Data Processing in the Cloud at Yahoo!

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Cloud Computing & Data Infrastructure

Yahoo Inc.

Outline

- What are clouds and their benefits
- Clouds at Yahoo
- Hadoop

Types of Cloud Services

- Two kinds of cloud services:
  - Horizontal ("Platform") Cloud Services
    - Functionality enabling tenants to build applications or new services on top of the cloud
  - Functional Cloud Services
    - Functionality that is useful in and of itself to tenants. E.g., various SaaS instances, such as Saleforce.com; Google Analytics and Yahoo!'s IndexTools; Yahoo! properties aimed at end-users and small businesses, e.g., flickr, Groups, Mail, News, Shopping
    - Could be built on top of horizontal cloud services or from scratch
    - Yahoo! has been offering these for a long while (e.g., Mail for SMB, Groups, Flickr, BOSS, Ad exchanges)

Cloud Characteristics

- Elastic, horizontal, capacity
  - Grow and shrink as needed
  - Large scale possible
- Utility – pay-per-usage, often no long term commitment needed
- Multi-tenant
- Availability, operations management, and connectivity built in
  - Customer focuses on his problem not IT management
- Private/Public
  - Private (within an organization): - e.g. Yahoo!, Google
  - Public: e.g. EC2, ElasticMapReduce App Engine
- Different abstraction levels
  - EC2 – provides "bare" machines (VMs)
  - Higher level: Hadoop (Yahoo), ElasticMapReduce, App Engine

Benefits of utility cloud computing

- Business agility, business innovation, technical innovation
  - Key computations solved in days and not months
  - Try out new ideas
  - Projects move from research to production in days
  - Easy to learn, even our rocket scientists use it!
- Scale, performance, availability
  - More robust, more global,
    more complete, better growth, for a given budget
- Cost
  - Lower cost – infrastructure is shared
- Major factors
  - You don't need to find new hardware to experiment
  - You can work with all your data!
  - No need for R&D to do IT (it just works)
    - Focus on the problem not IT

Yahoo!'s Unique Cloud: Unprecedented Scale

- **Massive user base and engagement**
  - 500M+ unique users per month
  - Hundreds of petabyte of storage
  - Hundreds of billions of objects
  - Hundred of thousands of requests/sec

- **Global**
  - Tens of globally distributed data centers
  - Serving each region at low latencies

- **Challenging Users**
  - Rapidly extracting value from voluminous data
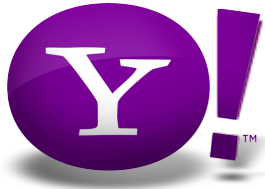 - Downtime is not an option (outages cost $millions)
 - Variable usage patterns

Technology Strategy

- **Open Source**
  - Hadoop, PIG, Xen, …
- **High performance**
  - Throughput
  - Latency
- **Multi-data center**
  - N-way replication
  - Consistency/availability tradeoffs
  - BCP
- **Supporting technologies used at Yahoo!**
- **Flat, flexible infrastructure**

Hadoop: A Key Cloud Technology

- A framework for storing & processing Petabyte of data using commodity hardware and storage
- Storage: HDFS, HBase
- Processing: MapReduce, Pig
- Distributed coordination: Zookeeper

Pig
MapReduce

HBase

HDFS

ZooKeeper
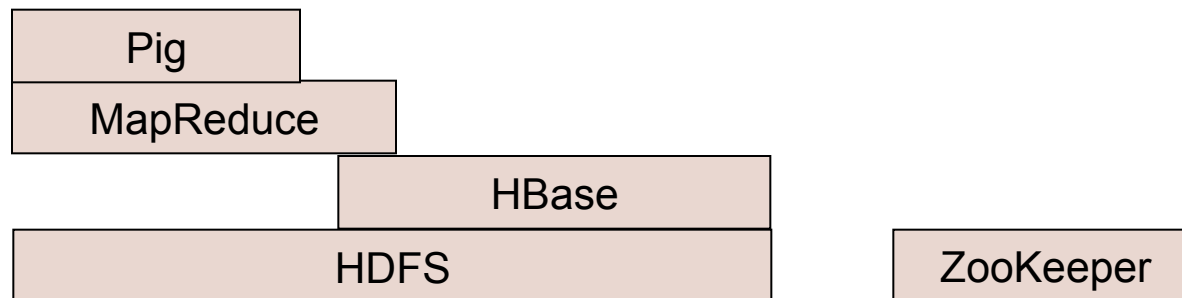
Hadoop Characteristics

- Commodity HW + Horizontal scaling
  - Add inexpensive servers with JBODS
  - Storage servers and their disks are *not* assumed to be highly reliable and available
- Use replication across servers to deal with unreliable storage/servers
- Metadata-data separation - simple design
  - Storage scales horizontally
  - Metadata scales vertically (today)
- Slightly Restricted file semantics
  - Focus is mostly sequential access
  - Single writers
  - No file locking features
- Support for moving computation close to data
  - i.e. servers have 2 purposes: data storage and computation
- MapReduce Data processing framework

Simplicity of design

why a small team could build such a large system in the first place

A growing user base - "powered by"

Year: 2007

YAHOO!   Powerset   last.fm

Year: 2008

Google   able grape   Cascading   INFORMATION SCIENCES INSTITUTE   Zvents Discover Things To Do   Cornell University Computing and Information Science   Visible MEASURES

ImageShack online media hosting   A9   IBM   ENORMO   Joost   News Corporation

Lookery   facebook   krugle   THE UNIVERSITY OF EDINBURGH   The New York Times   SECURITY ENHANCED DOMAIN NAME SYSTEM   NetSeer   LOTAME Locate, Target, & Message with Social Media   parc Palo Alto Research Center   veoh   rackspace HOSTING

Year: 2009

AOL   WorldLingo   cooliris   deepdyve BETA   TEXTMAP THE ENTITY SEARCH ENGINE Monitoring the World So You Don't Have To ...

eyealike   tailsweep   hulu   RapLeaf   Ning   quantcast   Hep USCMS

iterend   adknowledge   detikSearch   stampede beta   VK SOLUTIONS Global Solutions Provider

pressflip   HOSTING HABITAT   CbIR   HOLA SERVERS   Systems@ETH Zürich   TARAGANA Innovation · Quality · Simplicity

PSG College of Technology The Technology that leads the world   Terrier

Hadoop

Hadoop is critical to Yahoo's business

Massive Hadoop-Based Application @ Yahoo!

|	2008	2009
Webmap	~70 hours runtime ~300 TB shuffling ~200 TB output	~73 hours runtime ~490 TB shuffling ~280 TB output +55% hardware

Terasort	209 seconds
	  1 Terabyte sorted
	  900 nodes
		62 seconds
		  1 Terabyte, 1500 nodes
		
		16.25 hours
		  1 Petabyte, 3700 nodes

Largest cluster	2000 nodes •6PB raw disk •16TB of RAM •16K CPUs	4000 nodes •16PB raw disk •64TB of RAM •32K CPUs •(40% faster CPUs too)

Hadoop Applications: Search Assist™
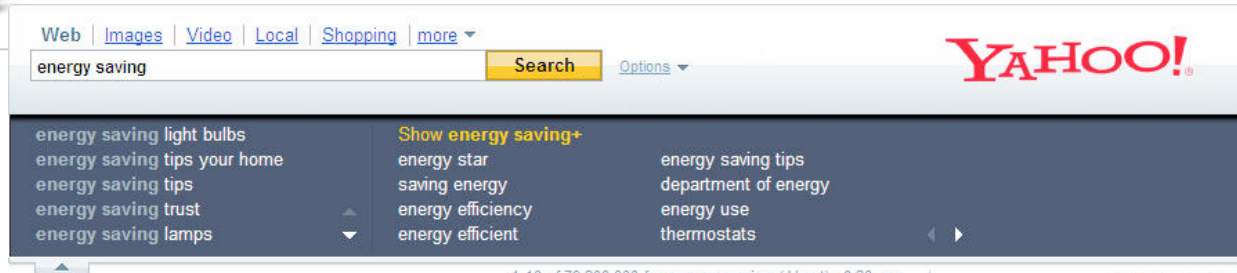
» **Database for Search Assist™ is built using Hadoop.**
» **3 years of log-data**
» **20-steps of map-reduce**

	Before Hadoop	After Hadoop
Time	26 days	20 minutes
Language	C++	Python
Development Time	2-3 weeks	2-3 days
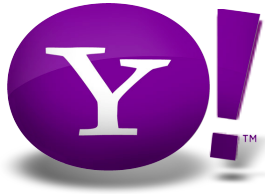
Collaborations around the globe

- M45 - Yahoo!'s supercomputing cluster
  - Carnegie Mellon University
  - The University of California at Berkeley
  - Cornell University
  - The University of Massachusetts at Amherst joined
- Partners in India
  - Computational Research Laboratories (CRL), India's Tata Group
  - Universities – IIT, IISc, IIIT-H, PSG
- Open Cirrus™ - cloud computing research & education
  - The University of Illinois at Urbana-Champaign
  - Infocomm Development Authority (IDA) in Singapore
  - The Karlsruhe Institute of Technology (KIT) in Germany
  - HP, Intel
  - The Russian Academy of Sciences, Electronics & Telecomm.
  - Malaysian Institute of Microelectronic Systems

More Info

- Main Web sites
  - http://hadoop.apache.org/core/
  - http://wiki.apache.org/hadoop/
  -
    http://wiki.apache.org/hadoop/
    GettingStartedWithHadoop
  - http://wiki.apache.org/hadoop/HadoopMapReduce

THANKS

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