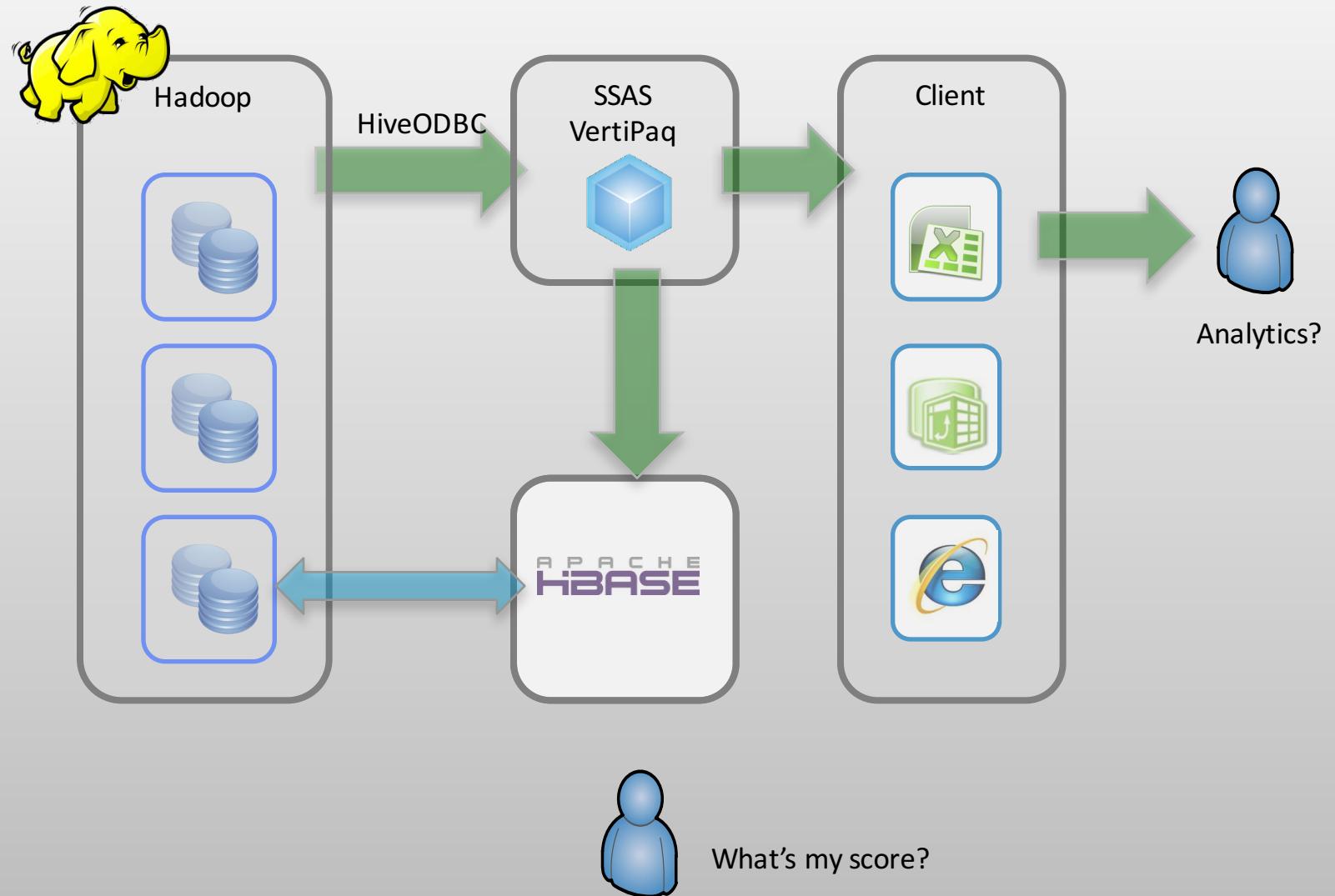
51

Your Klout Score:
52.51

Tweet Share

The Klout Score measures influence on a scale of 1 to 100. [Learn more](#)

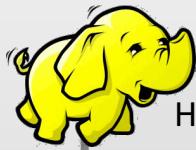
Klout: New Design



Query: Distributed Computing

Store and Distributed Querying

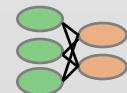
Commodity storage AND distributed querying directly against the data (move compute to the data)



Hadoop



MapReduce



Apache Pig



Scalable machine learning library:
k-means, SVD, recommenders, etc.

R and RHIPE

Statistical Computing and Graphics
Statistics library (S+, SAS, etc.)



Scalable machine learning library:
Petascale graph mining

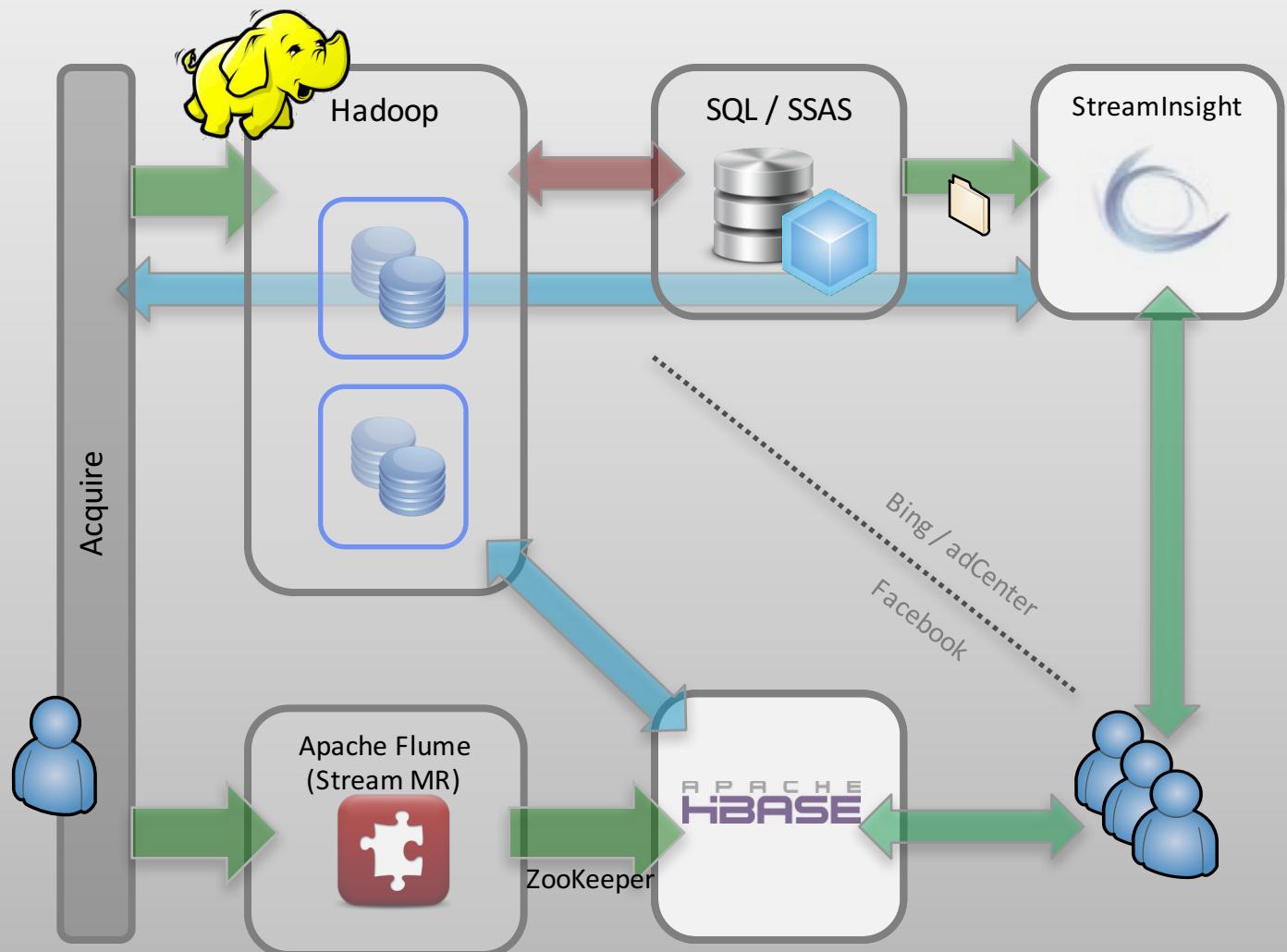


Highly Sensitive Short Read Mapping with MR
New parallel read-mapping algorithm for DNA sequencing

Event Processing / Real Time Messaging

Acquire, Store, Query -> Complex and Real Time Event Processing

Dealing with billions of daily events and messages requires auto-balancing, scalability, failover yet also consistency



Bing/adCenter Event Processing

- Display ads on msn.com
- Data goes into *Hadoop*
- ETL into SQL/SSAS
- Model for SI to use
- SI processes via model
- Updated display ad (latency <1min)
- Processing all 550B+ MSN users

Facebook Real Time Messaging

- Short set of volatile temporal data
- Continually growing dataset rarely accessed
- 20B events/day, 200,000 events/sec
- Latency <30s

bing



Near Real-Time Display Advertising Scenario

Bing / adCenter Event Processing Example

Hotmail | Messenger | Bing Latino | Sign in

msn Hotmail | Messenger | Bing Latino | Sign in

msn News Entertainment Sports Money Lifestyle More Local Edition Settings

Monday, October 4, 2010 Seattle, WA | 61°/51° °F °C

 Clearly, It's Time to Auto-Tune the Husky

Video: Even Jay-Z may rethink his Auto-Tune death cry after seeing Mishka the dog. Check out her [musical debut](#), plus a pup that prays & more 'Bubble' goodies.

Video: Kitty city, dogs playing accordions & more

Bing: Watch more Auto-Tune videos

MUST SEE **NEWS** **VIDEO** **AUTOS**



- ① Video: Vague terror warnings lead to tighter security
 - Slideshow: Green and mean at Paris auto show
- ② Video: Pakistan: Protecting NATO tankers not on us
 - Border closure heightens US-Pakistan tensions
- ③ Chilean president: Rescue of miners 'very close'

Share your tips on how you make family time different and better for a chance to win!*

[SUBMIT A TIP](#) [OFFICIAL RULES](#)

Lever 2000 BECAUSE EVERY TOUCH COUNTS WHY LEVER 2000 IS BETTER YOU COULD WIN A VACATION \$1 COUPON

Advertisement Ad Feedback

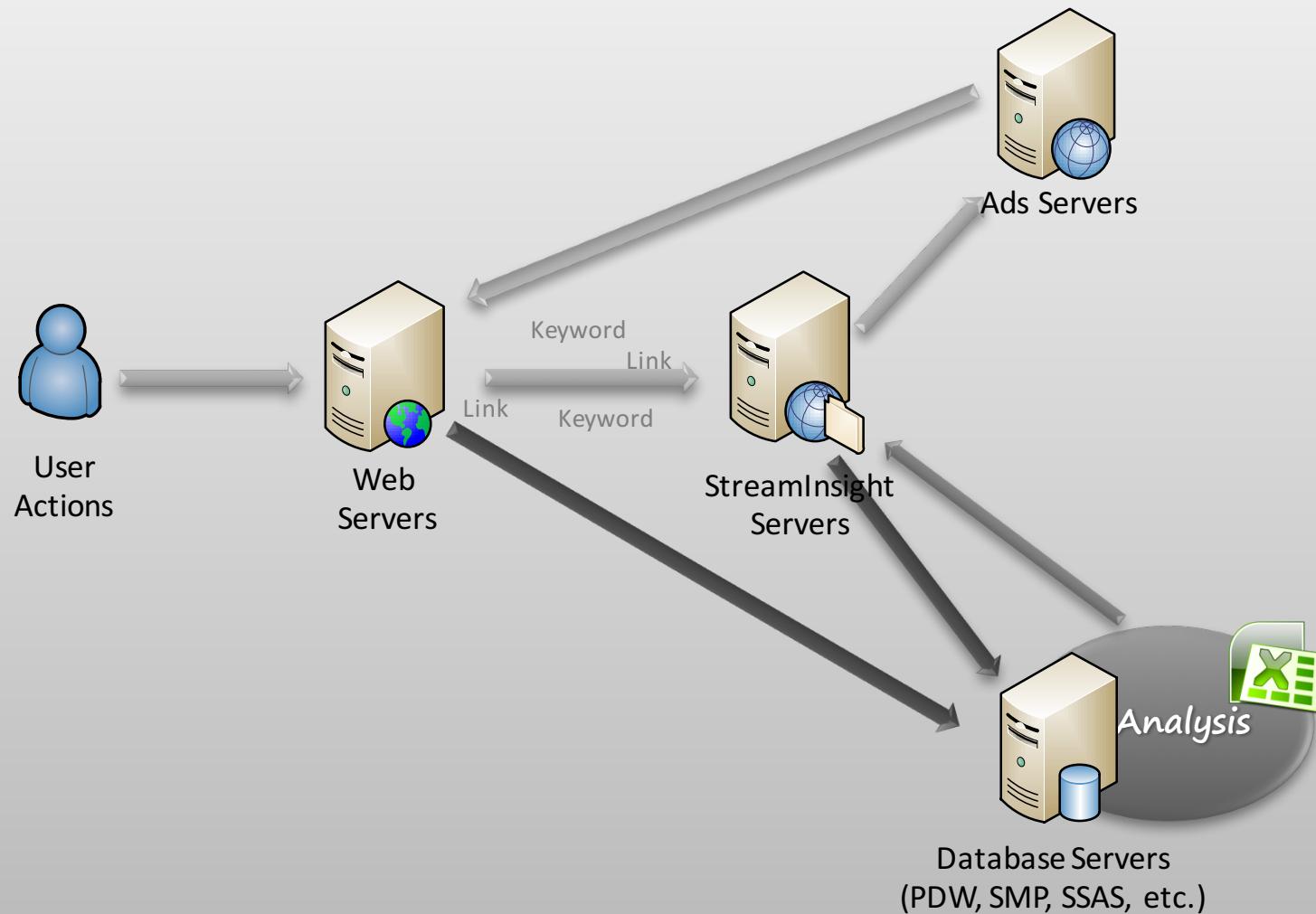
Bing on the go with the Bing Toolbar

POPULAR SEARCHES

**Iconic beauties**
From Bacall to Garbo to Jolie, meet the [alluring women of yesterday & today](#).

GALLERIES: On-&-off celeb couples | Recent recalls

bing: Near Real Time Advertising Flow





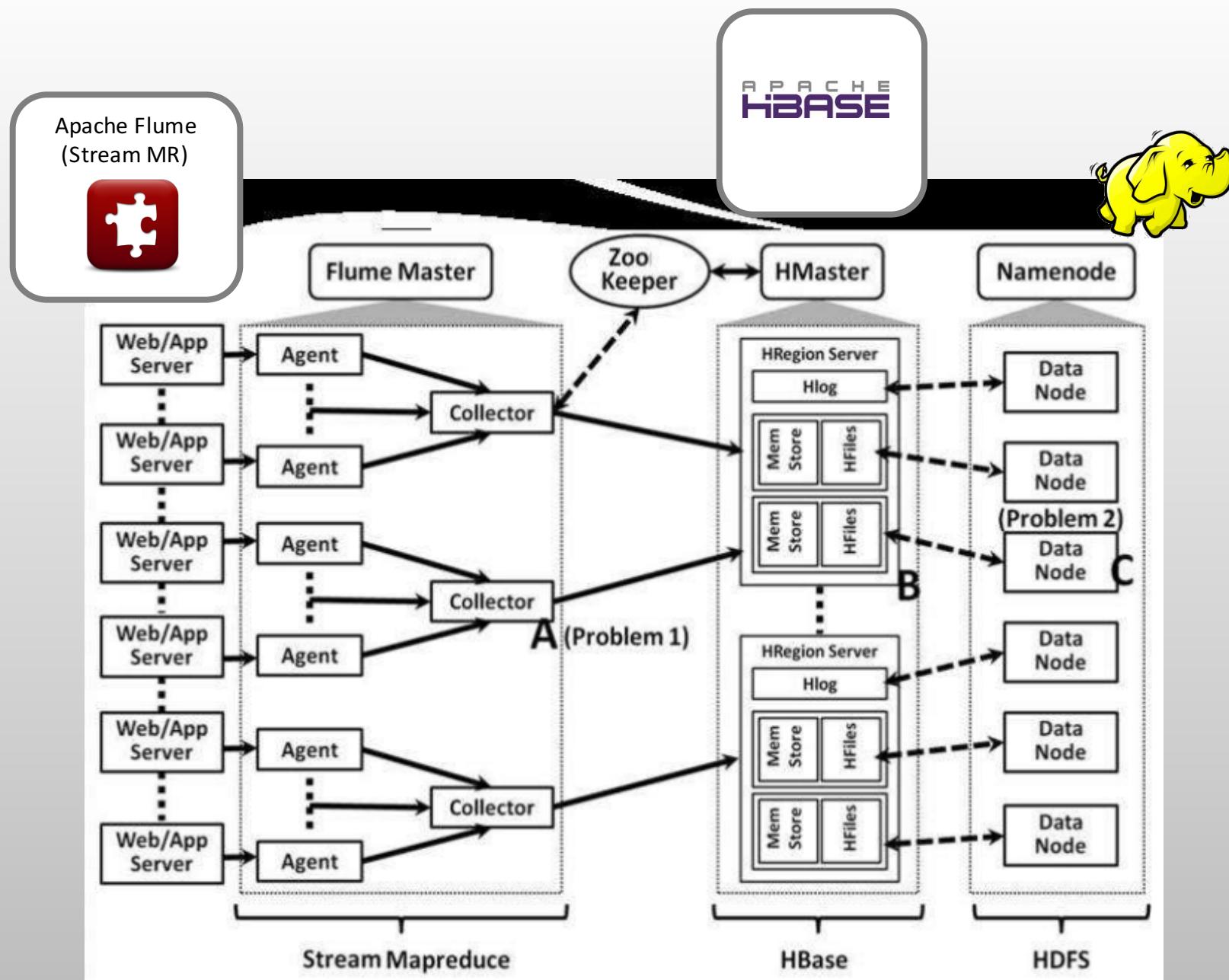
FACEBOOK

Solution architectures are readily available via Slideshare, blogs, FB, etc.

Most commonly copied HBase story

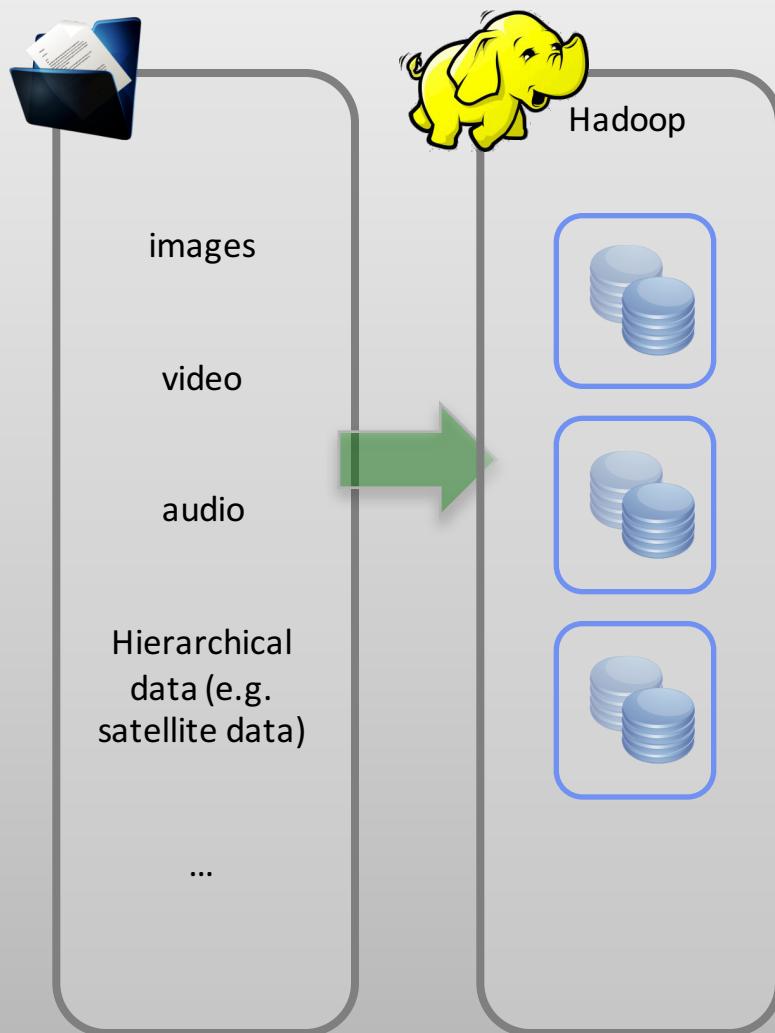
Facebook's New Real Time Messaging System:

HBase to Store 135+ Billion Messages a Month

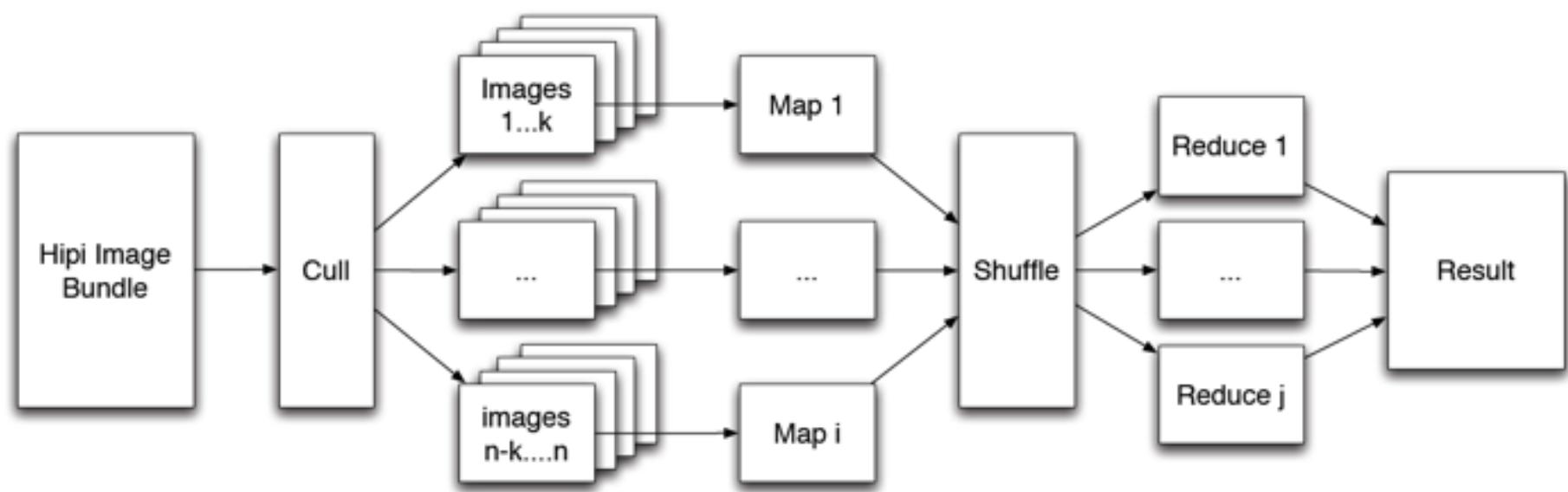


Big Data: Not only RDBMS but also entering into HPC

Dealing with billions of events including video, imaging, hierarchical data; entering into the specialized HPC domain

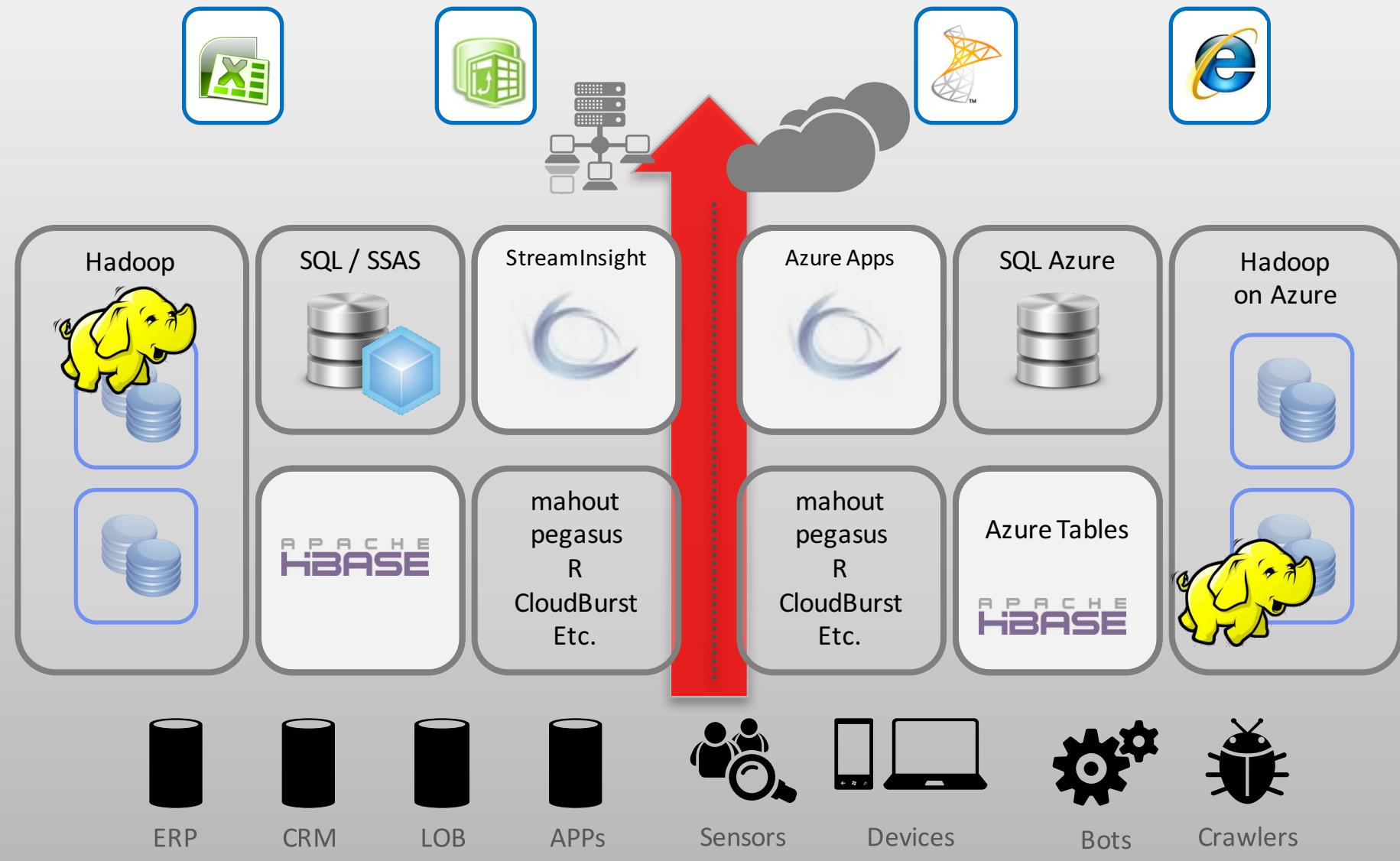


<http://hipi.cs.virginia.edu/>



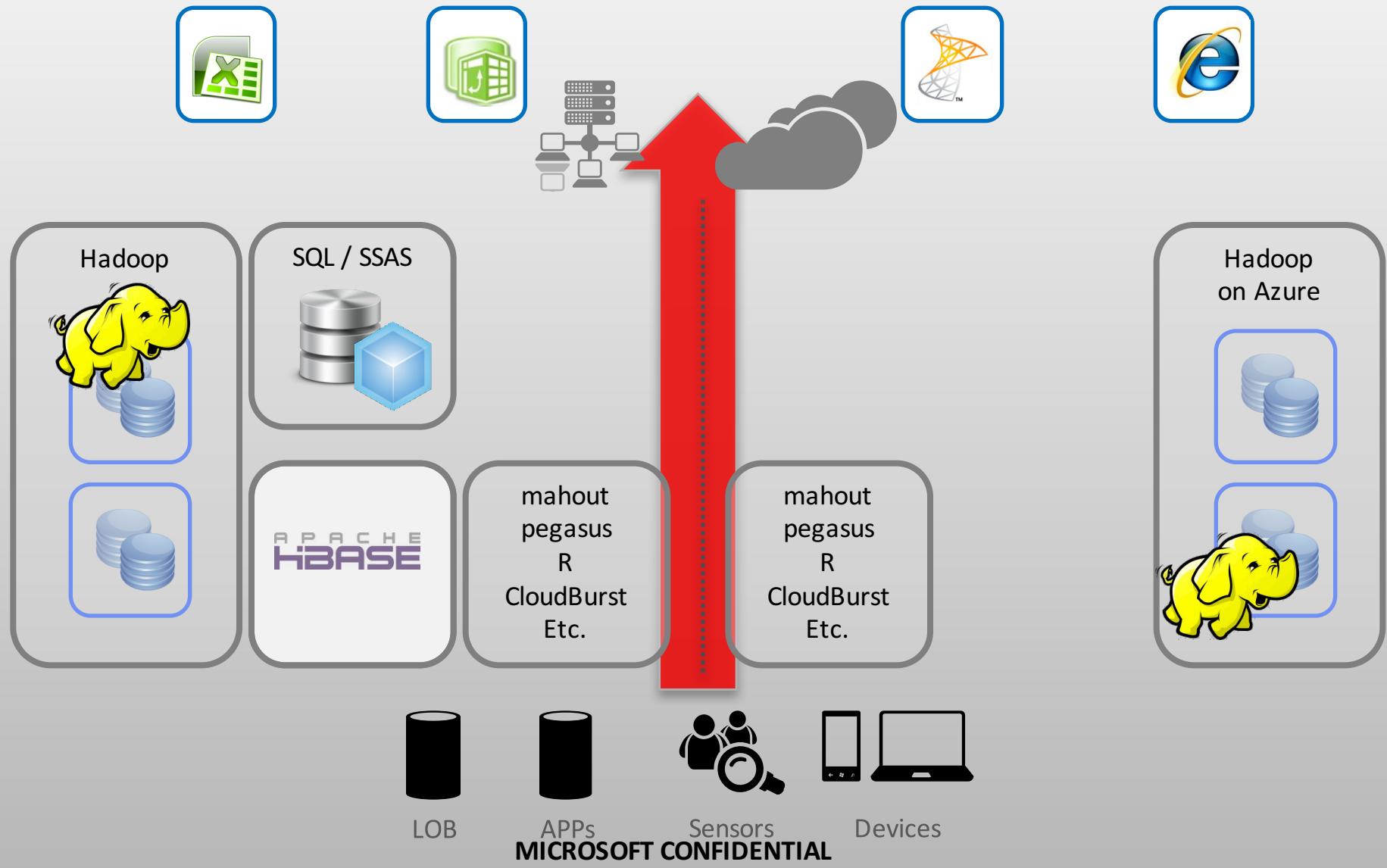
Data Sharing and Isolation

Cloud and on-premise data stay separated – compute where the data resides



RHIO / Healthcare scenario

Regional Healthcare Informatics Organization



Q&A

