Cloud Computing with Microsoft Azure

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Azure's Three Flavors

Azure Operating System (*Platform as a Service*)

Worker/Web Role, Blobs, Queues, Tables

Azure .NET Services (*Software as a Service*)

Access Control Service

SQL Azure (SQL Server in the sky)

Workflow Services

Azure Hosted Services (*Application as a Service*)

Hosted Exchange

Host SharePoint

Cloud Operating System

Abstracts the underlying infrastructure

Manages resources

Azure Platform

- Service management
- Compute
- Storage
- Developer experience
  - You define rules and provide code
  - Platform deploys, monitors, and manages your service according to your rules

Azure Services Platform

Your Service

Web/ Worker Role
Blobs, Tables, Queues

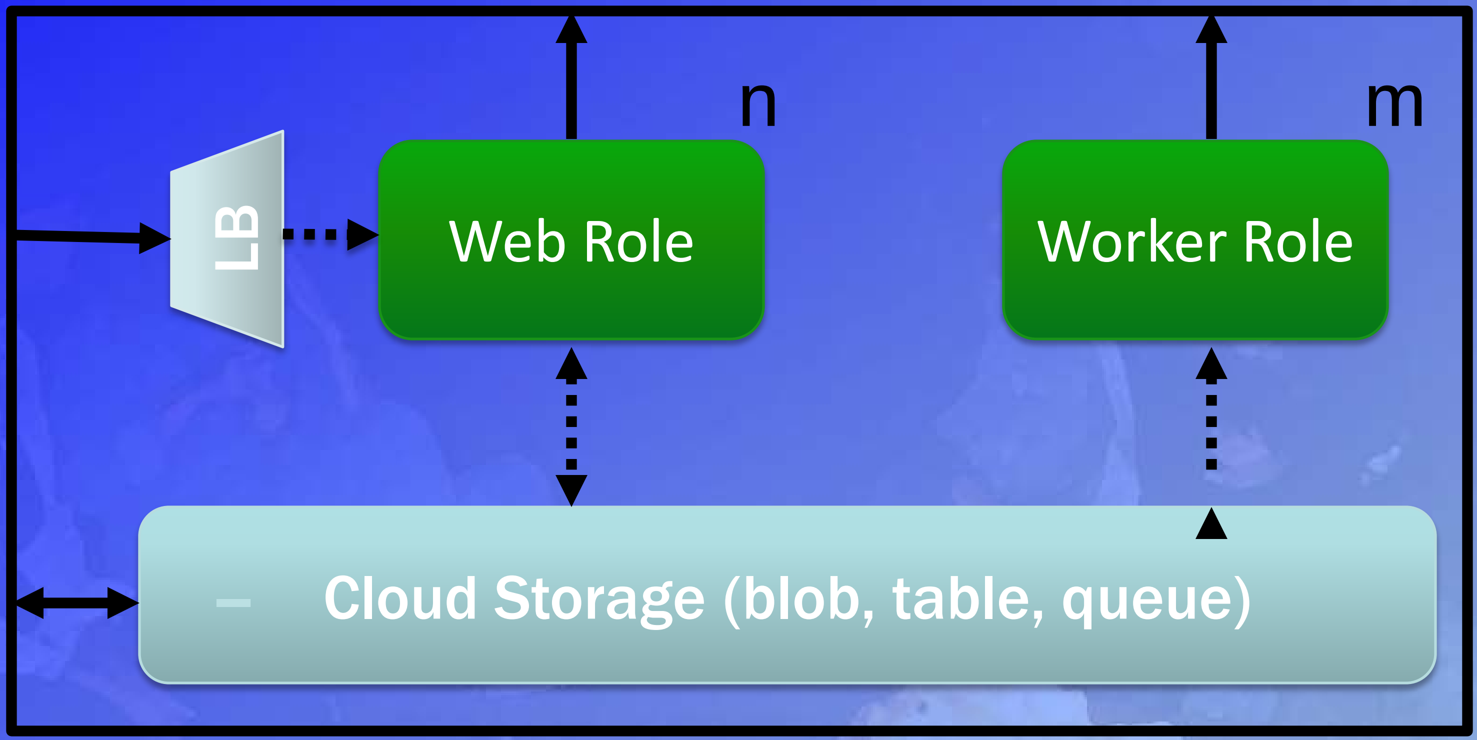
SQL Azure

Access Control

Live Services

Dynamic CRM Services

Demo: Scalable Architecture



Cloud Computing is Utility Computing

Illusion of Infinite Computing Resources on Demand

No up front commitment

Pay for resources as needed

Three Classes of Vendors

Scalability, Failover, Recovery

- Amazon
- Google / Force.com
- Microsoft

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

Economic Conditions

Pricing

Service Level Agreement (SLA)

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

Does not consider the cost of infrastructure employees or the 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

Announced Azure SLA

Computation: 99.95% up time

SQL Azure: 99.9% up time

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%

Compelling Case

SMB Applications

Massive Computation Needs

No Need to Build to Peak Capacity

Cloud Bursting

Software as a Service

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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

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

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

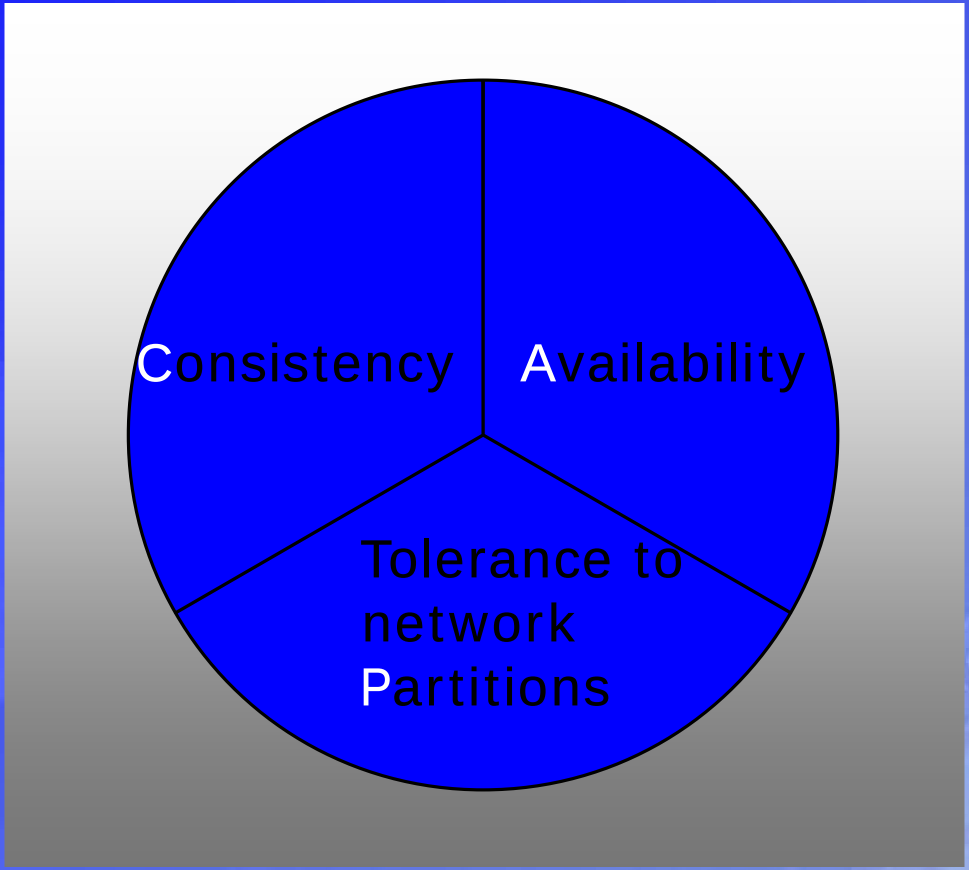
Relational Databases Scale Up Not Out

- 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?

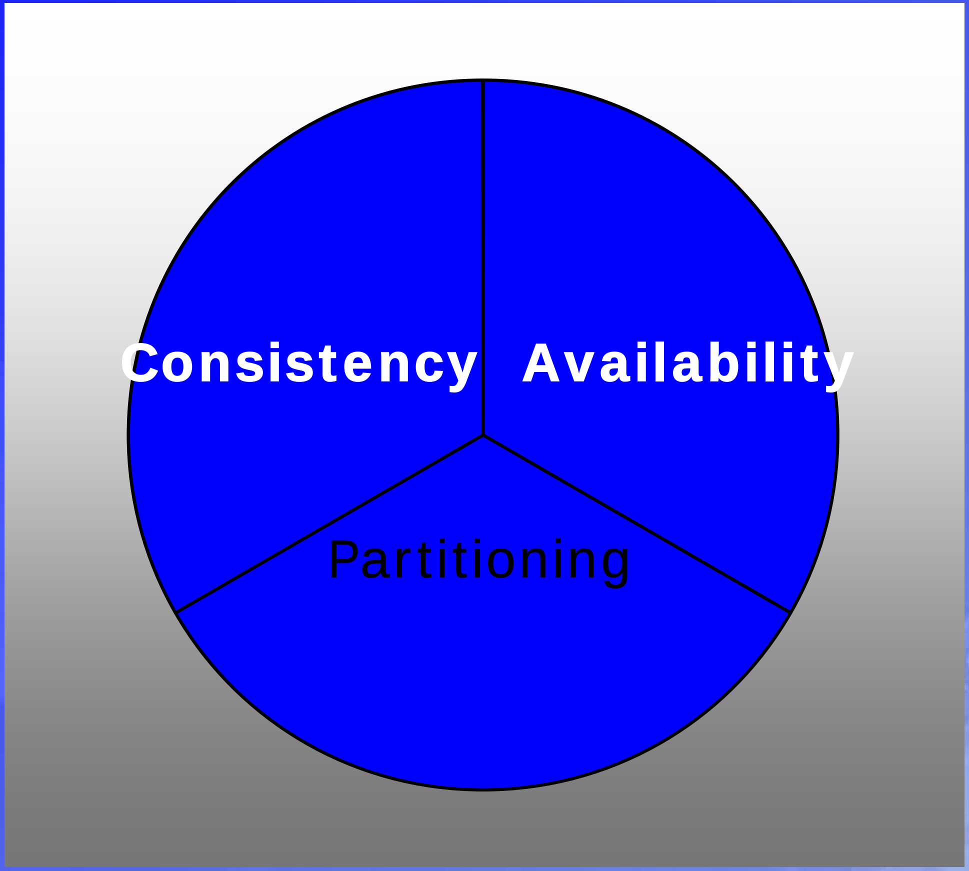
CAP Theorem



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

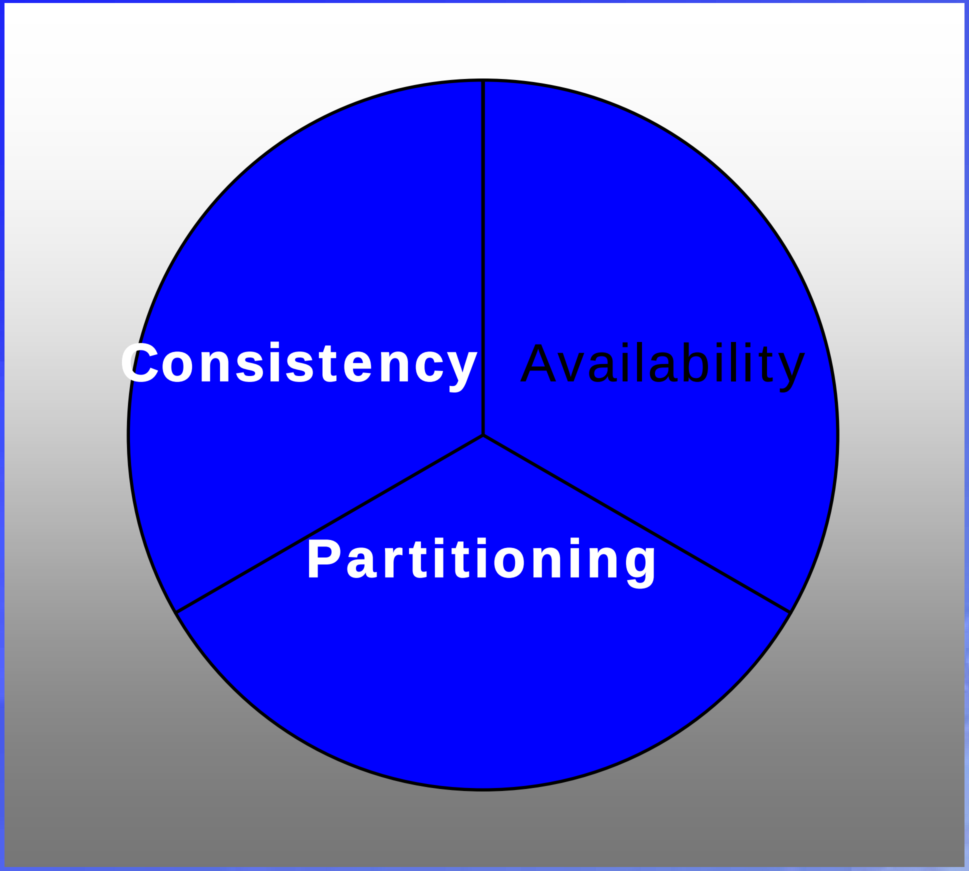
Database Cluster

LDAP

Two phase commit

Validate Cache

Consistency and Partitioning



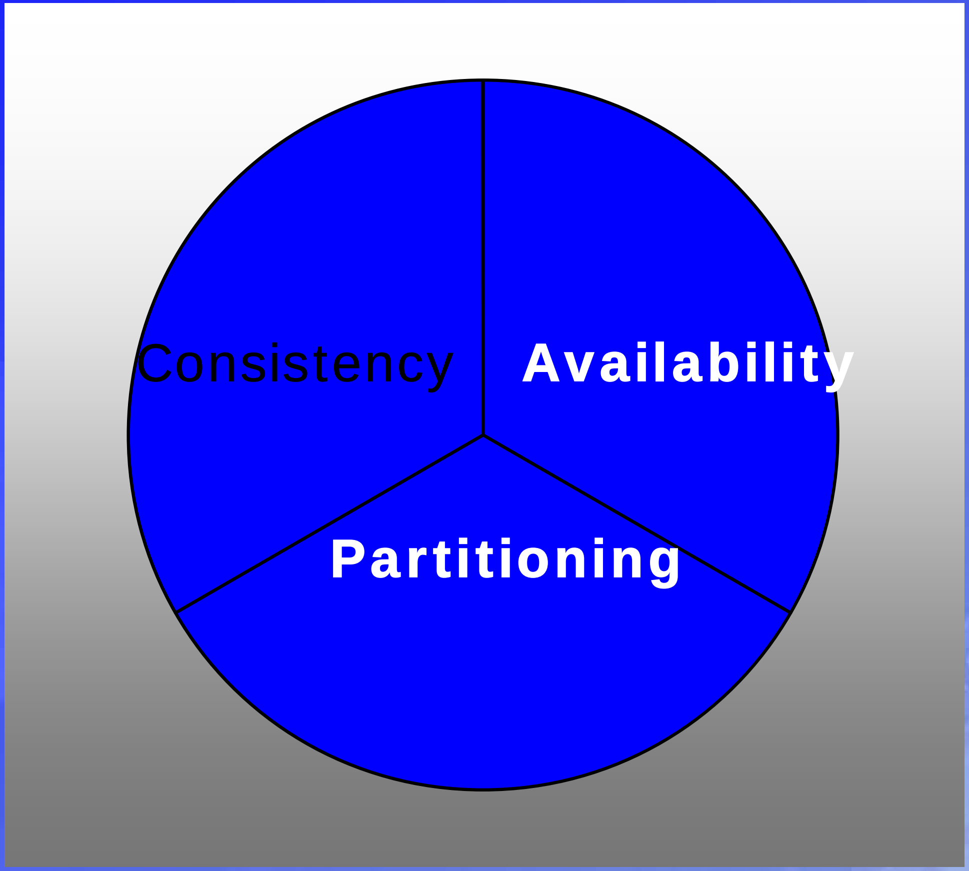
Distributed Database

Distributed Locking

Pessimistic Locking

Minority Partitions
Invalid

Availability and Partitioning



Forfeit Consistency

Google BigTable

Amazon Simple DB

Optimistic

Can Denormalize

No ACID transactions

Compensation

Storage in Azure

- World of Consistency
  - SQL Azure
- World of Internet Scale (Numbers or Geography)
  - Blobs, Tables, Queues

SQL Data Services

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

No Current Availability

- Get Started with SQL Express

Windows Azure 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

Azure 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

Demos ?

Conclusions

Understanding Azure is about understanding

- Economics of cost and availability
- Need for Scalability

Architectural Implications

- Design for Eventual Consistency

Remember the 2 / 10 rule