

Answer to the Quiz

Time Duration 70 minutes

BY

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<https://sites.google.com/site/animeshchaturvedi07/academic-teaching/cloudcomputing>

Questions are in equal marks proportion that is five marks each

- Q1. Who had won the “ACM A. M. Turing Award” in 2013? What is the role of contributions by the winner in the growing larger scale distributed systems and cloud computing? What is the title of highly cited research paper by the winner?
- Q2. Which type of cloud computing model will you choose “if your organization has significant infrastructure but still undergoing huge spikes of users (or requires cloud bursting)”?
- Q3. Suppose your organization want to transfer 100 TB of data from X to Y location. Assume average bandwidth found to be 30 Mbit/sec in between X to Y. What medium you will choose physical or network to transfer the data from X to Y? $1 \text{ TB} = 10^{12} \text{ Bytes}$, $1 \text{ Byte} = 2^3 \text{ bits}$ and $1 \text{ Mbit/sec} = 10^6 \text{ bits/sec}$.
- Q4. Describe Google File System (GFS) and Hadoop Distributed File System (HDFS)?
- Q5. Draw the architectures for “Hadoop on Google Cloud Platform” and “Google App Engine”.

Answer

Answers to the questions can be inferred from the following

- Answer 1 in slide 4 and 5
- Answer 2 in slide 6
- Answer 3 in slide 7
- Answer 4 in slide 8 to 14
- Answer 5 in slide 14 to 19

Turing Award 2013

- “Leslie Lamport, a Principal Researcher at Microsoft Research, as the recipient of the 2013 ACM A. M. Turing Award.” Lamport’s proposed widely used algorithms and tools that have applications in cloud computing.
- His 1978 paper “Time, Clocks, and the Ordering of Events in a Distributed System” is one of the most cited in the history of computer science.
- “Turing Award for imposing clear, well-defined coherence on the seemingly chaotic behavior of distributed computing systems, in which several autonomous computers communicate with each other by passing messages. He devised important algorithms and developed formal modeling and verification protocols that improve the quality of real distributed systems. These contributions have resulted in improved correctness, performance, and reliability of computer systems.”

Turing Award 2013

- “Google Vice President of Research Alfred Spector noted that “with the growing shift to ever-larger scale distributed systems and cloud computing, Lamport’s work has taken on a significantly increased role. His results have benefited many research communities including those in parallel and high performance computing systems, concurrent algorithms, and software reliability. And, his work has had implications not just in the theoretical community, but also with the engineers and programmers who design and implement many types of systems.”
- Harry Shum, Microsoft executive vice president of Technology and Research: “I really started to appreciate the incredible contribution his work has made to our industry, especially in cloud computing and distributed systems, when I worked at Bing. At Bing, we studied his paper on Paxos and applied his technology to build the distributed systems that we still use today.”

<http://www.acm.org/press-room/news-releases/2014/turing-award-13>

<http://research.microsoft.com/en-us/news/features/lamport-031814.aspx>

Hybrid cloud

- Hybrid cloud will help in extension of the capacity or the capability of a cloud service, by aggregation, integration or customization with another cloud service. Ability to connect, managed or dedicated services with both private and public cloud resources.
 1. If an organization have some client data on a private cloud application, but want to interconnect that application to a business intelligence application provided on a public cloud as a software service.
 2. If an organizations use public cloud computing resources to meet temporary capacity needs that can not be met by the private cloud.
- **Cloud bursting:** when the demand for computing capacity increases then an application deployment model in a private cloud or data center will "bursts" to a public cloud. During spike in processing demand requirement private cloud infrastructure that supports average workloads will start using cloud resources from public or private clouds together.
- **Advantage:** payment only for the extra compute resources when they are needed.

Data Transfer Bottlenecks

Physical medium will be selected for data transfer. Because For data-intensive application, data placement and transport across the boundaries of clouds, may be complicate.

Data transfer costs is an important issue

- Overcome the high cost of Internet transfers is to ship disks.
 - Assume that we want to ship 100TB from X to Y. Suppose measured bandwidth average found to be 30 Mbit/sec.

It would take

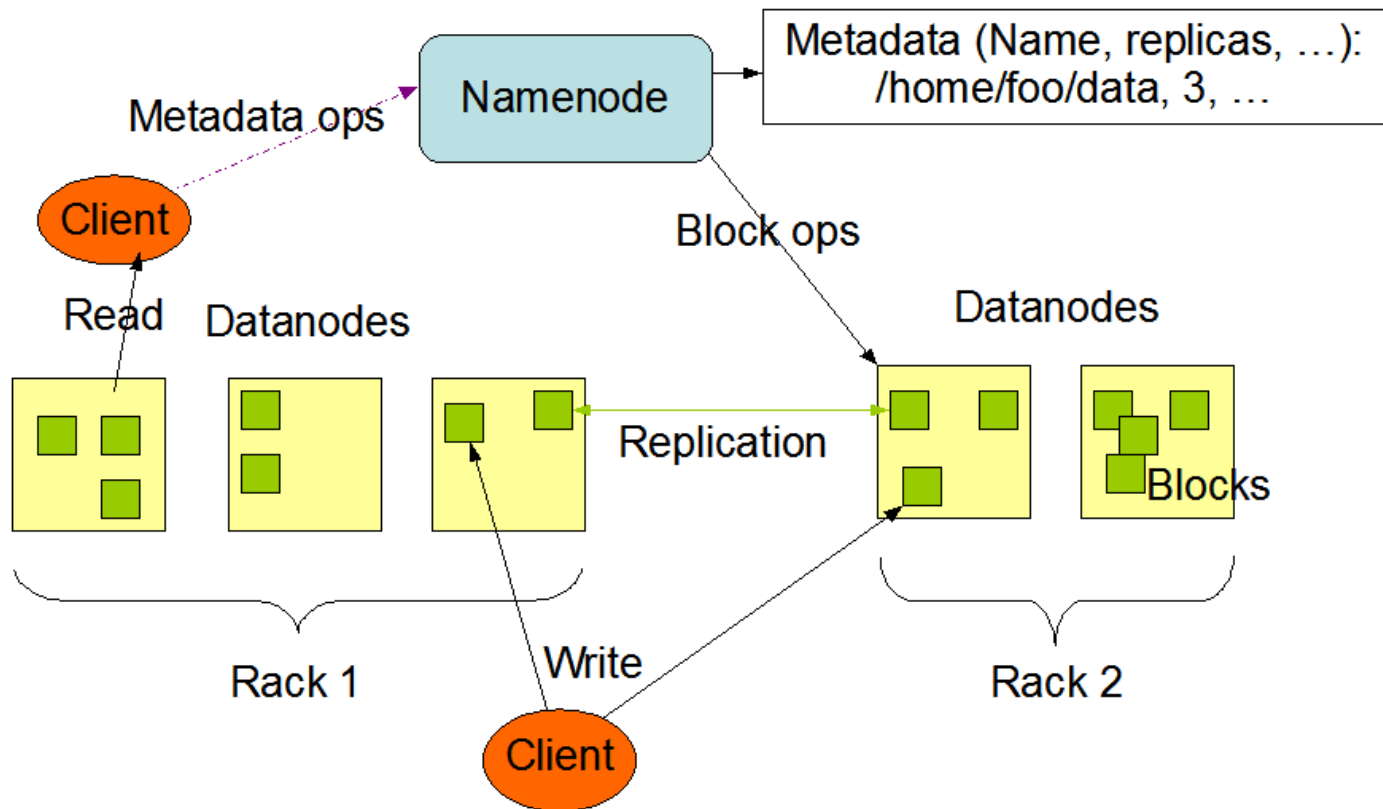
$$\begin{aligned} & 100 * 10^{12} \text{ Bytes} / (30 \times 10^6 \text{ bits/second}) \\ & = (8 \times 10^{14}) / (3 \times 10^7) \text{ seconds} = 8/3 \times 10^7 \text{ seconds,} \\ & = 308 \text{ plus days.} \end{aligned}$$

Very high network transfer fees for this data.

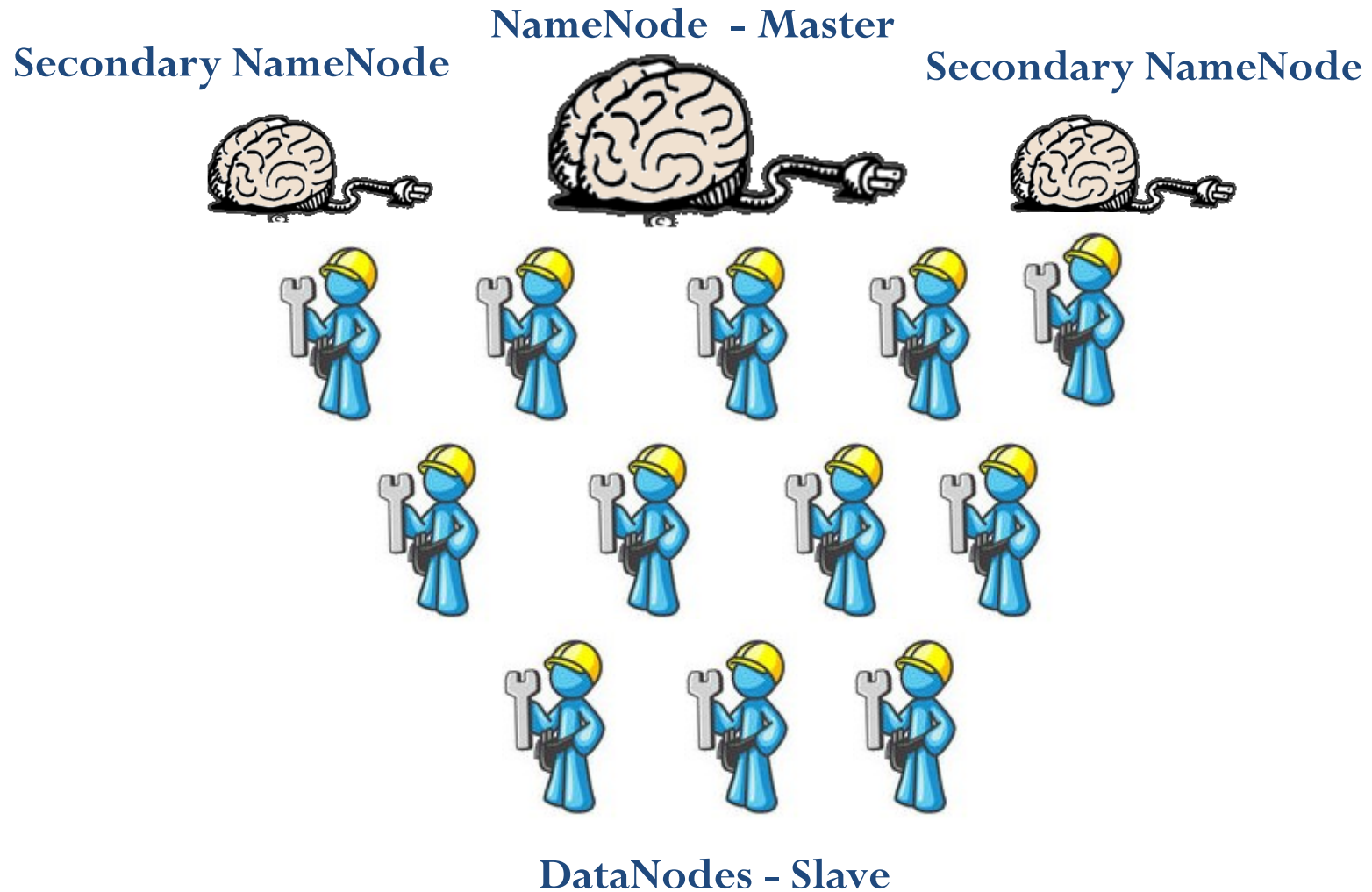
Mell, Peter, and Tim Grance. "The NIST definition of cloud computing."
National Institute of Standards and Technology 53.6 (2009): 50.

Hadoop Distributed File System

HDFS Architecture



HDFS Force



Hadoop Distributed File System

Name Node: Manages File System - mapping files to blocks and blocks to data nodes. Maintains status of data nodes

- Heartbeat: Datanode sends heartbeat at regular intervals, if heartbeat is not received, datanode is declared to be dead
- Blockreport: DataNode sends list of blocks on it. Used to check health of HDFS

Data Node:

- Replicates (On Datanode failure, On Disk failure and On Block corruption)
- Data integrity (Checksum for each block, Stored in hidden file)
- Rebalancing- balancer tool (addition of new nodes, decommissioning and deletion of some files)

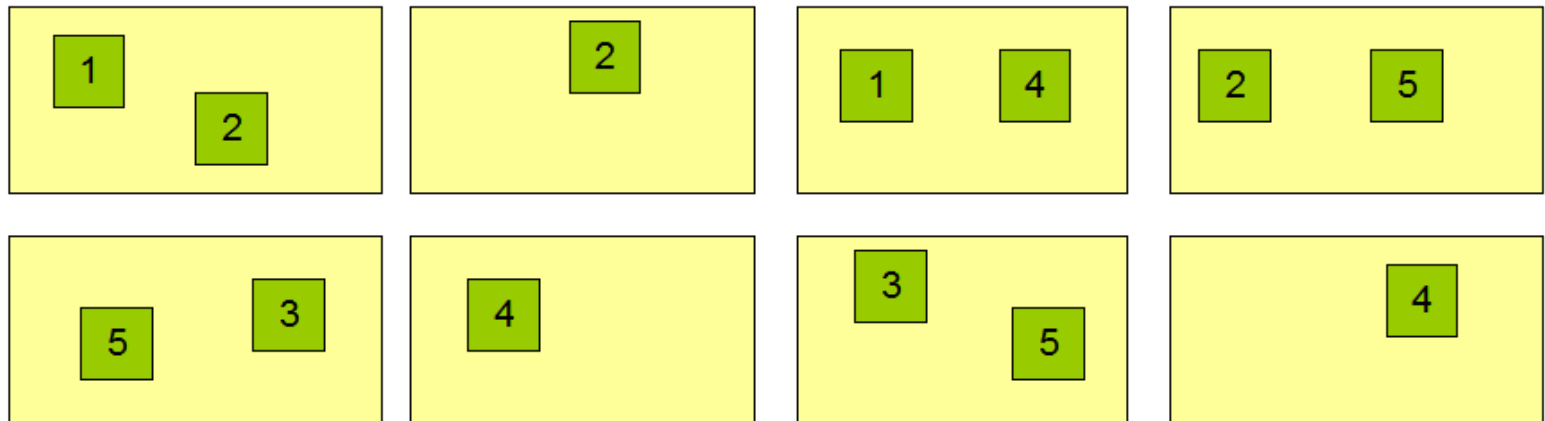


HDFS Data Replication

Block Replication

Namenode (Filename, numReplicas, block-ids, ...)
/users/sameerp/data/part-0, r:2, {1,3}, ...
/users/sameerp/data/part-1, r:3, {2,4,5}, ...

Datanodes



Google File System

- A scalable distributed file system for large distributed data-intensive applications.
- It provides fault tolerance. High aggregate performance to a large number of clients.
- It is widely deployed within Google as the storage platform for the generation and processing of data used by Google service as well as research and development efforts that require large data sets.
- The largest cluster to date provides hundreds of terabytes of storage across thousands of disks on over a thousand machines, and it is concurrently accessed by hundreds of clients. Earlier Google effort, "BigFiles", developed by Larry Page and Sergey Brin. Files are divided into fixed-size chunks of 64 megabytes.
- GFS is not implemented in the kernel of an operating system, but is instead provided as a userspace library.

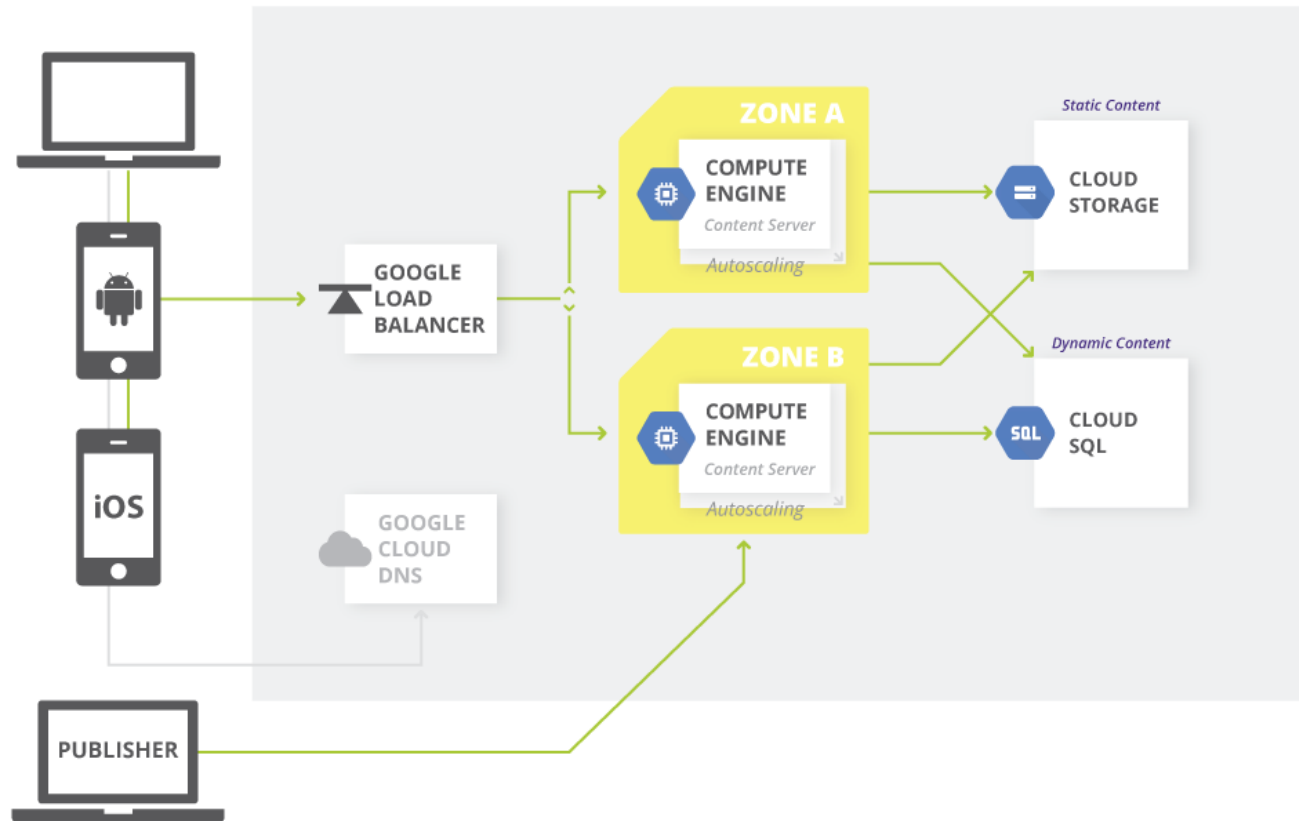
<http://research.google.com/archive/gfs.html>

http://en.wikipedia.org/wiki/Google_File_System

Google Content Management

- Web information, marketing campaigns or social media.
- Personalized for individual users or groups.
- Google Cloud Platform (GCP) components and services to create a Content Management system.
- Google Load Balancer to support traffic routed to multiple zones for high availability.
- Google's Cloud DNS provides a robust DNS manages the domain.
- Static content → Cloud Storage
- Dynamic content → Cloud SQL implementation.

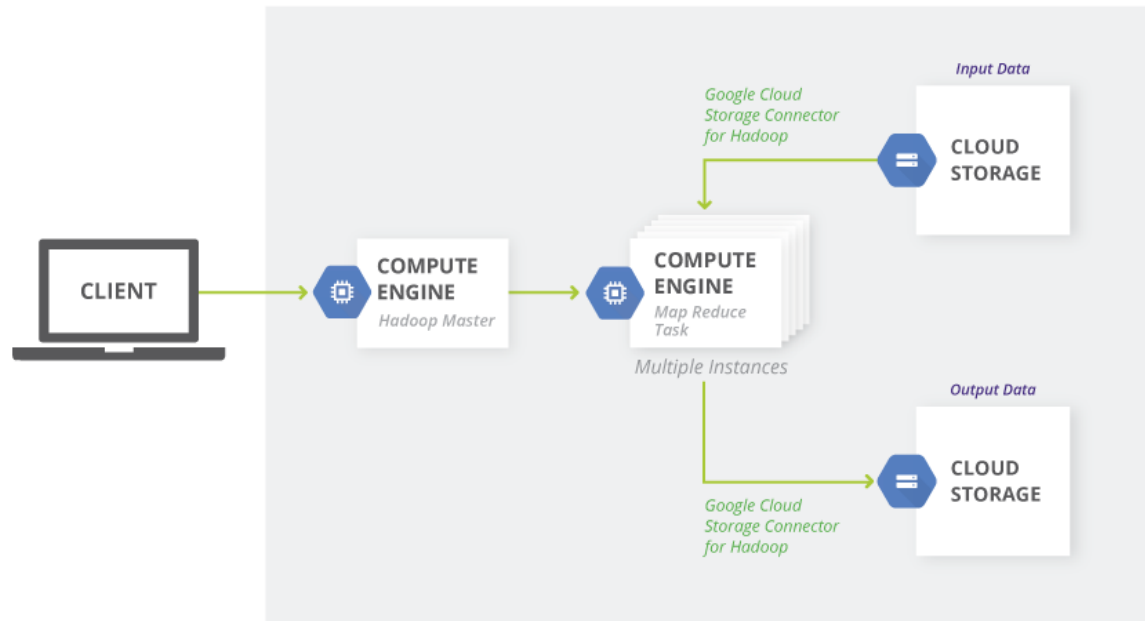
Google Content Management



Architecture: Hadoop on Google Cloud Platform

- Infrastructure for MapReduce using Hadoop.
- Compute power and Cloud Storage to store the input and output of the MapReduce jobs.
- Hadoop Master: includes the HDFS NameNode and the MapReduce JobTracker.
- Nodes in the cluster will run MapReduce tasks with DataNode and MapReduce TaskTracker.
- Backing-up the storage through Google Cloud Storage Connector for Hadoop. HDFS, can be used, Google's Cloud Storage.

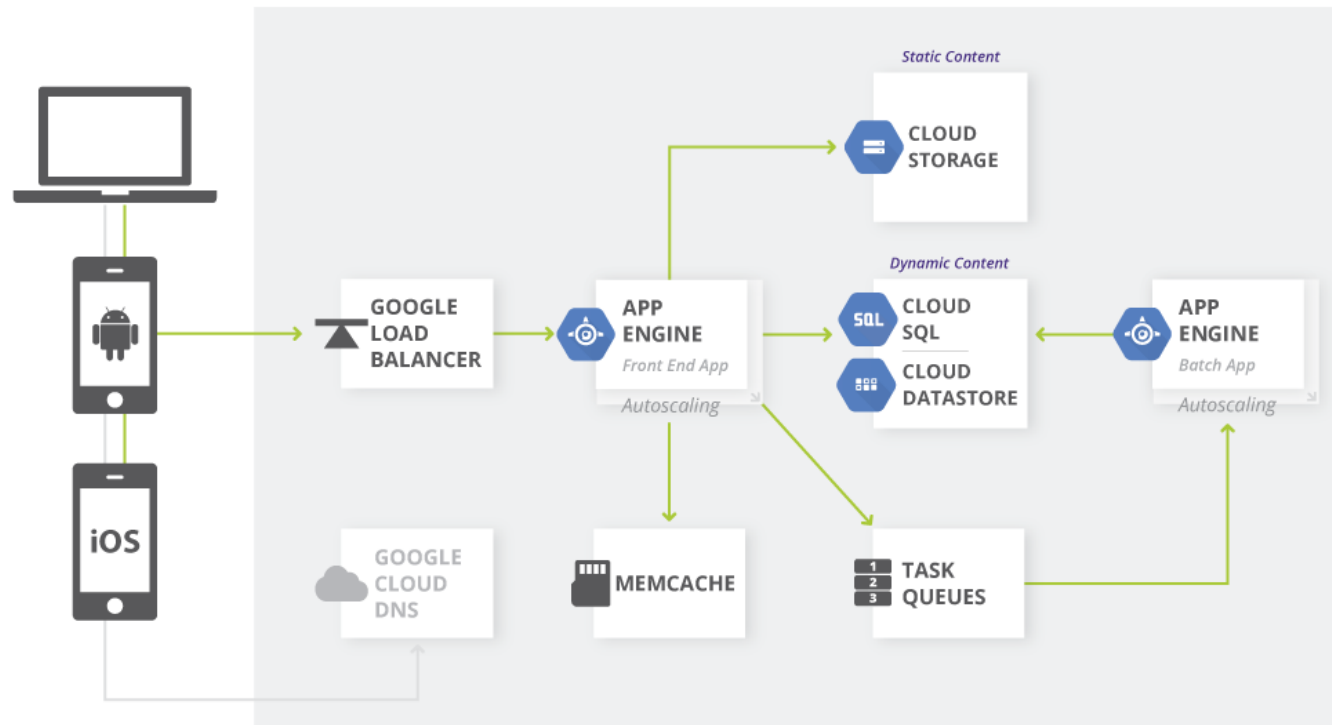
Architecture: Hadoop on Google Cloud Platform



Architecture: Web Application on Google App Engine

- Simple development and deployment of Web Applications with autoscaling compute power as well as the integrated features like distributed in-memory cache, task queues and datastore, to create robust applications quickly and easily.
- For applications written in Java, Python, PHP and Go.
- Supports multiple application versions which support A/B testing.
- Memcache is an in-memory cache to provide extremely high speed access to information cached by the web server (e.g. authentication or account information).
- Task Queues provide a mechanism to offload longer running tasks to backend servers, freeing the front end servers to service new user requests.
- Google Load Balancer which provides transparent load balancing to applications.
- Google's Cloud DNS is used to manage DNS domain of user.

Architecture: Web Application on Google App Engine



Google Web Tool - Kit

- GWT gives us API to design rich web applications.
- GWT is a Swing-like Java framework. Developer can write web application without writing HTML or JavaScript code.
- GWT is a development environment similar to any Web-Server-Code or Desktop-app development environment.
- GWT helps to debug, re-factor and unit test a Web-Client.
- GWT provides a so-called hosted mode, that allows developers to debug Java code, as well as a web mode which executes the GWT-generated JavaScript code.
- **Google uses GWT for its Sites:** Google Docs, Google AdSense, Google Wallet
- **Other Sites:** gogrid.com, Scenechronize, Google Moderator, Whirled. See more at <http://gwtgallery.appspot.com/>

ขอบคุณ

Thai

Grazie
Italian

תודה רבה
Hebrew

Gracias

Спасибо

Russian

Spanish

Thank You

شكراً

Arabic

Obrigado

Portuguese

English

多謝

Traditional
Chinese

Merci

French

Danke

German

多谢

Simplified
Chinese

धन्यवाद

Hindi

நன்றி

Tamil

Tamil

ありがとうございました

Japanese

감사합니다

Korean