Cloud Computing Will Change Electronic Commerce

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Cloud Computing is Utility Computing

Illusion of Infinite Computing Resources on Demand

- No up front commitment
- Pay for resources as needed

Utility Computing Scenarios

Outsource Your Infrastructure

Occasional Need for Massive Computation

No Need to Build to Peak Capacity

Cloud-Bursting

Software as a Service

Data Close To Your Customer

Internet Scale

Flavors of Vendors

Platform as a Service

Software as a Service

Application as a Service

Cloud Appliance Vendors

Platform as a Service

Google App Engine

Amazon EC2

Microsoft Azure

Force.com

Rackspace Intensive

…

Cloud Operating System

Abstracts the underlying infrastructure

Manages resources

Classes of Platform Vendors

Scalability, Failover, Recovery

- Amazon
- Google / Force.com
- Microsoft

Software as a Service

SQL Azure

Google Big Table

Amazon Simple DB

SharePoint Services

Azure Tables and Blobs

Application as a Service

Hosted Exchange

Salesforce.com

Facebook

Gmail

Mozy

Cloud Appliance Vendors

Cisco Uniform Computer Service

EMC ?

- VMWare vCloud

Dell PAN System

Application as A Service

Hosted Exchange

Gmail

Salesforce.com

Mozy

Cloud Computing

The Good

The Bad

The Ugly

The Good News

Pricing

Compelling Case

SMB Applications

Massive Computation Needs

No Need to Build to Peak Capacity

Cloud Bursting

Software as a Service

Bandwidth is the Future

One YouTube viewing consumes nearly 100 times as much cellular bandwidth as a voice call.

In Asia 200 million people watch video on their smart phones.

Google is investing in new undersea fiber lines connecting North America and the Far East.

Source: Wall Street Journal 10/14/2009

Bandwidth is Limited

Shannon's Law: $C = B \log_2 (1 + S / N)$

Capacity = bit / second

Bandwidth (hertz)

S/N * 5 to double capacity given bandwidth

Web Browsing vs. Web Surfing

Who pays for the increased bandwidth?

Mobile Browsing is a different business Model than Web surfing

What does "free browsing mean"?

What are the roles of advertising?

Hence the arguments over net neutrality and preferential pricing.

"

Example: Azure Platform Pricing

Compute $0.12 per hour

Storage $0.15 per GB month

Storage Transactions $0.01 per 10K

Bandwidth

- $0.1 in per GB
- $0.15 out per GB
- Within the datacenter is free

SQL Azure

Up to 1 GB database $9.99 /month

Up to 10 GB database $99.99 / month

Bandwidth

- 0.1 in per GB
- 0.15 out per GB

SMB Data Costs

10 GB SQL Database

2 GB a month data in, 4 GB a month data out

$100.77 a month

A SAN can cost from $30-40,000

25 year equivalent

Infrastructure employee costs about $500,000 /year

Does not consider cost of software licenses.

SMB Compute Costs

$1051 per year for one compute process with no idle time

$31.53 if you did a storage save every second

$3600 per year 2 TB of disk storage

About $5000 / year

Employee and licensing costs not considered

Financial Perspective

Running software in a data center is far cheaper than anything a small or medium sized business could afford.

It also allows electronic commerce applications to get started faster.

- Telecommunications, email lives in the cloud
- Web servers, databases live in the cloud
- Hire business, programmers domain experts
- Use only what they need

With this Price..

- Amazon, Google offer similar price savings
- Starting up a web venture is very easy
  - No need to hire infrastructure people
  - Spend money on building business
- Pay as you go
- Ready as customer demand increases

The Bad News

Service Layer Agreements

Utility SLA

		2007		2008
	Goal	Actual	Goal	Actual
Calls Answered Within 30 Seconds	80%	84.64%	80%	85.47%
Average # Service Interruptions Per Customer	1.373	1.027	1.373	1.051
Average # Min Without Power Per Customer	168.69	82.61	168.69	78.55
Service Appointments Met	87.78%	98.52%	88.37%	98.73%
Actual Meters Read "on cycle" vs estimate	93.15%	98.75%	93.15%	99.05%
Complaint Cases Per 1000 Customers	1.496	.974	1.496	1.080

Utility Availability: 99.98%

Outages

- Amazon and Google have no real SLAs
  - Google Asia
  - Gmail Outages
  - Amazon Outages
  - Telecomm Sidekick lost its user phone data.

Announced Azure SLA

Computation: 99.95% up time

SQL Azure: 99.9% up time

Penalties not announced

Google, Amazon, have no real penalties

Regulatory Compliance

Data Centers have not yet been certified for:

- PCI
- HIPAA,
- etc.

This is will develop over time for vendor or consumer demands.

Example: Microsoft Health Vault

The Ugly News

Possible Changes to Application Development

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Latency Exists

Speed of light in fiber optic cable: 124,000 miles per second

A ping Japan from Boston takes 100 ms.

Real number is about 250 ms.

Fetch 10 images for a web site: 1 second

Ignores Latency of the operation

Latency is Not Bandwidth

- Size of the shovel vs. how fast you can shovel
- Infinite shovel capacity(bandwidth) is limited by how fast one can shovel (latency).

Great Bandwidth, Poor Latency

Buy a two terabyte disk drive

Put it in a car and drive to New York

Expensive to Move Data

- Computational Power Gets Cheaper Faster than Network Bandwidth
- Cheaper to compute where data is instead of moving it
  - *Distributed Computing Economics* Jim Gray
- Want data to be close to where your customer is

Connectivity is Not Always Available

- Cell phone
- Data Center Outages
- Equipment Upgrades
- Data redundancy to improve reliability

Waiting for Data Slows Computation

Partition Your Data to Improve Performance

Partition Your Data to Achieve Internet Scale

Data Naturally Lives In Multiple Places

Distributed Transactions Impede Throughput

Human Interaction

Relational Databases Scale Up Not Out

- Relational Databases scale well on a single node or cluster
  - Complexity of relations
  - Query plans with hundreds of options the query analyzer evaluates at runtime
  - Normalization
  - ACID Transactions
- Two Phase Commit guarantees consistency if you have infinite time
- Quick scale up difficult with hardware upgrade

Economics Dictate Scale Out Not Up

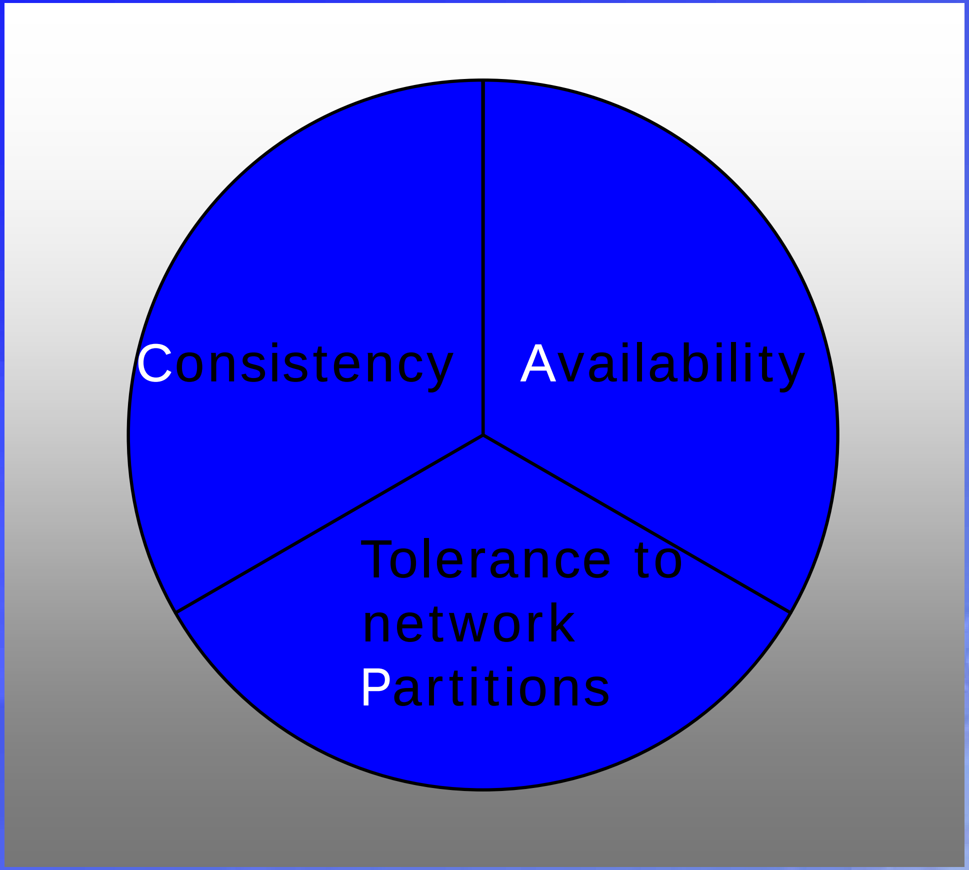
Cheap, commodity hardware argues for spreading load across multiple servers

How do you distribute data among several databases?

How do you achieve consistency?

How do you achieve throughput with distributed transactions?

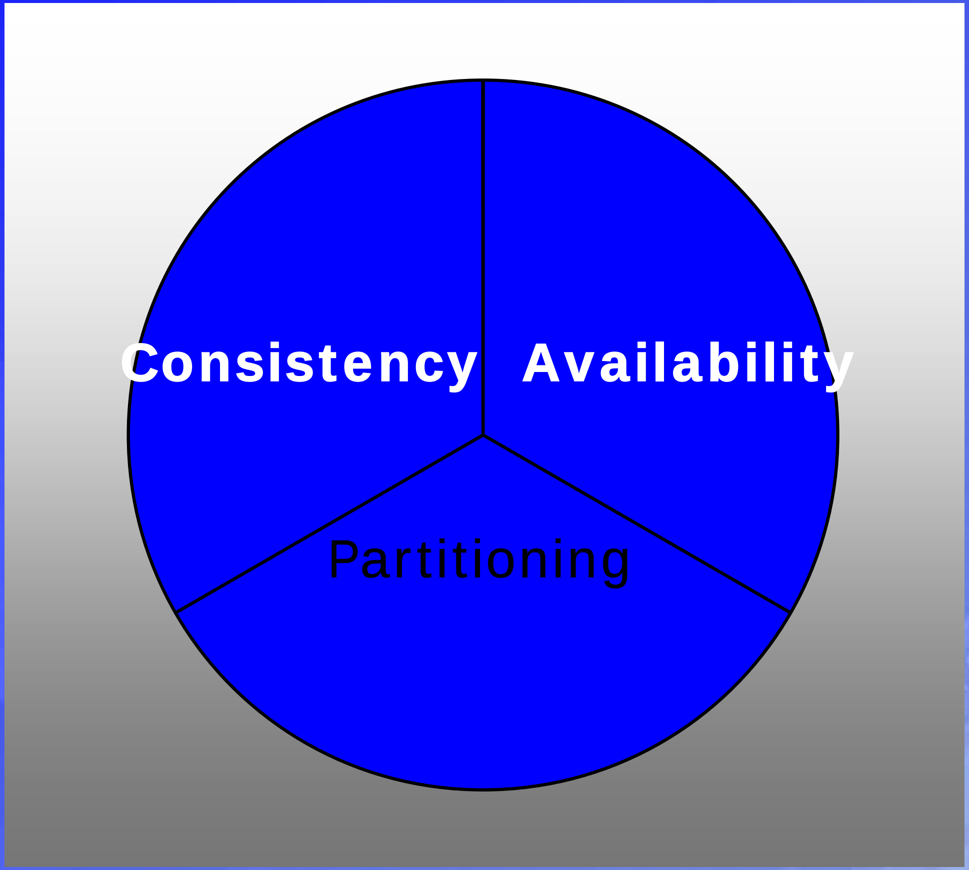
CAP Theorem



Can Have Any Two

Eric Brewer, UC Berkeley, Founder Inktomi
http://www.cs.berkeley.edu/~brewer/cs262b-2004/PODC-keynote.pdf

Consistency and Availability



Single site Database

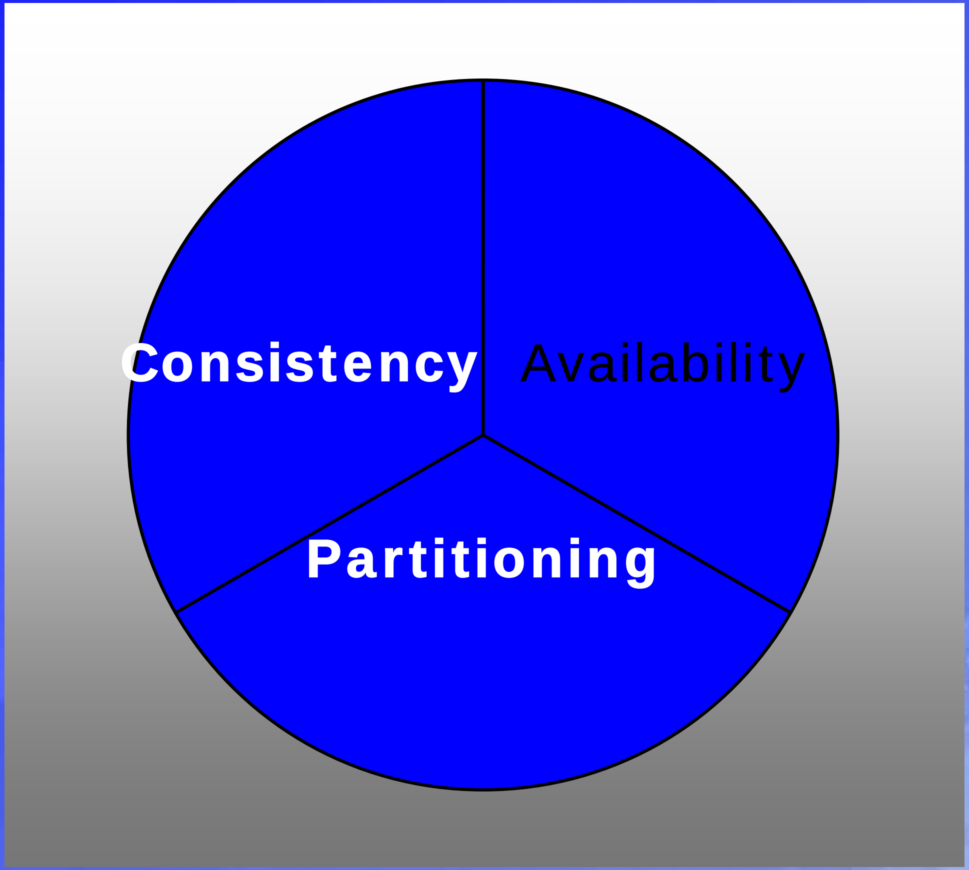
Database Cluster

LDAP

Two phase commit

Validate Cache

Consistency and Partitioning



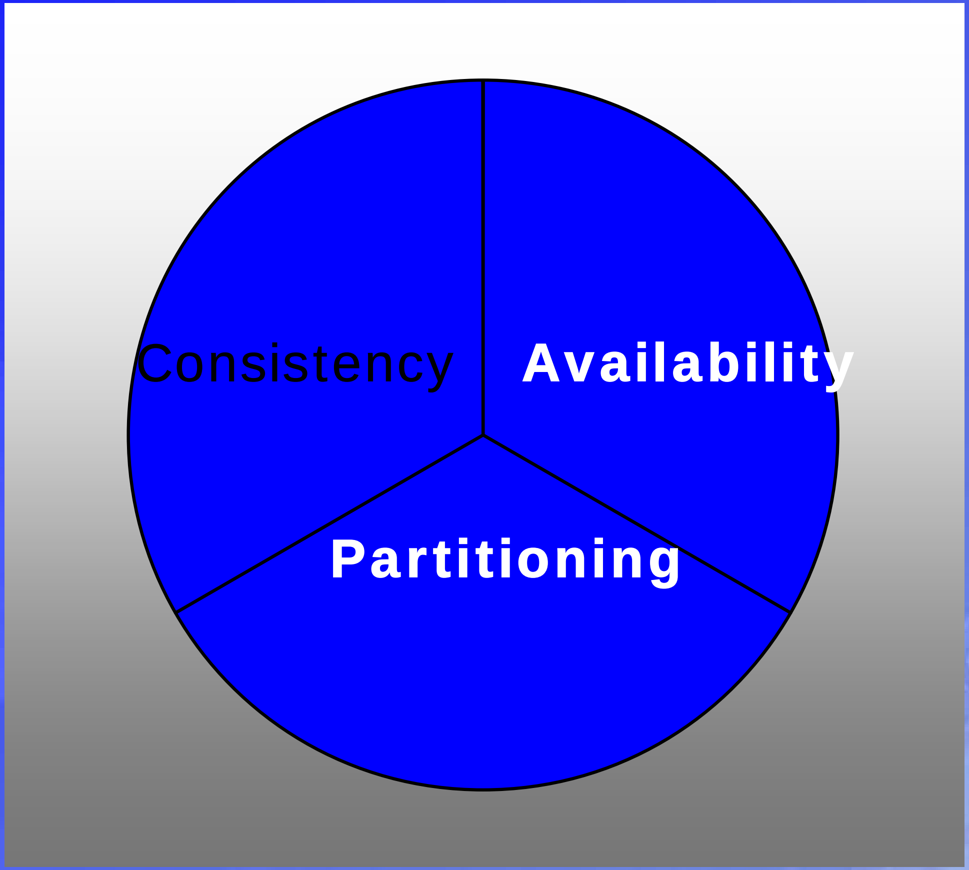
Distributed Database

Distributed Locking

Pessimistic Locking

Minority Partitions
Invalid

Availability and Partitioning



Forfeit Consistency

Google BigTable

Amazon Simple DB

Optimistic

Can Denormalize

No ACID transactions

Compensation

Cloud Storage

World of Consistency

- Relational Database

World of Internet Scale (Numbers or Geography)

- Blobs, Tables, Queues

Cloud Relational Databases

- SQL Azure
  - Revised to be SQL Server in the sky
    - Tables, Stored Procedures, Triggers, Constraints Views, Indices
    - Uses TDS (Tabular Data Stream) Protocol
  - Change connection string to get to another SQL Server
- MySQL, Sql Server, Oracle, etc. on Amazon VM

Cloud Storage Services

Tables of key/value pairs for highly scalable structured storage

CRUD operations

No FK relations, Joins, Constraints, Schemas

Partition / Tables / Entities / Properties

Entity has Unique Row Key

Cloud Storage Services

Fit well with tens or hundreds of commodity servers

Better mapping with objects than ORM

No integrity constraints

No joined queries

No standards among vendors (lock in)

Will Microsoft have query limits?

- Amazon no query longer than 5 seconds
- Google no more than 1000 items returned

Car Table

Key	Attribute 1	Attribute 2	Attribute 3	Attribute 4	
1	Make: BMW	Color: Grey	Year 2003		
2	Make: Nissan	Color : Red Yellow	Year: 2005	Transmission: Easytronic	
3	Plane: Boeing	Color: Blue		Engine: Rolls Royce	

Do You Need To Partition Your Data to Scale?

- No Partitioning
- Natural Partitioning
- Partitioning for Availability

If you have to partition to scale, how do you decide between availability and consistency ?

What is the Cost of an Apology?

Amazon

Airline reservations

Stock Trades

Deposit of a Bank Check

Deleting a photo from Flickr or Facebook

Sometimes the cost is too high

Authentication

- SAML tokens expire

Launching a nuclear weapon

Businesses Apologize Anyway

- Vendor drops the last crystal vase
- Check bounces
- Double-entry bookkeeping requires compensation
  - at least 13th century
- Eventually make consistent

State of the Software ≠State of the World

Software approximates the state of the world

It makes the best guess possible

Sometimes that is wrong

Other computers might have other opinions

Overturn software myths of the past 25 years.

How consistent?

Business Decision

How much does it cost to get it absolutely right?

Computers can remember their guesses

Can replicate to share guesses

It may be cheaper to forget, and reconcile later

Design For Eventual Consistency

- Identify objects by unique key (partition key / row key)
- Objects can move when repartitioning
- Cannot assume two objects remain on the same machine
- Data might go offline
- Transactions can only apply on per object basis
- Different computations might come to different conclusions
- Define message based workflows for ultimate reconciliation and replication of results

Security in the Cloud

Identify Users and Applications

HIPAA, PCI, etc, compliance

Physical Security of Data

Access to Data

Conclusions

Understanding Cloud Computing is about understanding

- Economics of cost and availability
- Need for Scalability

Possible Architectural Implications

- Design for Eventual Consistency

Remember the 2 / 10 rule