Factors Driving Cloud Adoption

Patrick Chanezon
Developer Relations Manager, Cloud & Apps
chanezon@google.com
http://twitter.com/chanezon

C4I AFCEA Symposium
May 23 2010

P@ in a slide

accenture

AOL

Sun microsystems

Google™

- Software Plumber, mix of Enterprise and Consumer
  - 18 years writing software, backend guy with a taste for javascript
  - 2 y Accenture (Notes guru), 3 y Netscape/ AOL (Servers, Portals), 5 y Sun (ecommerce, blogs, Portals, feeds, open source)
- 6 years at Google, API guy (first hired, helped start the team)
  - Adwords, Checkout, Social, HTML5, Cloud

P@ & Military Software

1993 - Software metrics Dod-Std-2167A

THOMSON-CSF

THALES

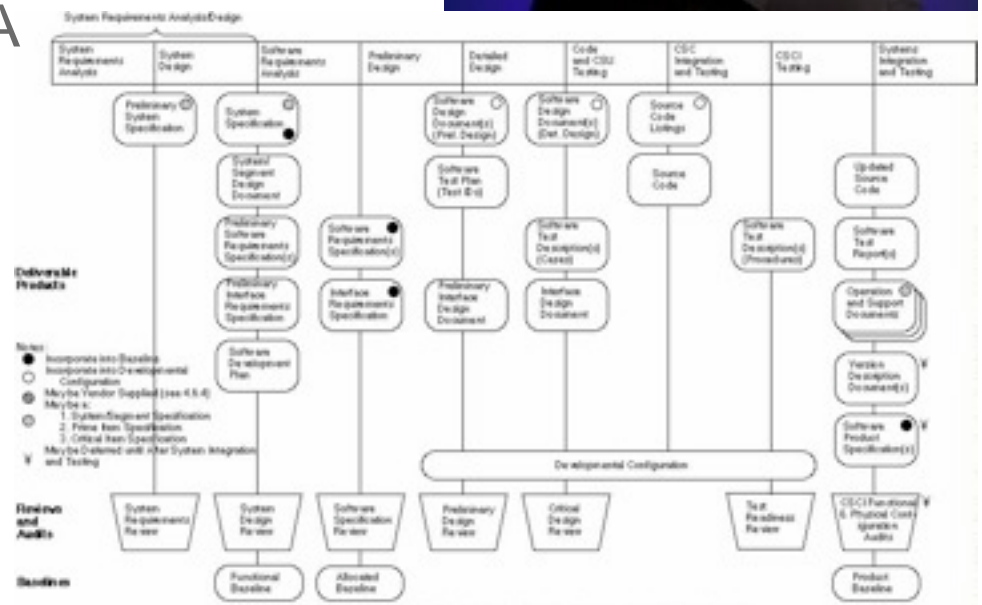


Figure 1-9 DoD-Std-2167A Deliverable Products, Reviews, Audits, and Baselines

1994 - C3I

MINISTÈRE DE LA DÉFENSE

DGA

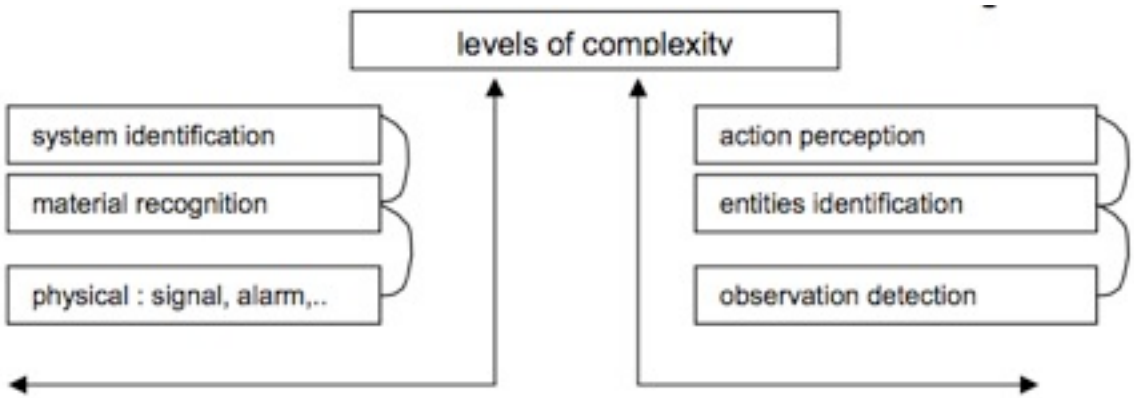
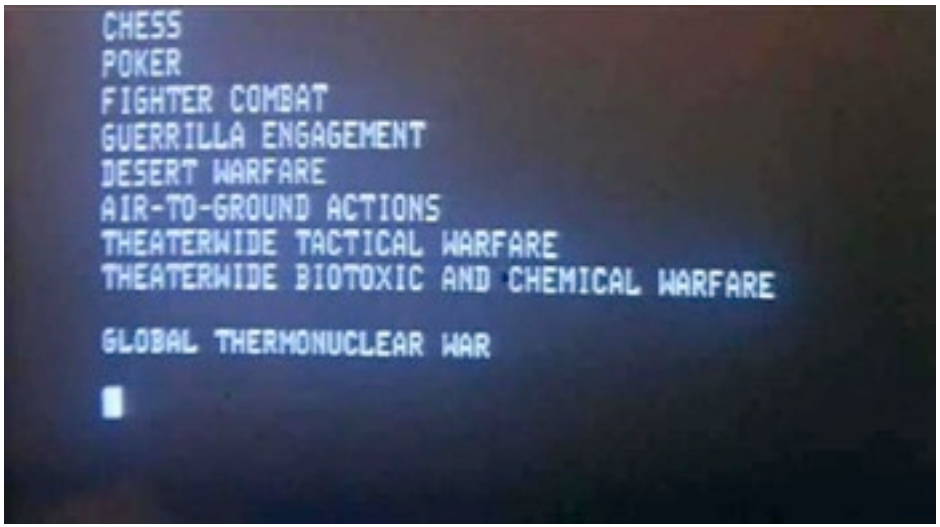


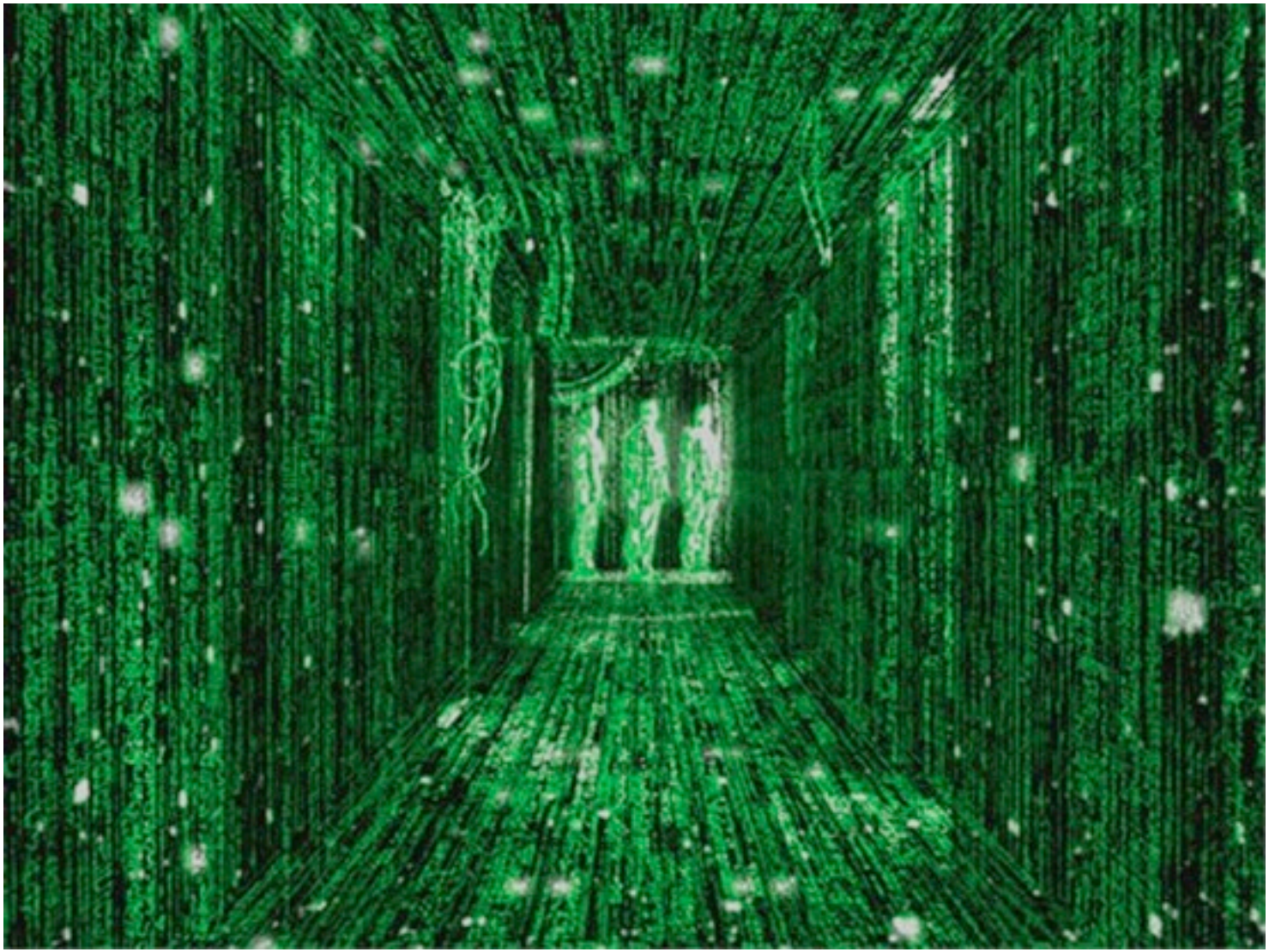
Fig. 1 semantics information complexity

Architecture Changes: 60's Mainframe

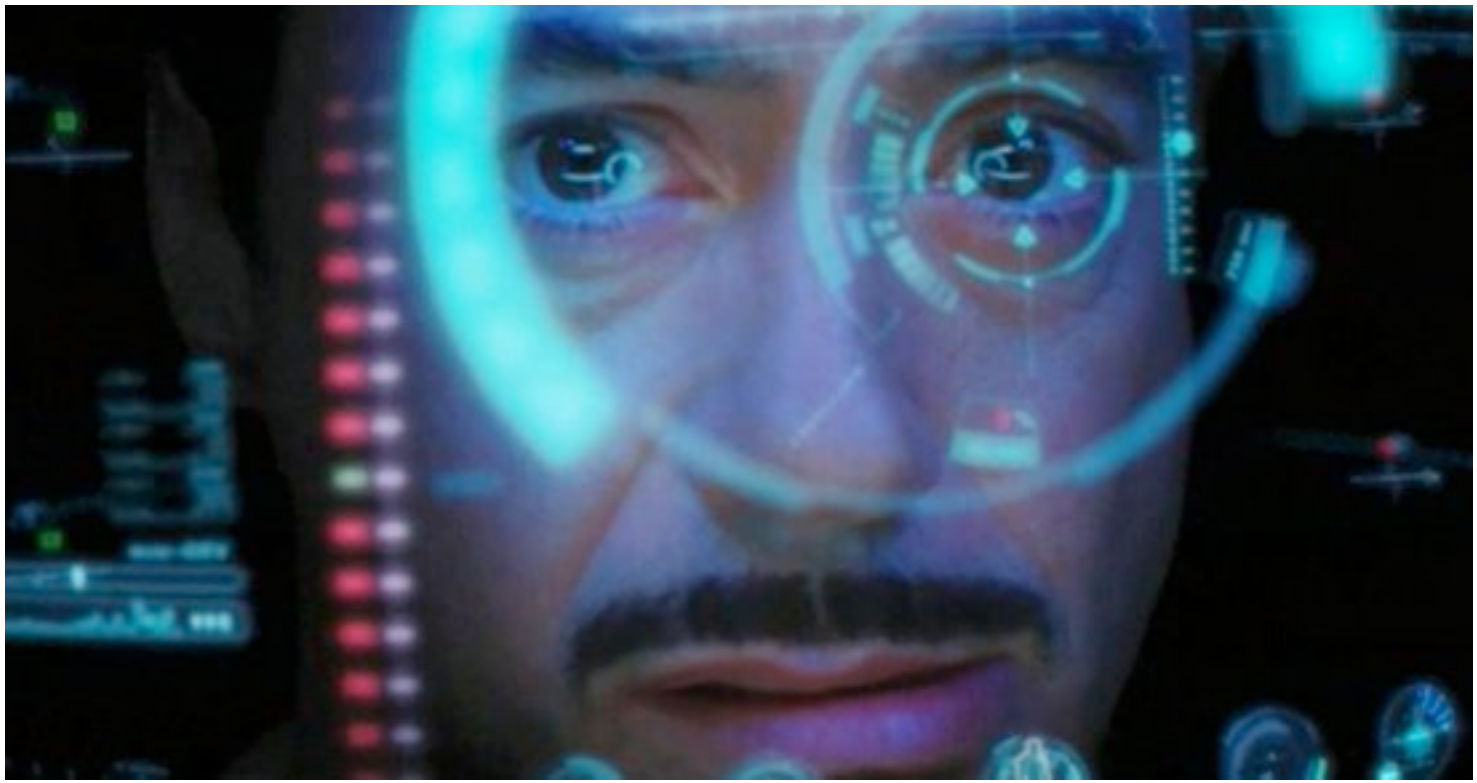
Architecture Changes: 80's Client-Server



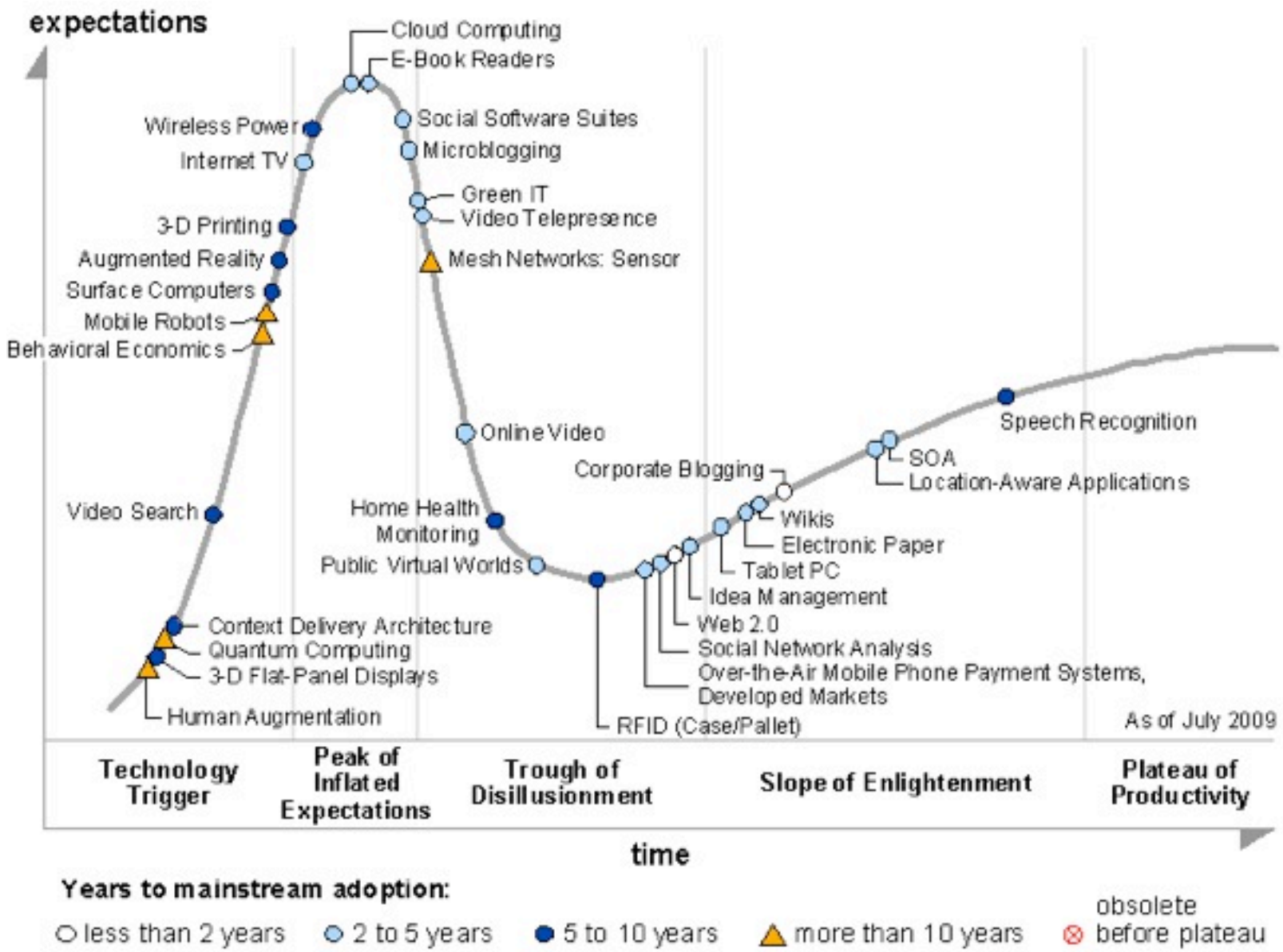
Architecture Changes: 90’s Web



Architecture Changes: 2010's Cloud, HTML5, Mobile



Hype warning: Cloudy, with a chance of real innovation

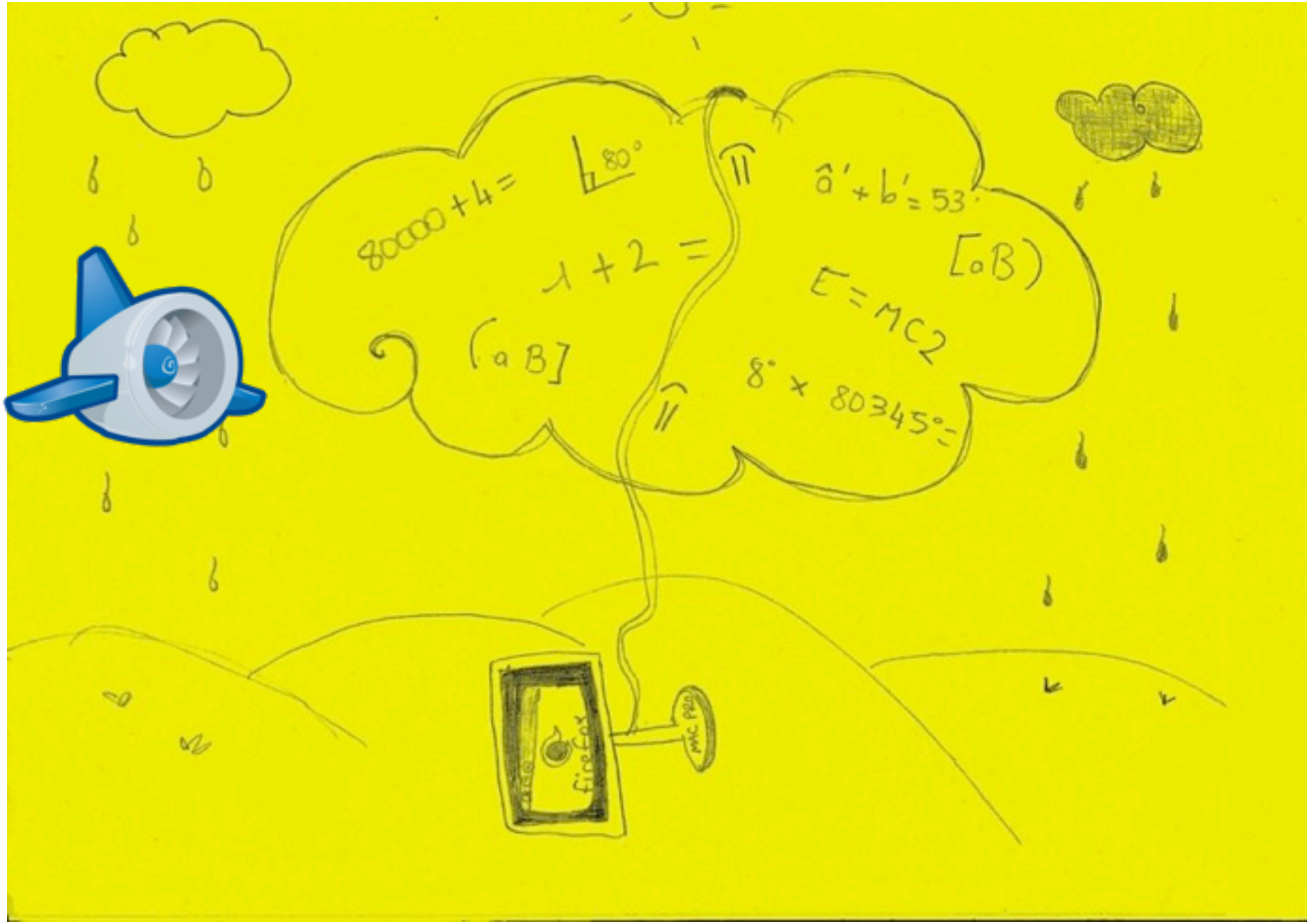


Source: Gartner (August 2009)

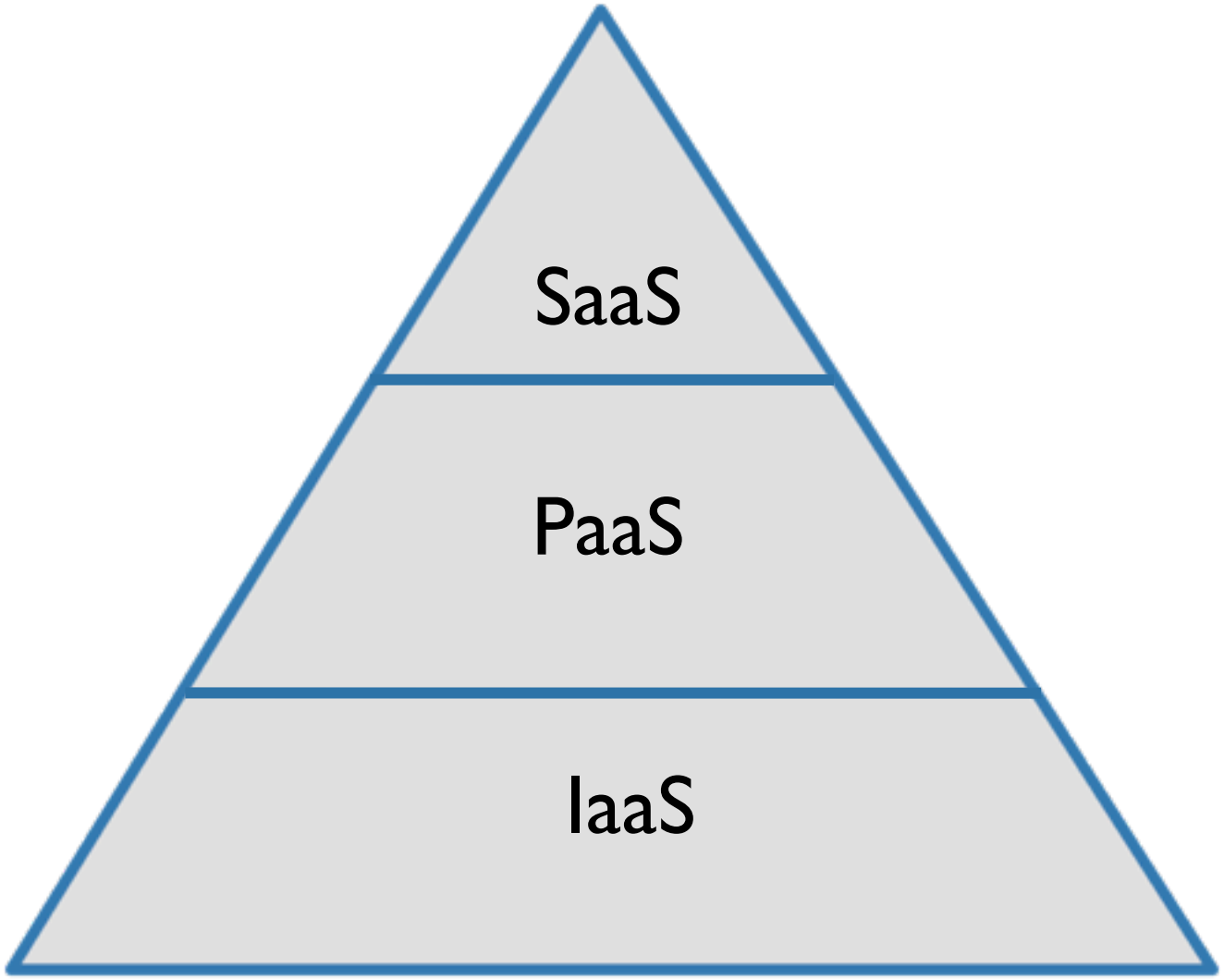
Cloud started at Consumer websites solving their needs

- Google, Amazon, Yahoo, Facebook, Twitter
- Large Data Sets
- Storage Capacity growing faster than Moore's Law
- Fast Networks
- Horizontal -> Vertical scalability
- Open Source Software
- Virtualization
- Cloud is a productization of these infrastructures
  - Public Clouds Services: Google, Amazon
  - Open Source Software: Hadoop, Eucalyptus, Cloud Foundry

Cloud, according to my daughter

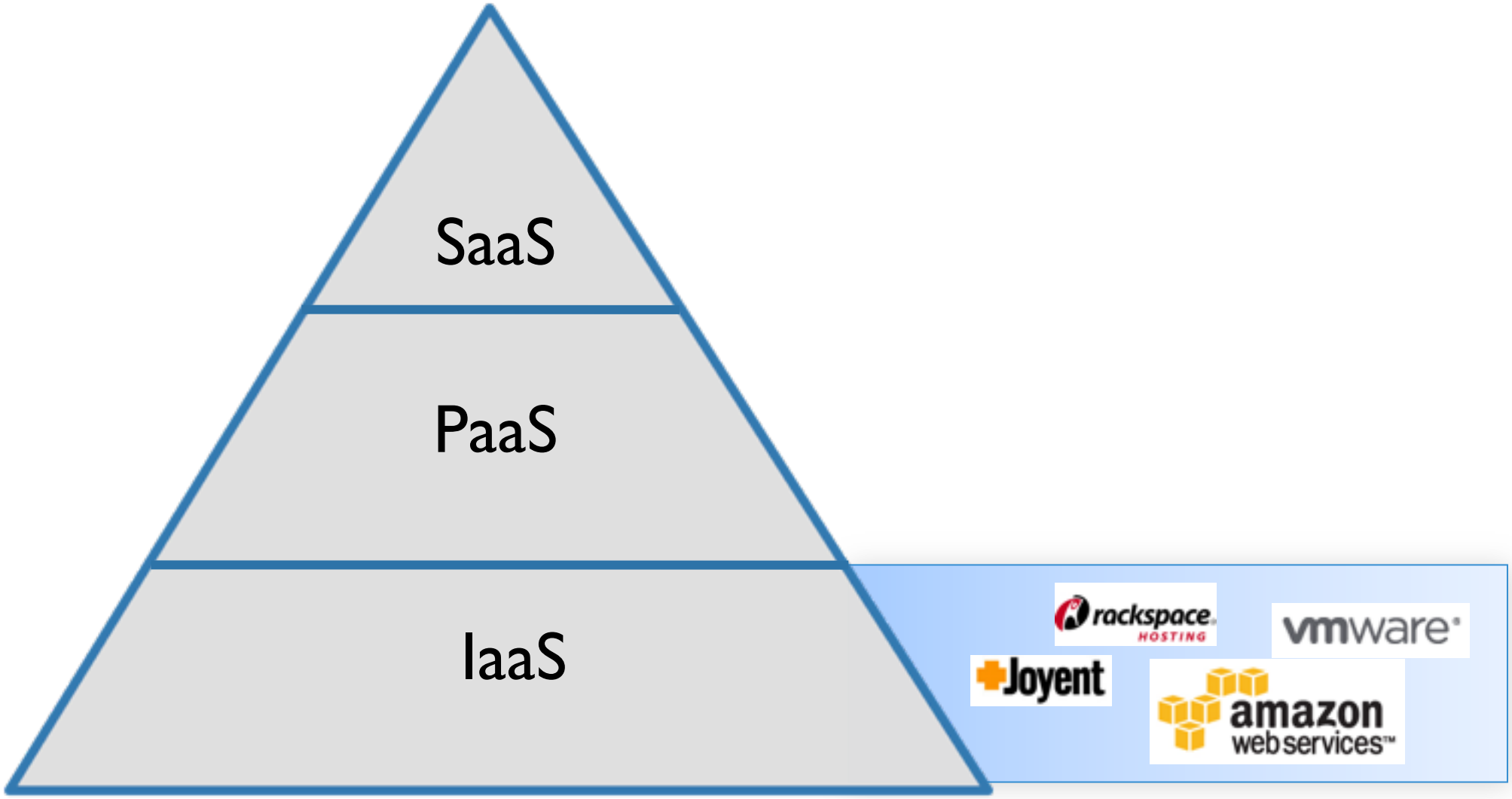


Cloud Computing Categories



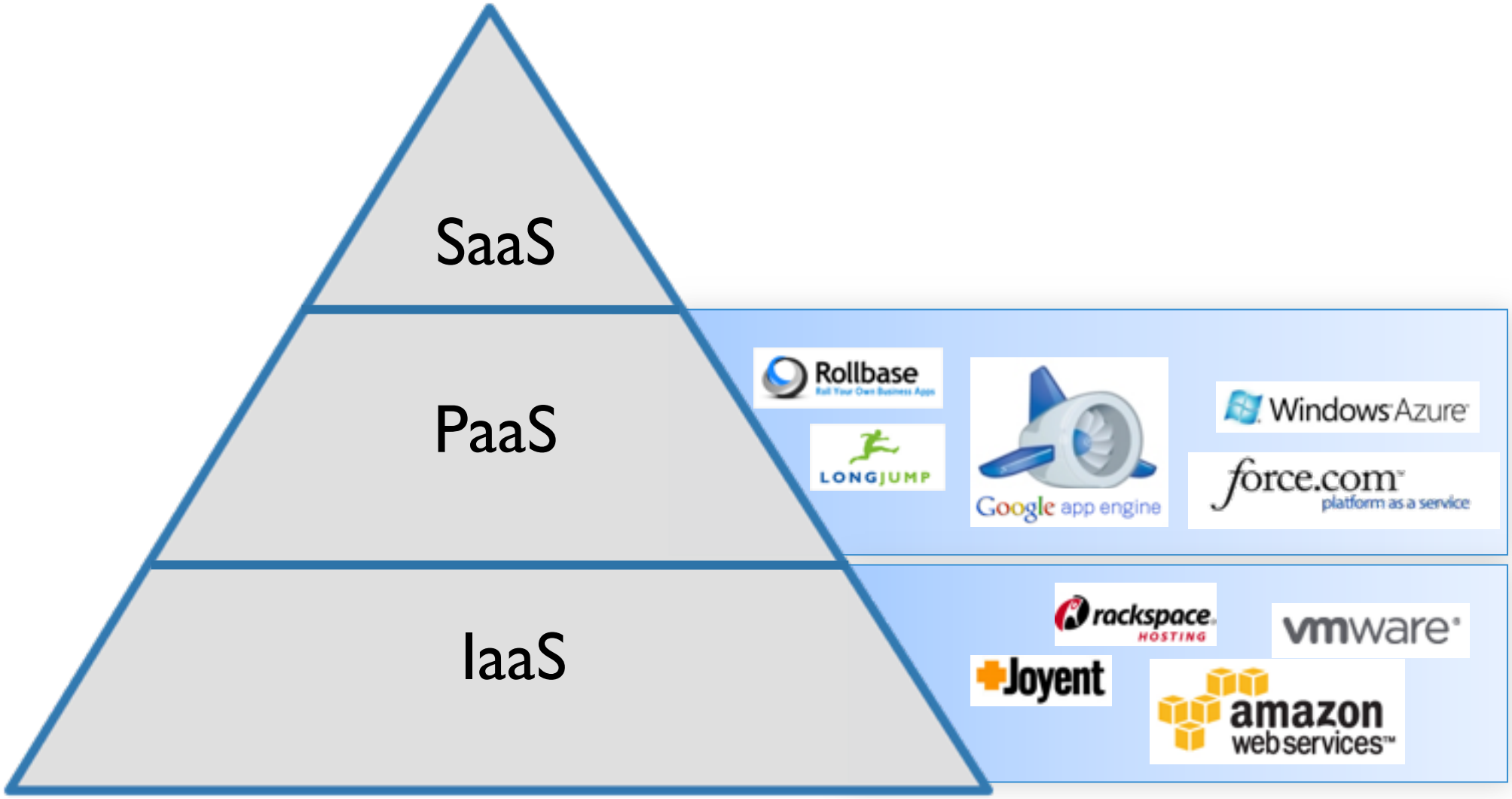
Source: Gartner AADI Summit Dec 2009

Cloud Computing Categories



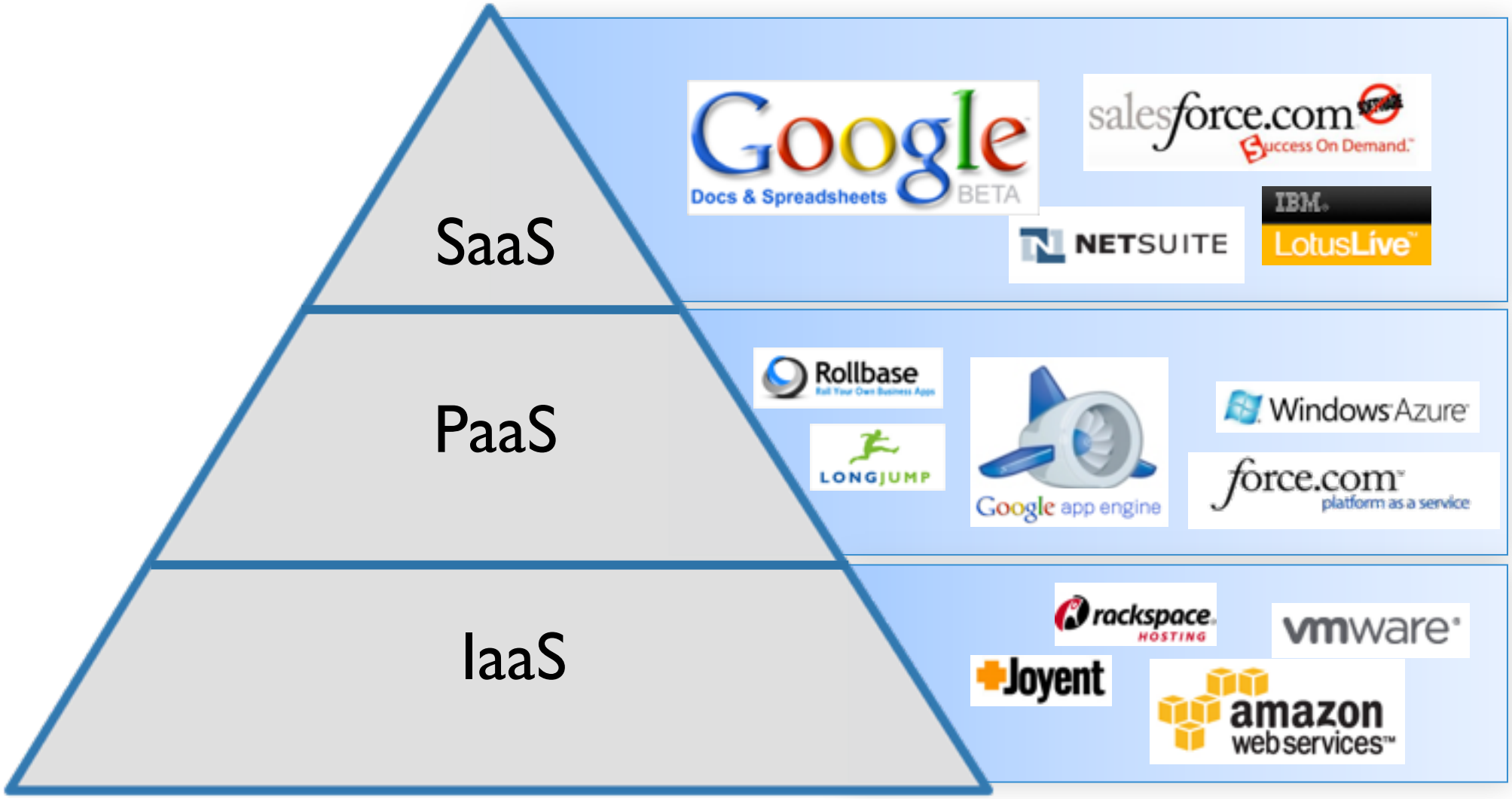
Source: Gartner AADI Summit Dec 2009

Cloud Computing Categories



Source: Gartner AADI Summit Dec 2009

Cloud Computing Categories



Source: Gartner AADI Summit Dec 2009

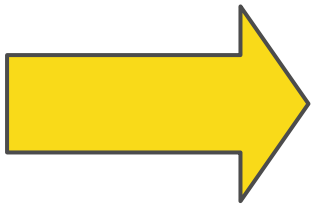
Infrastructure culture

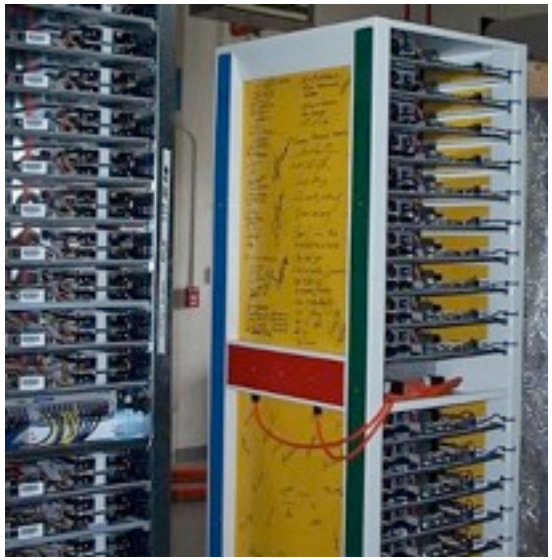
- Larry and Serguey's 1998 paper "The Anatomy of a Large-Scale Hypertextual Web Search Engine"
  - http://infolab.stanford.edu/~backrub/google.html
- Other Google Research papers since then
  - http://research.google.com/pubs/papers.html
- Build on the shoulders of giants
- Custom stack made of standards parts: machines, linux, servers
- Standard infrastructure: sharding, GFS, MapReduce, BigTable
- Google App Engine: easy cloud, for Googlers and others developers
- Standard languages: c/c++, java, python
- Horizontal scalability: parallel and asynchronous whenever possible

Programming the Cloud – The Google Way

- Fault tolerant distributed storage: Google File System
- Distributed shared memory: Bigtable
- New programming abstractions: MapReduce
- Domain Specific Languages: Sawzall

Google.stanford.edu (Circa 1997)





Current Rack Design

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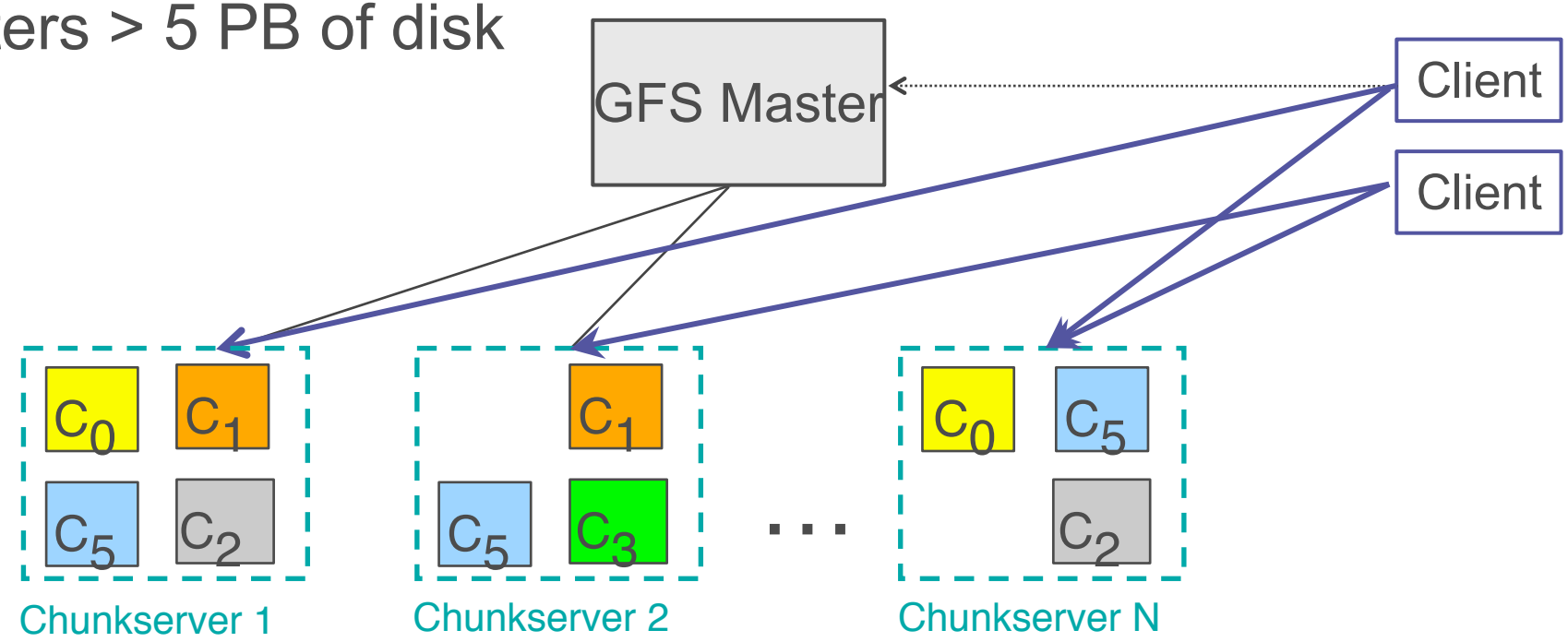
Fault Tolerant Distributed Disk Storage: GFS

- Data replicated 3 times. Upon failure, software re-replicates.
- Master: Manages file metadata. Chunk size 64 MB.
- Optimized for high-bandwidth sequential read / writes
- Clusters > 5 PB of disk



http://research.google.com/archive/gfs-sosp2003.pdf

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Distributed Shared Memory: Bigtable

- Sparse, distributed, persistent, multidimensional, sorted
- Not a relational database (RDBMS): no schema, no joins, no foreign key constraints, no multi-row transactions
- Each row can have any number of columns, similar to a dictionary data structure for each row.
- Basic data types: string, counter, byte array
- Accessed by row key, column name, timestamp
- Data split into tablets for replication
- Largest cells are > 700TB

http://research.google.com/archive/bigtable-osdi06.pdf

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Datastore layers

	Complex queries	Entity Group Transactions	Queries on properties	Key range scan	Get and set by key
Datastore	✓	✓	✓	✓	✓
Megastore		✓	✓	✓	✓
Bigtable				✓	✓

Megastore API

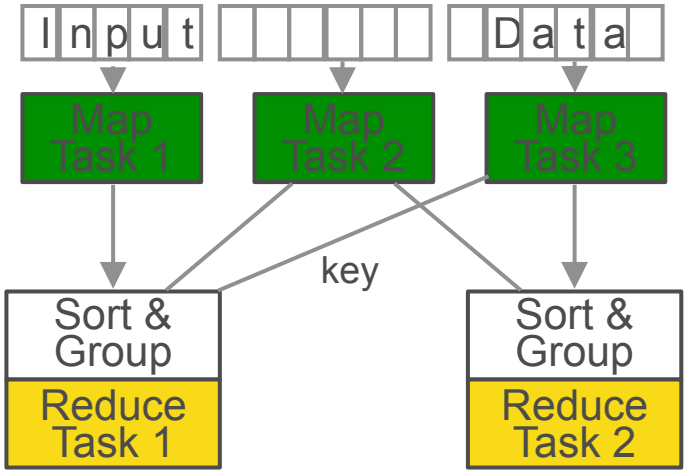
- “Give me all rows where the column ‘name’ equals ‘ikai’”
- “Transactionally write an update to this group of entities”
- “Do a cross datacenter write of this data such that reads will be strongly consistent” (High Replication Datastore)
- Megastore paper: http://www.cidrdb.org/cidr2011/Papers/CIDR11_Paper32.pdf

Programming Abstraction: MapReduce

- Represent problems as Map and Reduce step (inspired by functional programming)
- Distribute data among many machines, execute same computation at each machine on its dataset
- Infrastructure manages parallel execution
- Open source implementation: Hadoop

```
map(in_key, data)
 → list(key, value)

reduce(key, list(values))
→ list(out_data)
```



http://research.google.com/archive/mapreduce.html

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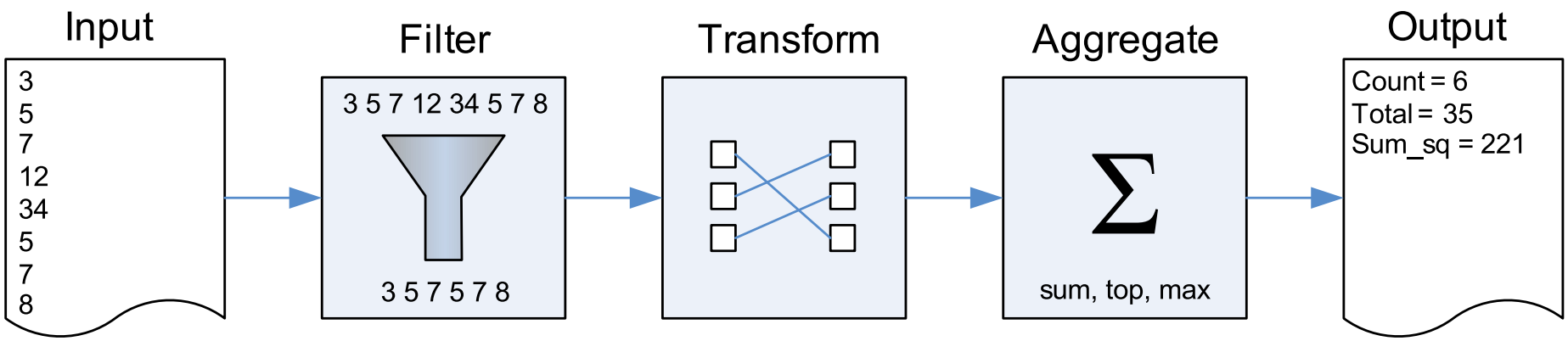
Language for Parallel Log Processing: Sawzall

- Commutative and associative operations allow parallel execution and aggregation
- Language avoids specifying order by replacing loops with quantifiers (constraints)




```
count: table sum of int;
total: table sum of float;
x: float = input;
emit count <- 1;
emit total <- x;
```

```
function(word: string): bool {
  when(i: some int;
        word[i] != word[$-1-i])
    return false;
  return true;
};
```

http://labs.google.com/papers/sawzall.html

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Internet as a Platform: The Challenges

<u>Architect's Dream</u>

- Loosely coupled
- Extensible
- Standards-based
- Fault tolerant
- Unlimited computing power
- Ubiquitous

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Internet as a Platform: The Challenges

Architect's Dream

- Loosely coupled
- Extensible
- Standards-based
- Fault tolerant
- Unlimited computing power
- Ubiquitous

Developer's Nightmare

- NO Call Stack
- NO Transactions
- NO Promises
- NO Certainty
- NO Ordering Constraints

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New Game Rules

ACID (before)

ACID (today)

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New Game Rules

ACID (before)

- Atomic

ACID (today)

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New Game Rules

ACID (before)

- Atomic
- Consistent

ACID (today)

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New Game Rules

ACID (before)

- Atomic
- Consistent
- Isolated

ACID (today)

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New Game Rules

ACID (before)

- Atomic
- Consistent
- Isolated
- Durable

ACID (today)

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New Game Rules

ACID (before)

- Atomic
- Consistent
- Isolated
- Durable

ACID (today)

- Associative

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New Game Rules

ACID (before)

- Atomic
- Consistent
- Isolated
- Durable

ACID (today)

- Associative
- Commutative

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New Game Rules

ACID (before)

- Atomic
- Consistent
- Isolated
- Durable

ACID (today)

- Associative
- Commutative
- Idempotent

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New Game Rules

ACID (before)

- Atomic
- Consistent
- Isolated
- Durable

ACID (today)

- Associative
- Commutative
- Idempotent
- Distributed

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New Game Rules

ACID (before)

- Atomic
- Consistent
- Isolated
- Durable

Predictive
Accurate

ACID (today)

- Associative
- Commutative
- Idempotent
- Distributed

Flexible
Redundant

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Starbucks Does not Use 2-Phase Commit Either

- Start making coffee before customer pays
- Reduces latency
- What happens if…

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Starbucks Does not Use 2-Phase Commit Either

- Start making coffee before customer pays
- Reduces latency
- What happens if…

Customer rejects drink

Coffee maker breaks

Customer cannot pay

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Starbucks Does not Use 2-Phase Commit Either

- Start making coffee before customer pays
- Reduces latency
- What happens if…

Customer rejects drink → Remake drink

Coffee maker breaks

Customer cannot pay

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Starbucks Does not Use 2-Phase Commit Either

- Start making coffee before customer pays
- Reduces latency
- What happens if…

Customer rejects drink → Remake drink

Coffee maker breaks → Refund money

Customer cannot pay

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Starbucks Does not Use 2-Phase Commit Either

- Start making coffee before customer pays
- Reduces latency
- What happens if…

Customer rejects drink → Remake drink

Coffee maker breaks → Refund money

Customer cannot pay → Discard beverage

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Starbucks Does not Use 2-Phase Commit Either

- Start making coffee before customer pays
- Reduces latency
- What happens if…

Customer rejects drink	→	Remake drink Retry
Coffee maker breaks	→	Refund money
Customer cannot pay	→	Discard beverage

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Starbucks Does not Use 2-Phase Commit Either

- Start making coffee before customer pays
- Reduces latency
- What happens if…

Customer rejects drink	→	Remake drink Retry
Coffee maker breaks	→	Refund money Compensation
Customer cannot pay	→	Discard beverage

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Starbucks Does not Use 2-Phase Commit Either

- Start making coffee before customer pays
- Reduces latency
- What happens if…

Customer rejects drink	→	Remake drink Retry
Coffee maker breaks	→	Refund money Compensation
Customer cannot pay	→	Discard beverage Write-off

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Commoditization of distributed computing concepts & tools

- Languages: Erlang concepts -> Go, Scala
- NoSQL Zoo: BigTable, HBase, MongoDB, Reddis, Cassandra
- Map/Reduce: Apache Hadoop
- Paxos, Eventual Consistency, CAP Theorem
- REST, statelessness, idempotency

Economic Drivers

- Proportion of electricity in cost of computing
- Product -> Service
- Economies of Scale
- Moore’s Law
- Pay as you go utility model

Cultural Drivers

- Expectations of corporate IT customers have changed
- Consumerization of IT
- Consumer apps more and more like fashion
- Technology achieves ubiquity by disappearing

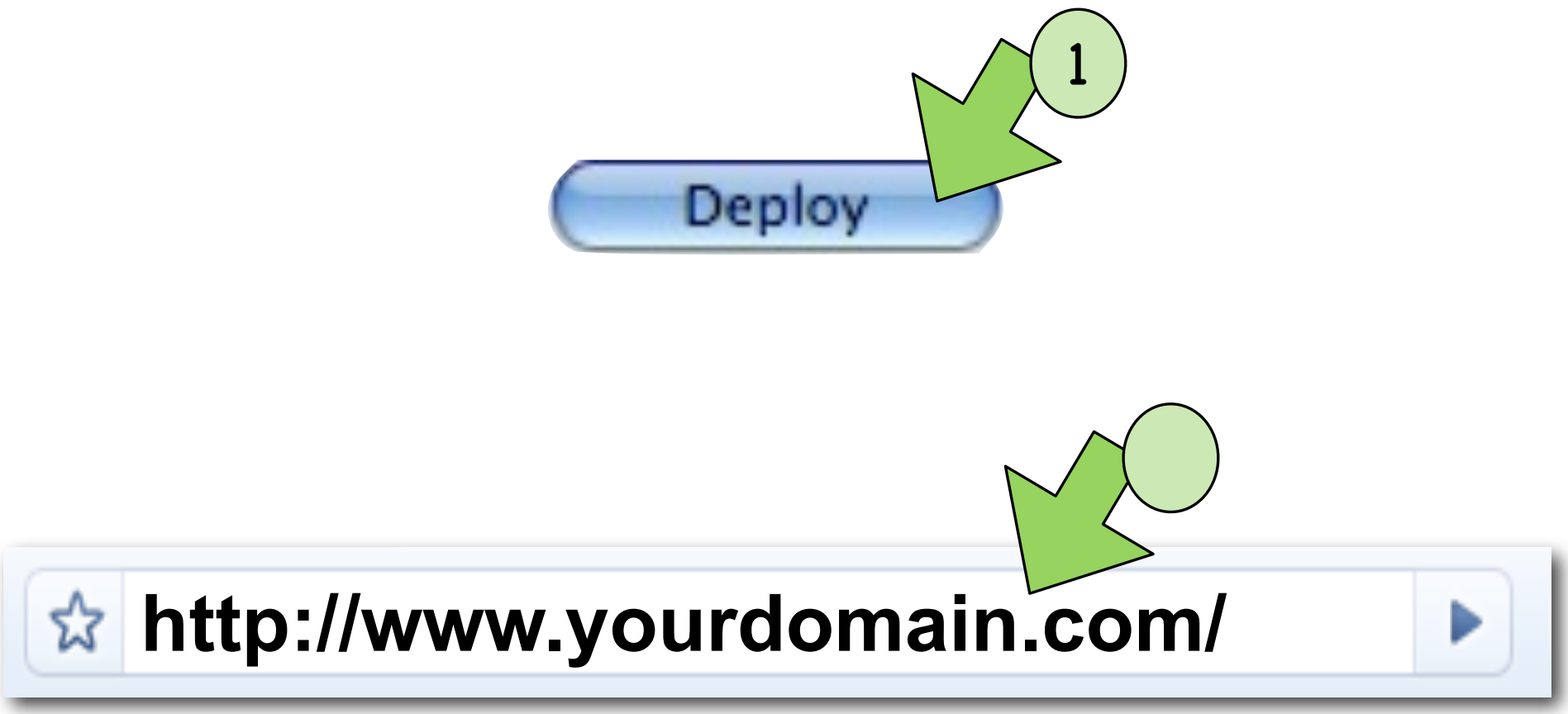
Access from Anywhere

Scales Up, Scales Down, with Demand

Innovation Not Administration

Cultural Drivers: Agility

- Waterfall -> Agile methodologies
- Cloud enables an Agile culture, driver for innovation



Fail often, fail quickly, and learn

Fail often, fail quickly, and learn

- Risk taking/Experimentation is encouraged
  - http://blog.red-bean.com/sussman/?p=96
- “Do not be afraid of day-to-day failures — learn from them. (As they say at Google, “don’t run from failure — fail often, fail quickly, and learn.”) Cherish your history, both the successes and mistakes. All of these behaviors are the way to get better at programming. If you don’t follow them, you’re cheating your own personal development.”
- Ben Collins-Sussman (Subversion, code.google.com)

Agile Development Processes

Agile Development Processes

- Influences from XP, Agile, Scrum
- Code reviews
- Test Driven Development: Testing on the Toilets program and blog
- Many internal development tools: Mondrian recently open sourced
- Changed the meaning of beta
- Teams co-located: 3-15 people, 4/cubicle, all close to each other
- International offices: manage whole projects, avoid coordination costs

Open Source Culture

Open Source Culture

- Open Source Program Office
- Summer of Code
- Open sourcing parts of Google code
  - http://code.google.com/
- Making the web better: GWT, Gears, OpenSocial, Android

API Culture

API Culture

- Bill Joy: "Innovation happens elsewhere"
- From 3 to 62 APIs in 3 years
- Maps on websites
- Friend Connect: all sites can become social
  - http://code.google.com/ for the list
- Build an ecosystem around the APIs (my job)
- User's choice: get their data out

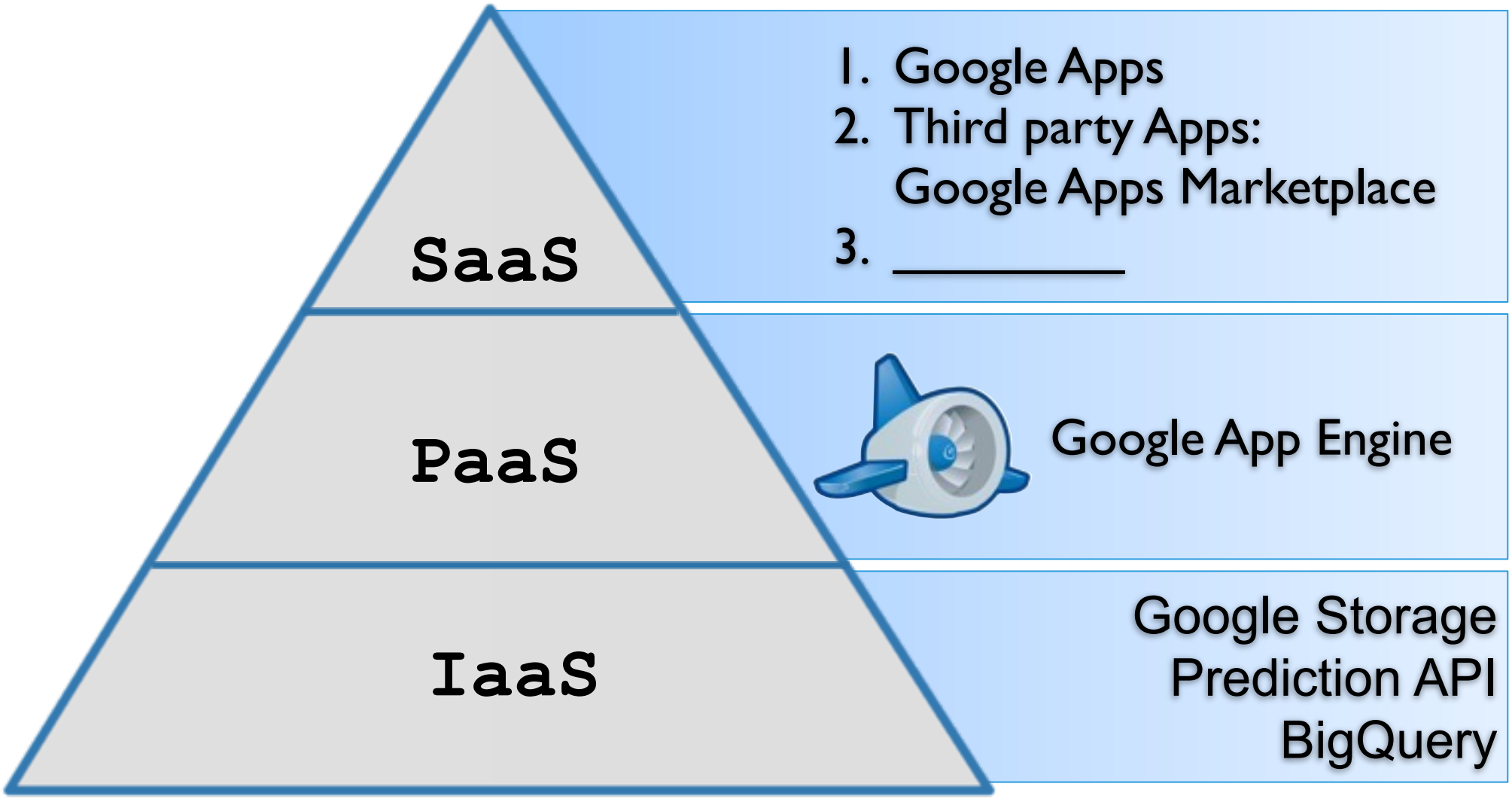
Data Liberation Front

http://www.dataliberation.org/

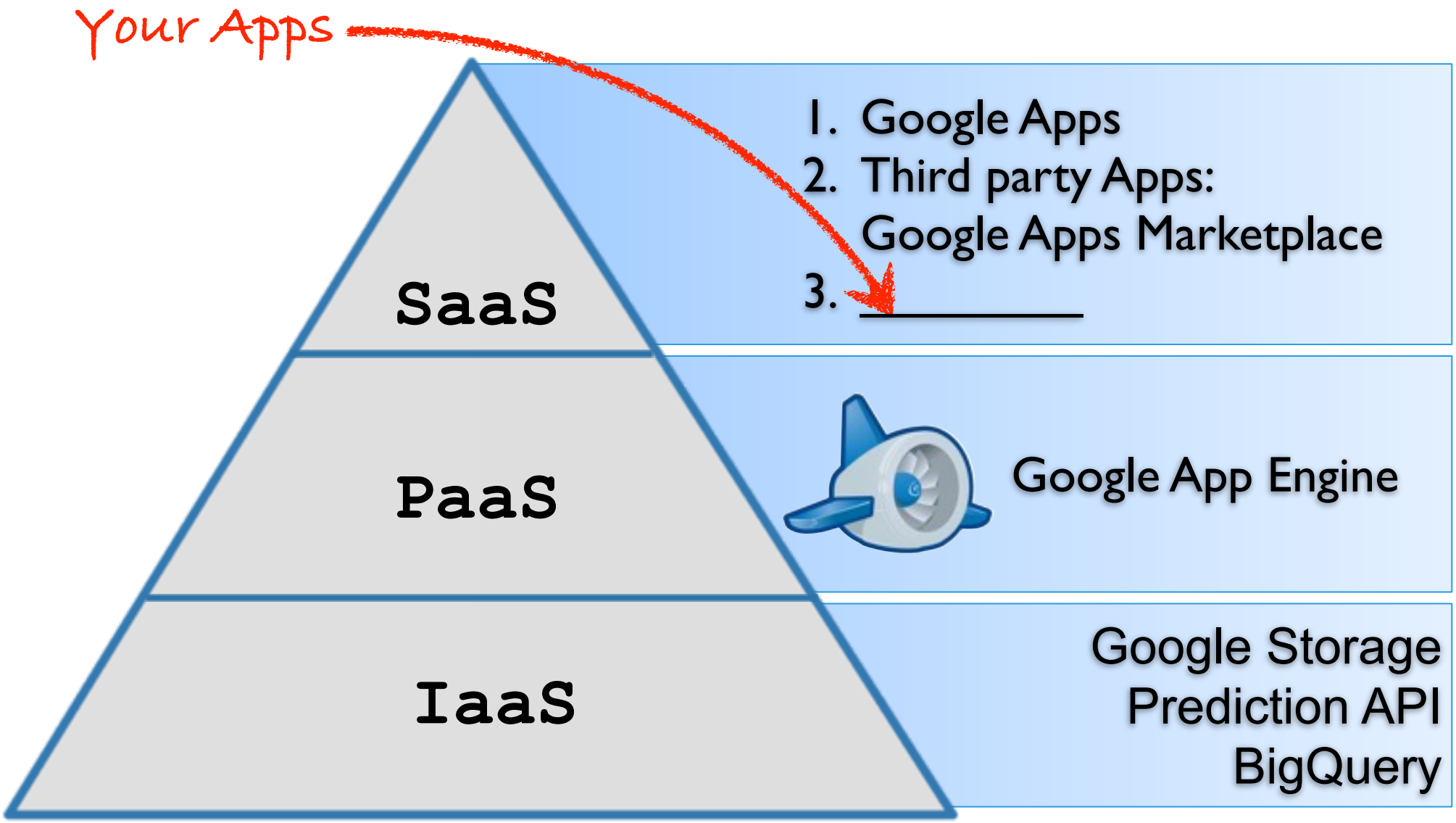
Users should be able to control the data they store in any of Google's products. Our team's goal is to make it easier to move data in and out.

Google Cloud Products

Google's Cloud Offerings



Google's Cloud Offerings



How Google Apps Adds Value

Productivity and Innovation

Realtime collaboration, constant updates, new features

Platform Independence

Work anywhere from any computer or mobile device

Reduced IT Complexity

Least complex, least expensive to license and manage

How Google Apps Adds Value

Security and Availability

Same uptime and infrastructure used for Google products

Built-in Enterprise Security Features

2-Factor Authentication, Single Sign On, Reporting Tools

How Google Apps Adds Value

Security and Availability

Same uptime and infrastructure used for Google products

Built-in Enterprise Security Features

2-Factor Authentication, Single Sign On, Reporting Tools

A Toolbox of Administrative APIs

Reporting, Compliance, Identity Management and more...

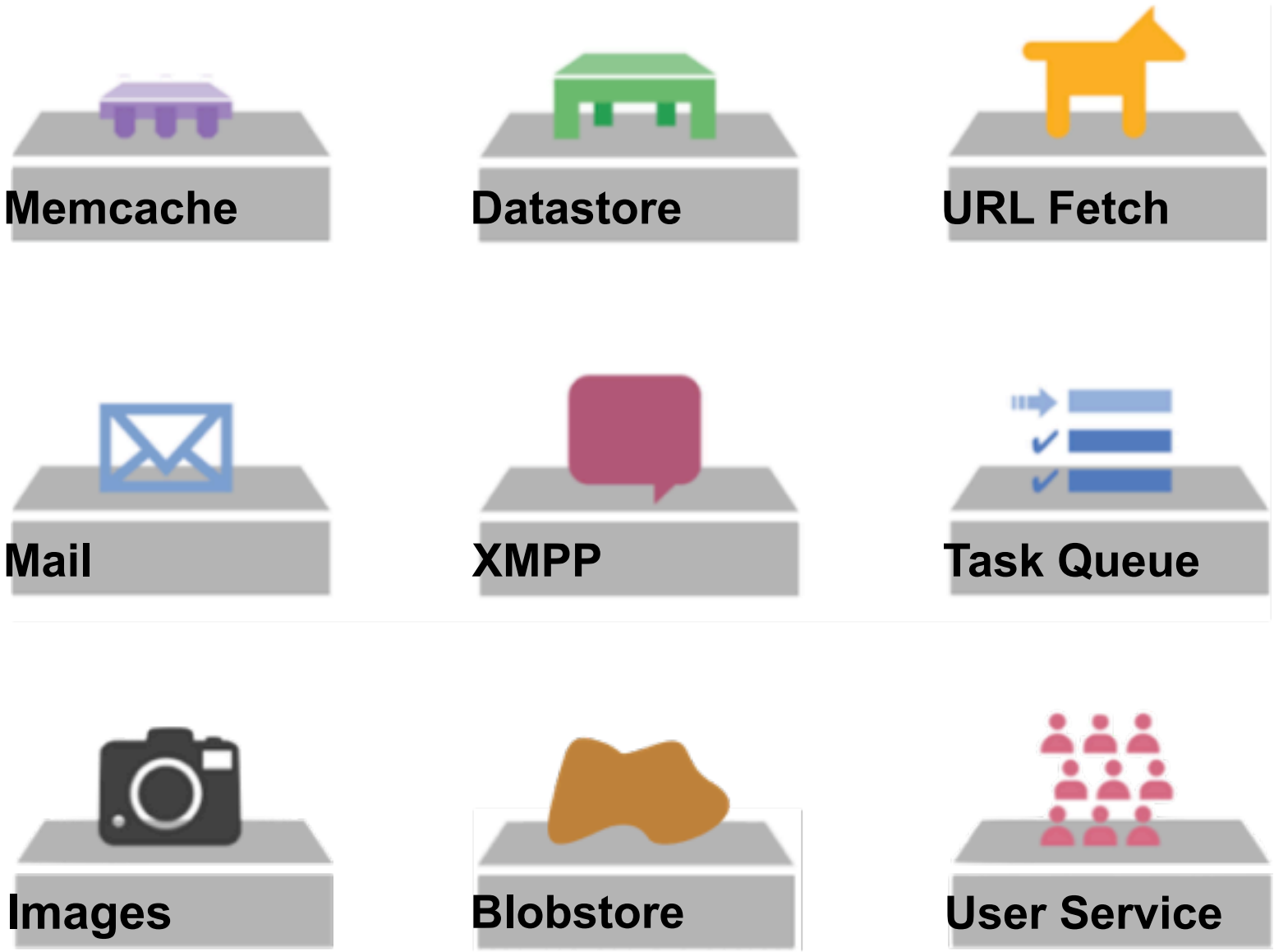
Why Google App Engine?

- Easy to build
- Easy to maintain
- Easy to scale

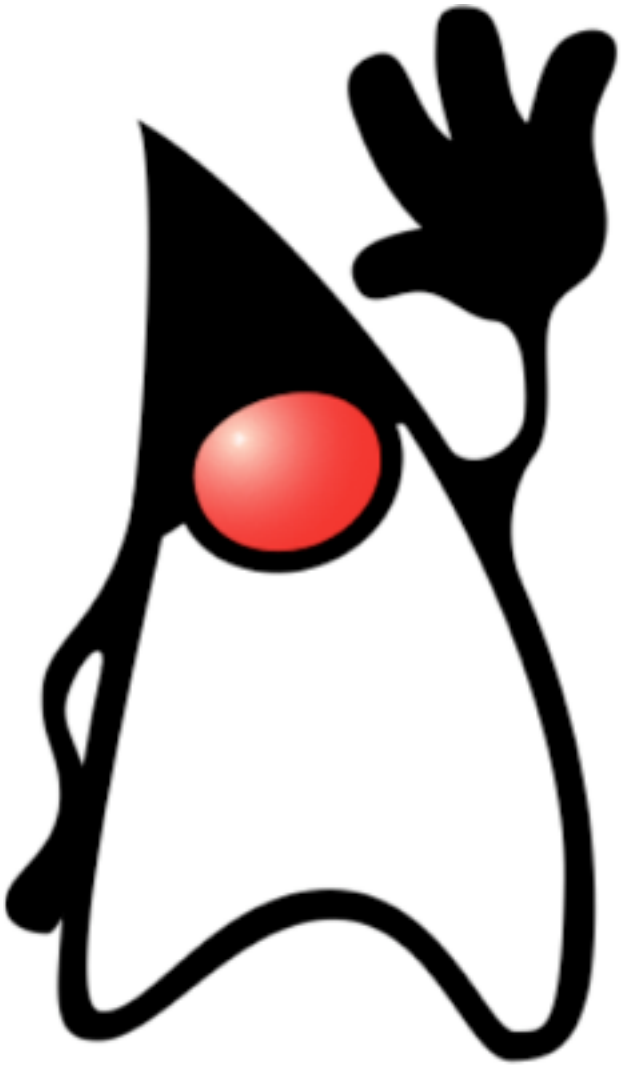
Cloud Development in a Box

- Downloadable SDK
- Application runtimes
  - Java, Python
- Local development tools
  - Eclipse plugin, AppEngine Launcher
- Specialized application services
- Cloud based dashboard
- Ready to scale
- Built in fault tolerance, load balancing

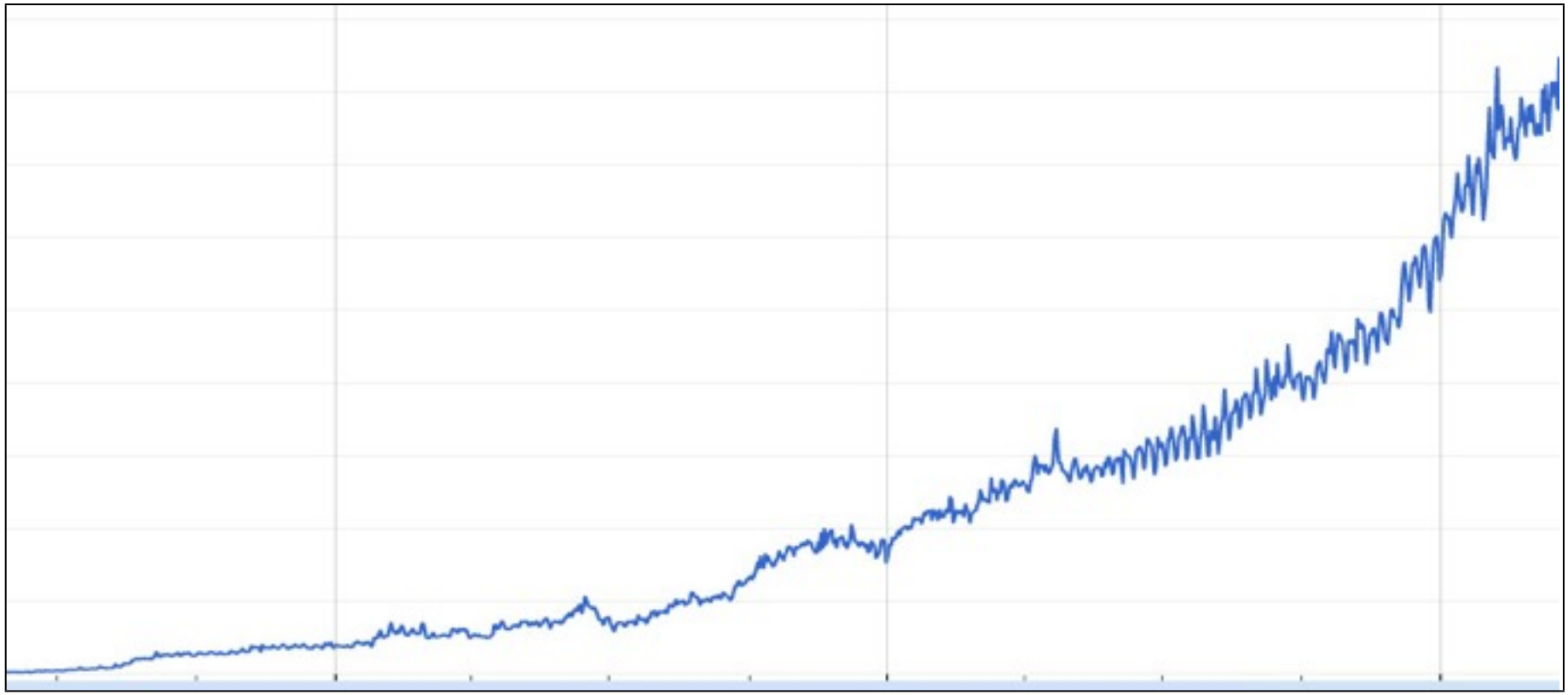
Specialized Services



Language Runtimes



App Engine Growth



2008

App Engine Launch
Python
Datastore
Memcache
logs export

2009

Batch write/read
Https
Status-Dashboard

Java
DB Import
cron

2010

Task Queues
XMPP
incoming email

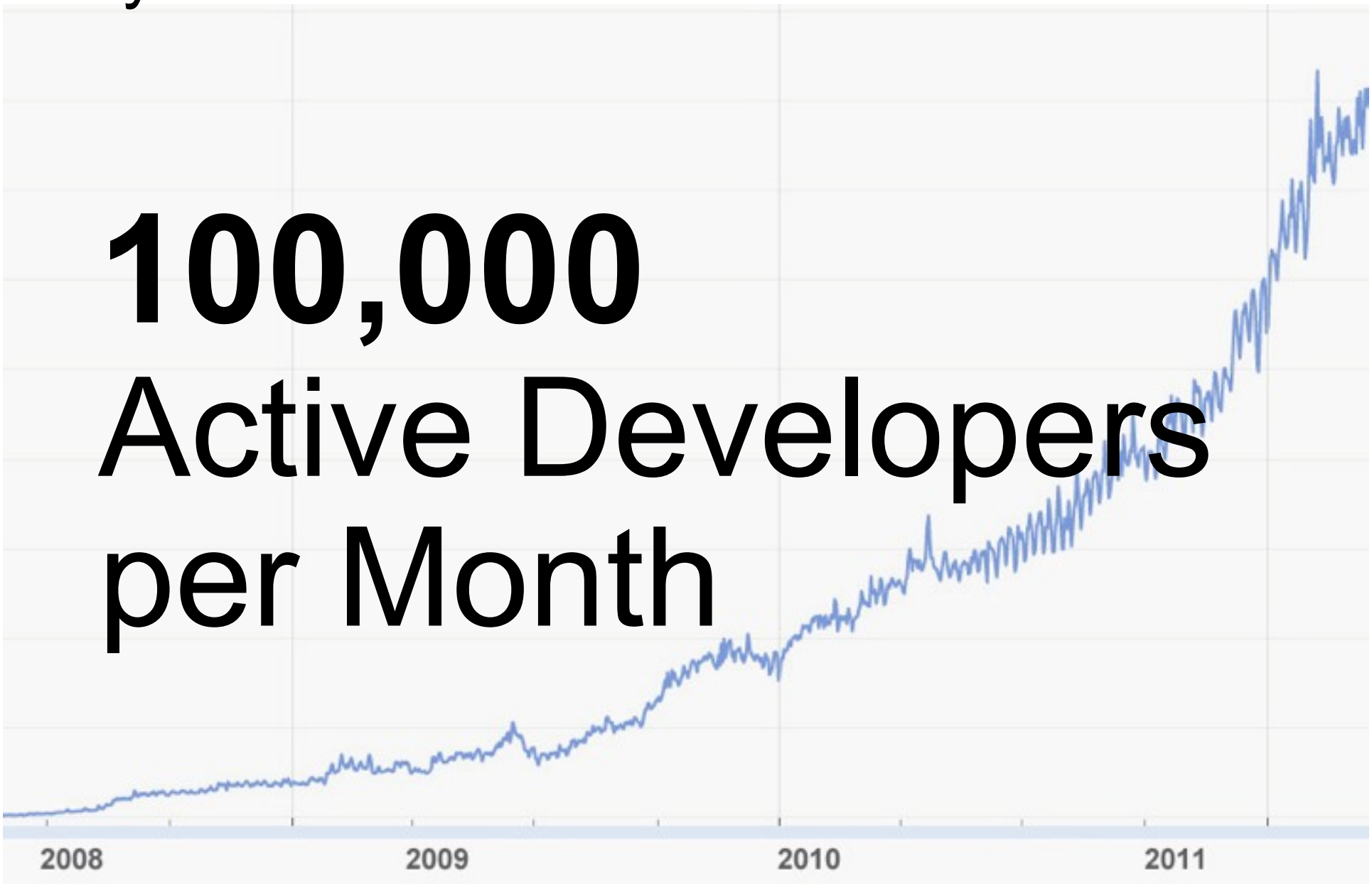
Blobstore
Appstats
cursors
Mapper

2011

Multitenancy
Instance Console
Always On
hi-perf imag
10 min tasks

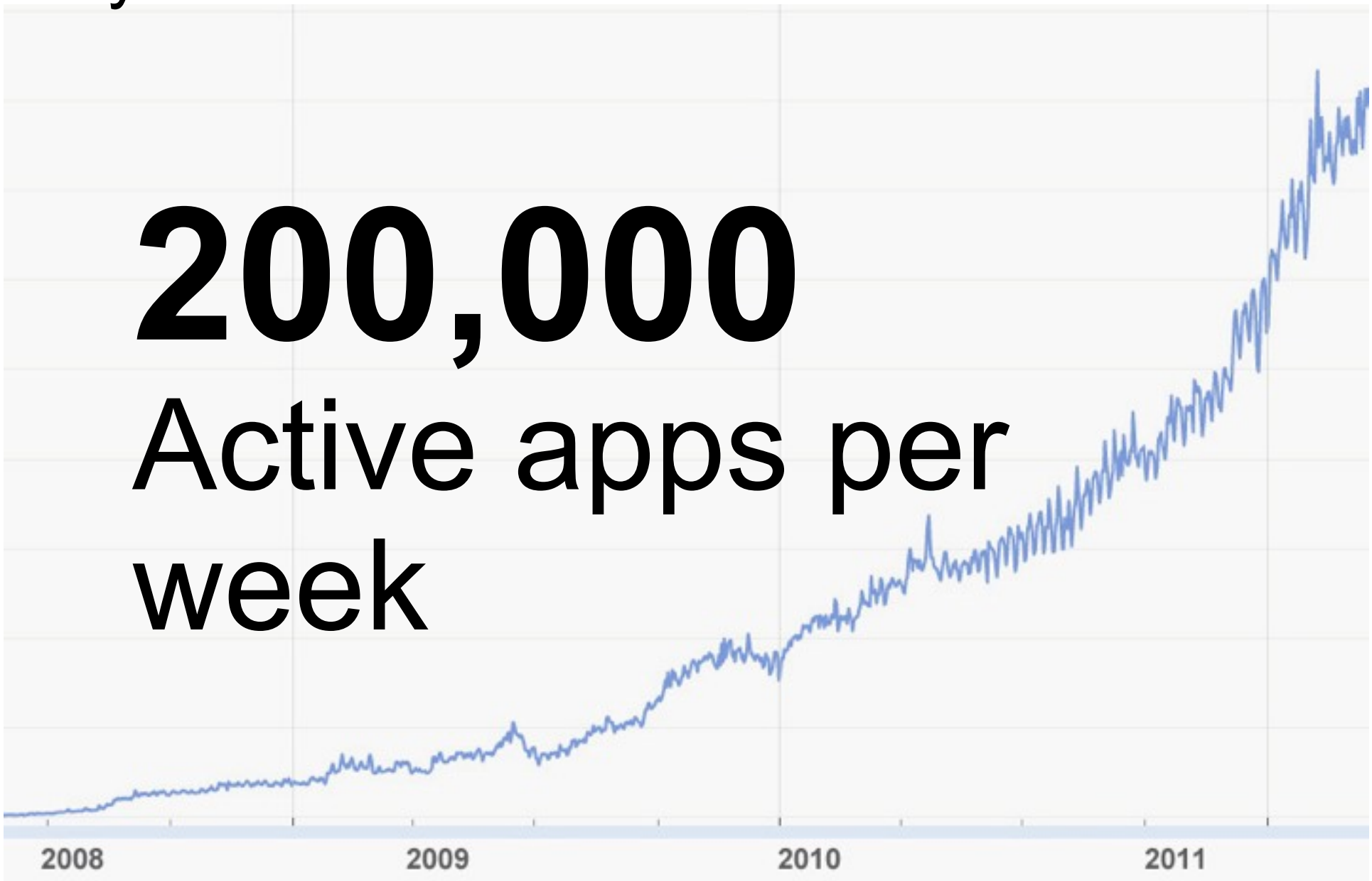
Hi-Replication
Datastore
Channel API
Files API
Remote API
Prosp Search

By the Numbers



100,000
Active Developers
per Month

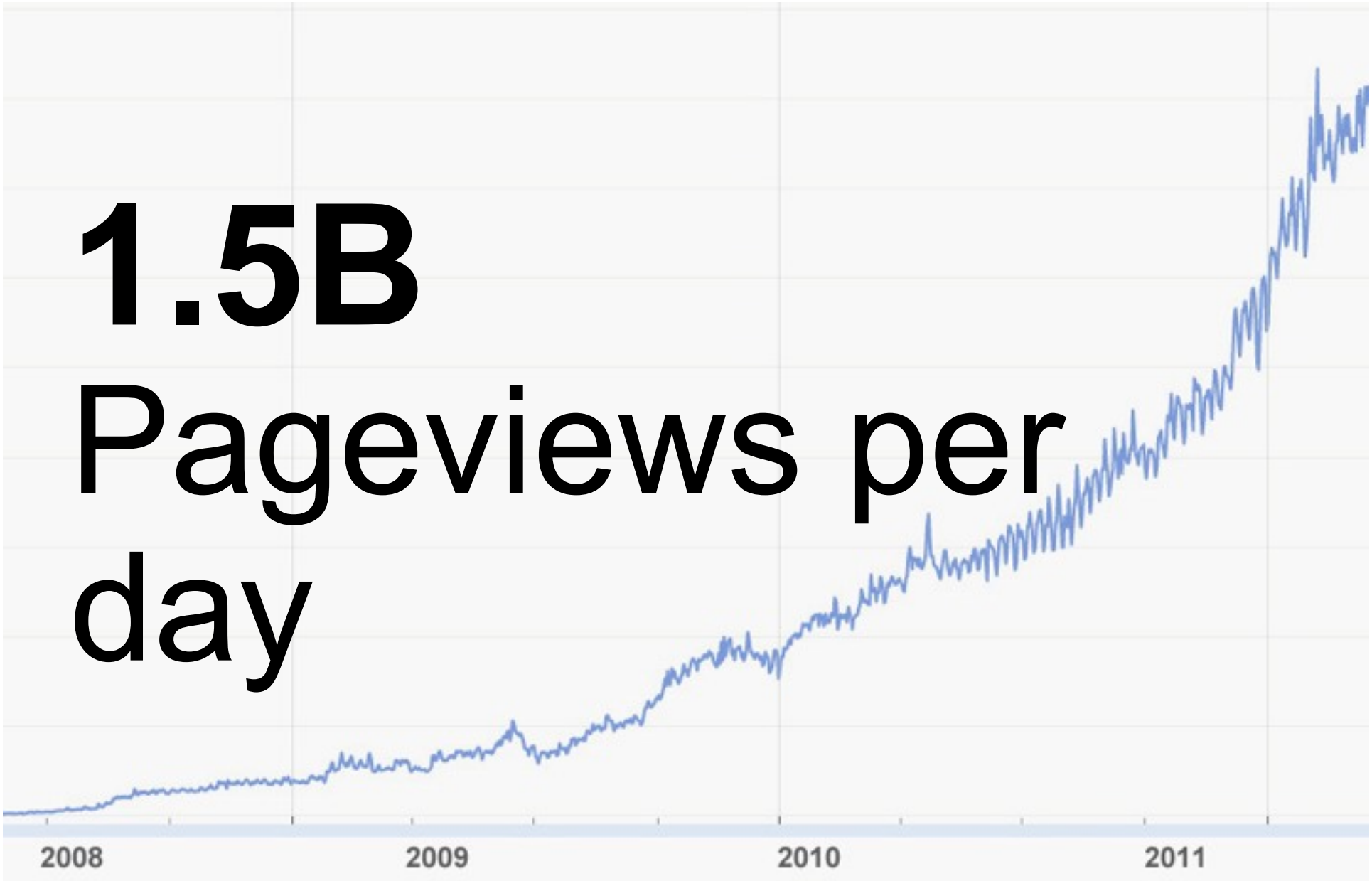
By the Numbers



200,000

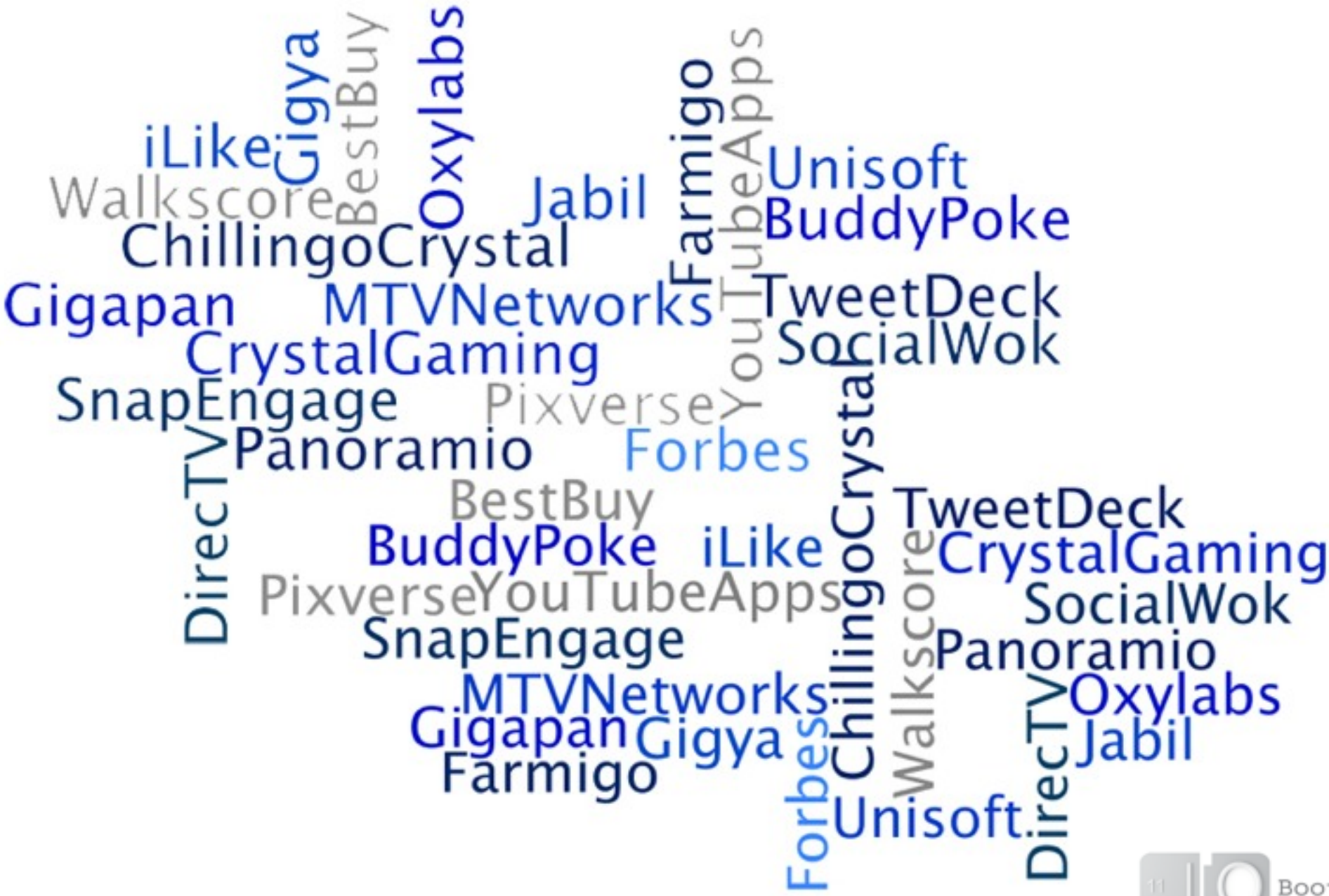
Active apps per week

By the Numbers



1.5B
Pageviews per day

Some App Engine Partners



Google Cloud In the Government sector

Google is Committed to Meeting the Add'l Challenges of Governments

Google Apps for Government

- Government only cloud in dedicated CONUS facilities
- Government pricing (GSA Schedule 70)

ATO Issued by GSA

- Certification & Accreditation based on Federal Information Systems Management Act (FISMA)
- FIPS 199 Moderate baseline

Leader in Public Sector Cloud Computing

- General Services Administration, USAID, Dept of Energy, Colorado, New Mexico, Orlando, Los Angeles, Treasury, Multonomah County, Smithsonian, Tennessee Valley Authority, ACUS, MACPAC, Wyoming

Google Confidential and Proprietary

Select DoD Customers

Requirements
- Provide common platform for non-classified collaboration

The Solution
- Implement Google Apps (eushare.org) to support unclassified communication and coordination across 51 countries throughout the Area of Responsibility
- Used during planning, execution, and after-action reporting of X24Europe, a recent global exercise

Requirements
- Provide common platform to support HA/DR mission area

The Solution
- Implement Google Apps (InRelief.org) to support cross-country, cross-language collaboration; Includes consolidation of social networking signals

Requirements
- Provide messaging platform for families to connect with deployed service members

The Solution
- Garrison Commander's toolkit for communicating to troops and their families.

Google Confidential and Proprietary

Factors to consider for picking a Cloud

- Price
- Type: Iaas, Paas, Saas
- Type of task: Apps, Big Data
- Public/Private/Hybrid
- Lock-In: Standards, Open Source

Issues to solve

- Cloud Interop: lack of standard
- Replication of Data across multiple Clouds
- Data privacy/integrity
  - encryption at rest
  - data auditing
- Trust, Culture of agility

Google Cloud Clients

- Chrome, HTML5
- ChromeBook, Device as a service $28/user/month
- Android: phone and tablets

Q&A