# NoSQL in the Cloud with Windows Azure Table

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# Objectives

- Introduction to Windows Azure Storage
- Windows Azure Table – Deeper dive
- Data Modeling for Scale

# Why NoSQL?

- Large demand for economically accessing structured data at Internet scale
    - Distributed store
    - Auto scale
    - Flexible schema

- Relational databases
    - Scale up your servers: But gets expensive very soon
    - Manually Shard: But now you lose certain relational capabilities across shards
    - Maintenance requires DBA expertise

# Windows Azure Storage – A Quick Introduction

# Windows Azure Storage

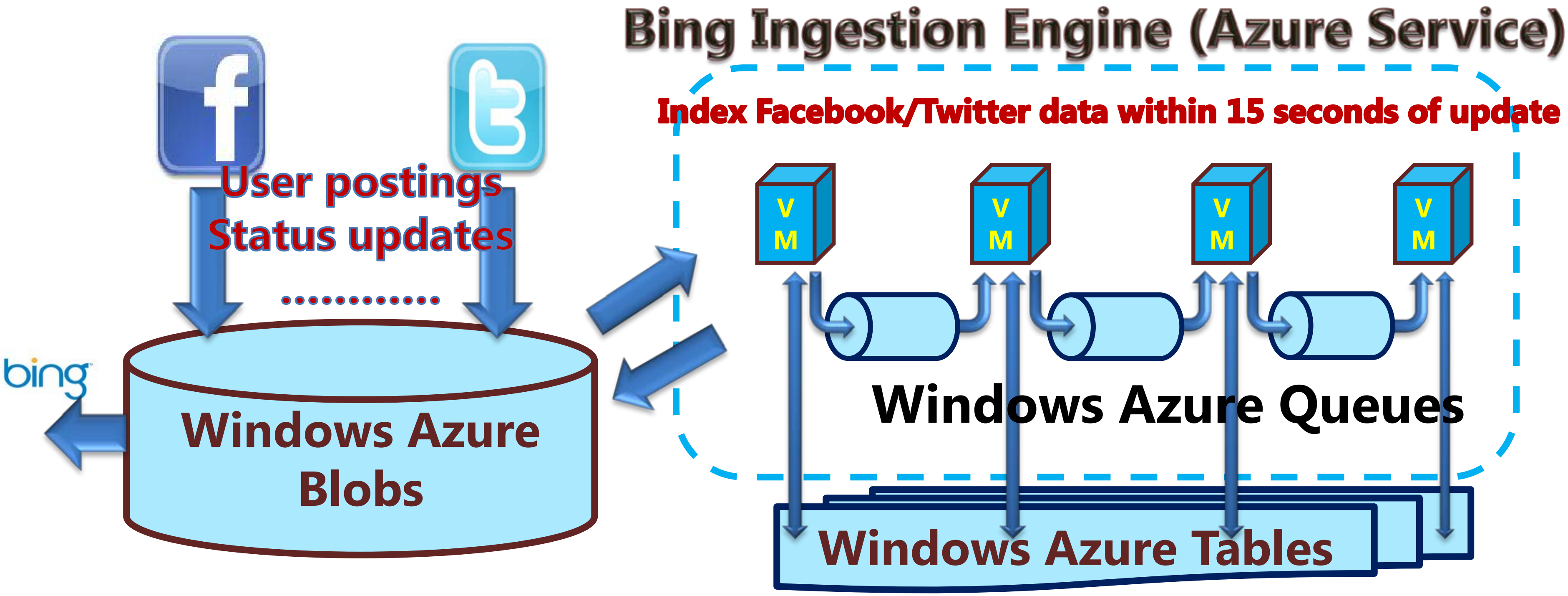
# Windows Azure Storage Characteristics

- A “pay for what you use” cloud storage system
  - **Durable**: Store multiple replicas of your data
    - Local replication:
      - Synchronous replication before returning success
    - Geo replication:
      - Replicated to data center at least 400+ miles apart
      - Asynchronous replication after returning success to user.
  - **Available**: Multiple replicas provide fault tolerance
  - **Scalable**: Automatically partitions data across servers to meet traffic demands
  - **Strong consistency** by default
- 880K requests/s at peak & 4+ Trillion objects
- Great performance for low transaction costs!

# Windows Azure Storage Characteristics

- Various Abstractions
  - **Blobs**: Store files and metadata associated with it
  - **Queues**: Durable asynchronous messaging system to decouple components
  - **Tables**: A strongly consistent NoSQL structured store that auto scales
  - **Drives and Disks**: Network mounted durable drives available for applications in the cloud
- All abstractions backed by same store
  - Same feature set across all abstractions (geo, durability, strong consistency, auto scale, monitoring, partitioning logic etc.)
  - Reduce costs by blending different characteristics of each abstraction
- Easy to use and open REST APIs
  - Client libraries in Java, Node.js, PHP, .NET etc.

# Case Study: Bing Realtime facebook/twitter search ingestion engine



Bing Ingestion Engine (Azure Service)

Index Facebook/Twitter data within 15 seconds of update

User postings
Status updates
............

Windows Azure Queues

Windows Azure Blobs

Windows Azure Tables

- Facebook/Twitter data stored into blobs
- Ingestion engine process blobs
  - Annotate with auth/spam/adult scores, content classification, expands links, etc
  - Uses Tables heavily for indexing
- Queues to manage work flow
- Results stored back into blobs
- Bing takes resulting blobs and folds into search index

**peak 40,000 Requests/sec**

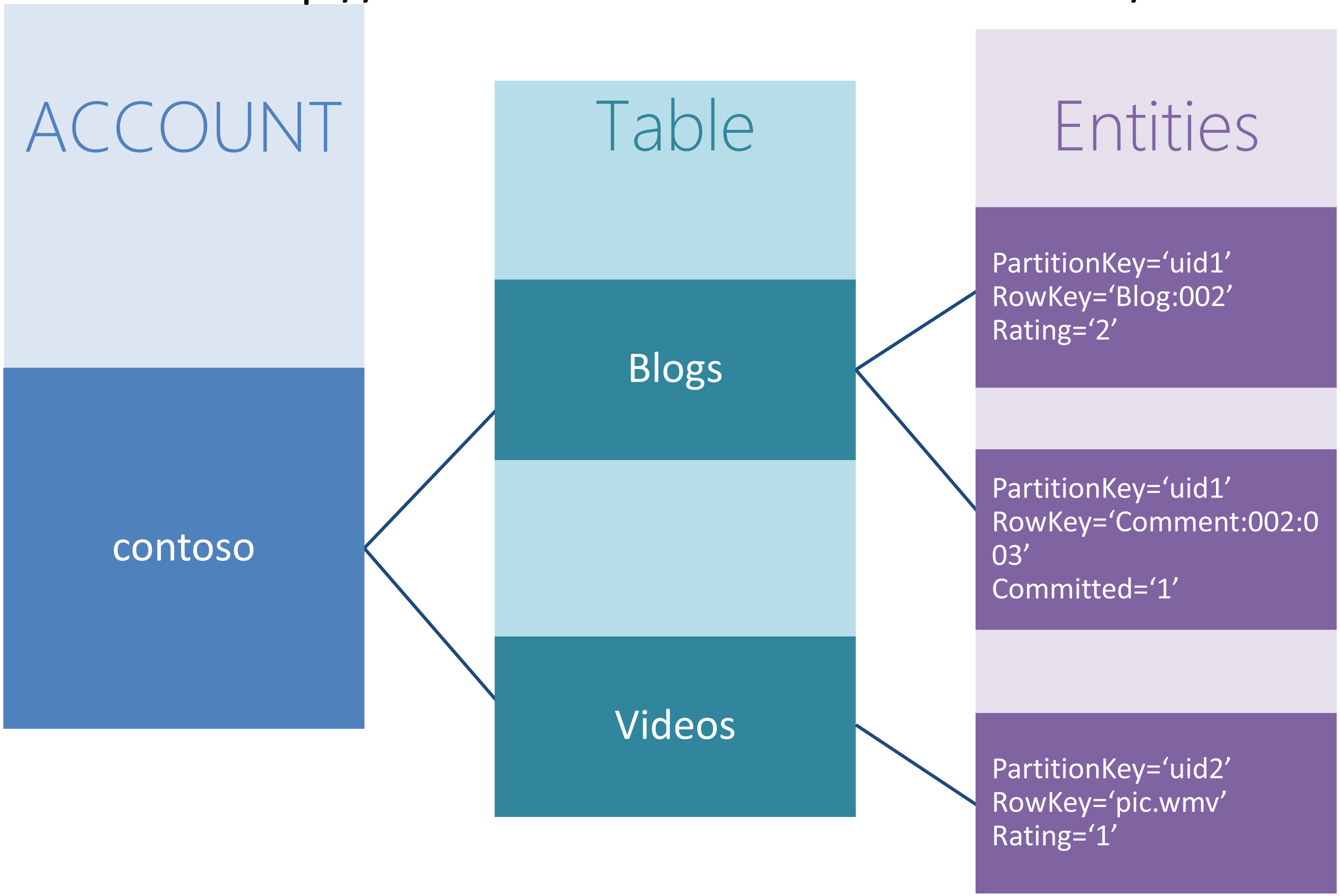
**2~3 billion Requests per day**

**Took 1 dev 2 months to design, build and release to production**

# Deeper Dive into Windows Azure Tables

# Windows Azure Table – Model

http://<account>.**table**.core.windows.net/



ACCOUNT

contoso

Table

Blogs

Videos

Entities

PartitionKey=‘uid1’
RowKey=‘Blog:002’
Rating=‘2’

PartitionKey=‘uid1’
RowKey=‘Comment:002:003’
Committed=‘1’

PartitionKey=‘uid2’
RowKey=‘pic.wmv’
Rating=‘1’

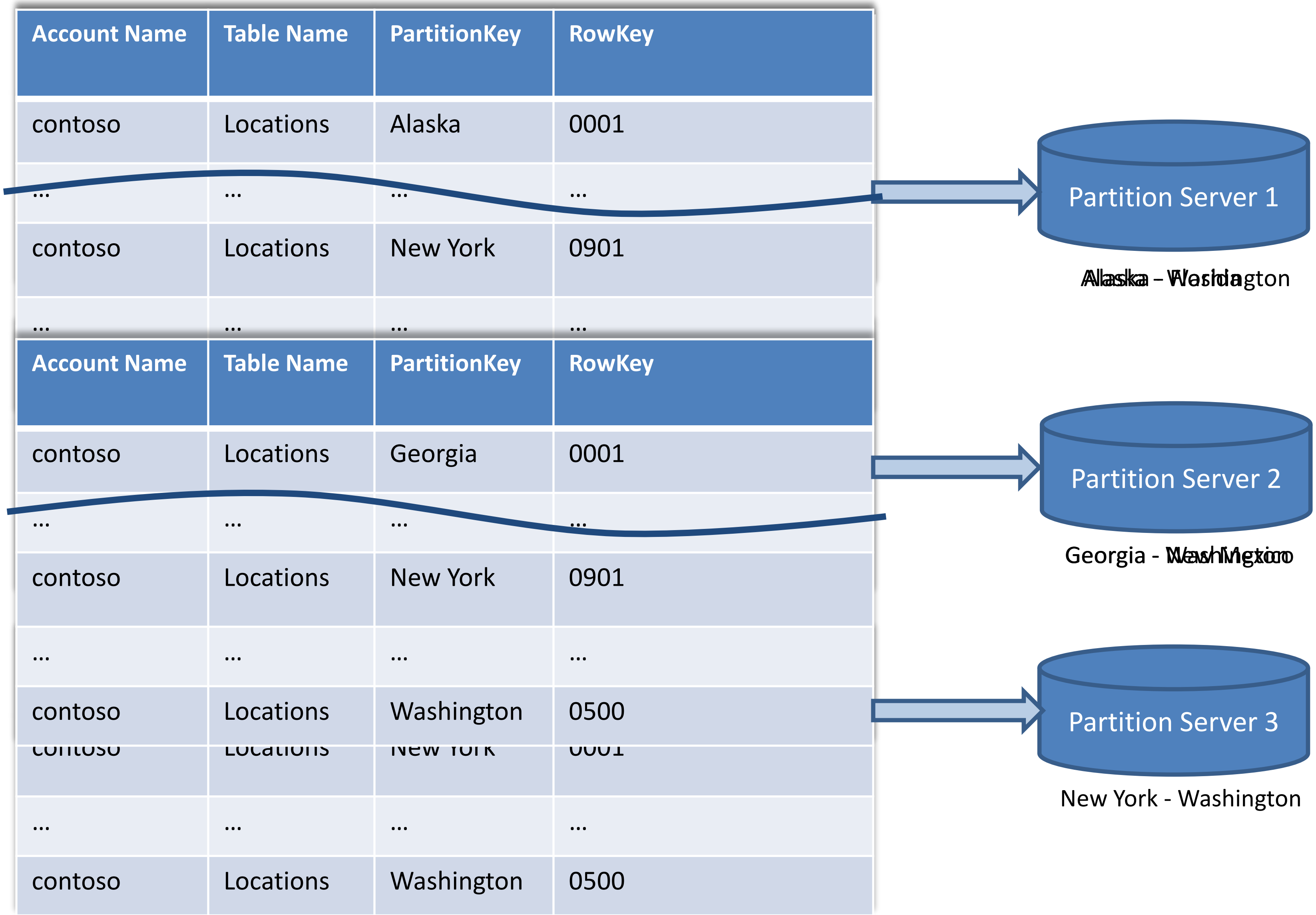
# Windows Azure Table – Basics

- Authentication
  - Owner only access by default
  - Control access using pre-signed Urls
- Flexible schema
  - Tables – No schema associated
  - Store different entity types in same table
- Single Index
  - (AccountName, TableName, PartitionKey, RowKey) => Clustered Index
  - Defines sort order
  - PartitionKey – Mandatory property which defines partitioning
  - RowKey – Mandatory property which defines uniqueness within a given partition

# Windows Azure Table – Basics

- Optimistic concurrency
  - Timestamp – A read only property maintained by server
- Partitioning
  - (AccountName, TableName, PartitionKey) => Partitioning key
  - Range based partitioning
  - Users can achieve hash based: PartitionKey = Hash(PartitionKey Value)
- Atomic Transactions
  - Entities with same partitioning key can be part of single batch request
- Exposed via RESTful APIs
  - OData protocol
  - Java, Node.js, PHP, .NET client libraries

# Windows Azure Table – Auto Scaling



| Account Name | Table Name | PartitionKey | RowKey |
|---|---|---|---|
| contoso | Locations | Alaska | 0001 |
| … | … | … | … |
| contoso | Locations | New York | 0901 |
| … | … | … | … |

| Account Name | Table Name | PartitionKey | RowKey |
|---|---|---|---|
| contoso | Locations | Georgia | 0001 |
| … | … | … | … |
| contoso | Locations | New York | 0901 |
| … | … | … | … |
| contoso | Locations | Washington | 0500 |
| contoso | Locations | New York | 0001 |
| … | … | … | … |
| contoso | Locations | Washington | 0500 |

# Data Modeling for Scale

# Data Modeling for Scale
# Where do I Start?

- How large can partitions get?
  - Strive for PartitionKey that does not create hotspots
  - No size limit on partition
    - Every entity can have different PartitionKey value
      - User table for popular movie streaming site may choose UserId
        - Avoids hotspots as user IDs are randomly distributed
    - All entities can have same PartitionKey value
      - Genre table for movies may choose to have Genre enum listed with same PartitionKey value
        - Caching of rarely changing data can reduce hotspots

# Data Modeling for Scale
# Where do I Start?

- Start with following questions:
  - What objects do I need to deal with?
  - What are the significant queries that I need?
    - Determines candidates for “keys”
      - Retrieve list of movies released by week
        - PartitionKey == YYYY-MM-Week#
  - What are the atomic transactions that I need?
    - Atomic batch transactions allowed on entities having same (AccountName, TableName, PartitionKey) value
      - Transactional consistency
      - Batch to reduce round trips
      - Example: User gets rewards point with every checkout
        - Table maintains rewards info and currently checked out movies
        - Rewards info and rental info maintained in an atomic transaction

# Data Modeling for Scale
# Composite keys

- Single index provided by system but hierarchical pivots required
- Concatenate properties to get composite key
- Prefixes are more critical
  - Retrieve list of movies released recently by genre
    - PartitionKey == Genre-YYYY-MM-Week#
    - RowKey == MovieName

# Data Modeling for Scale
# Denormalization is key!

- Resultset pivoted by different keys
  - Retrieve list of movies released by genre
    - PartitionKey == Genre & RowKey == MovieName
  - Retrieve list of movies with a given actor
    - PartitionKey == Actor & RowKey == MovieName
- Store data twice – once for "by genre" lookup and once for "by actor"
  - Duplicate just required partial data
  - For larger entities, store pointer to fact table
    - "By Genre" is the fact table that stores synopsis, thumbnail etc.
    - "By Actor" just stores the properties like movie name, genre, rating etc. that are required to display results
      - If user selects a movie – lookup for the movie "by genre" to retrieve synopsis, thumbnail etc.

# Data Modeling for Scale
# Index Table Pattern

- Partition level index
  - Entity group transaction to achieve consistent indexes
  - Example: List recent movies by Genre; List recent movies by rating
    - Store 2 entities with PartitionKey == YYYY-MM-Week#
    - One with RowKey == Genre-MovieName
    - Other with RowKey == Rating-MovieName

# Data Modeling for Scale
# Index Table Pattern

- Indexes across Partitions
  - Eventual consistent indexes
    - Add a message into queue that will add rows into index tables
    - Add row into fact table
    - Example: “By Actor” and “By Genre” queries.
      - Add message to queue which will update “By Actor” table if movie exists in fact table
      - Add movie to “By Genre” table
  - Usually Consistent indexes
    - Add a message into queue that will fix consistency on failures
    - Add row into fact table
    - Add row into index tables

# Data Modeling for Scale
# What happened to my Joins?

- Application responsible for joins
  - User info table and rental info table
    - When user logs in
      - Select * where PartitionKey = <UserId> from UserTable
      - Select * where PartitionKey = <UserId> from RentalTable

# Data Modeling for Scale
# What happened to my Joins?

- Shape data based on access pattern
  - Use flexible schema to store different types in same table
    - Scenario: Rewards for user on every rental
    - User info and rental info in same table
      - Both entities use PartitionKey == UserId
      - Prefix row key with type
      - User Entity RowKey = “”
      - Rental Entity RowKey = Rental-<Movie Name>
    - Get user and rental rows for user id
      - Select * where PartitionKey = <UserId>
    - Get user row for user id
      - Select * where PartitionKey = <UserId> && RowKey = “”
    - Get rental rows for user id
      - Select * where PartitionKey = <UserId> && RowKey.StartsWith(“Rental”)

# Data Modeling for Scale
## Summarize

- What are my significant queries?
- What atomic transactions do I need?
- Utilize flexible schema
- Make query processing fast by doing some work upfront
    - Maintain Index Tables
    - Denormalize data
    - Let applications do the join or shape the data for joins

# Summary

- Windows Azure Storage provides highly scalable, durable and available cloud storage system with strong consistency
- Pay for what you use model
- Abstractions - Blobs, Tables, Queues, Drives & Disks
- Windows Azure Tables is a NoSQL structured store that auto scales
- Patterns for designing large scale applications on Windows Azure Tables

# References

- SOSP paper - http://bit.ly/uP3ebT
- Storage team blog - http://blogs.msdn.com/b/windowsazurestorage/
- How to get most out of Windows Azure Table - http://bit.ly/bUS9f7
- Windows Azure - http://bit.ly/sMhxTS