Best Practices for Scaling Websites
Lessons from eBay

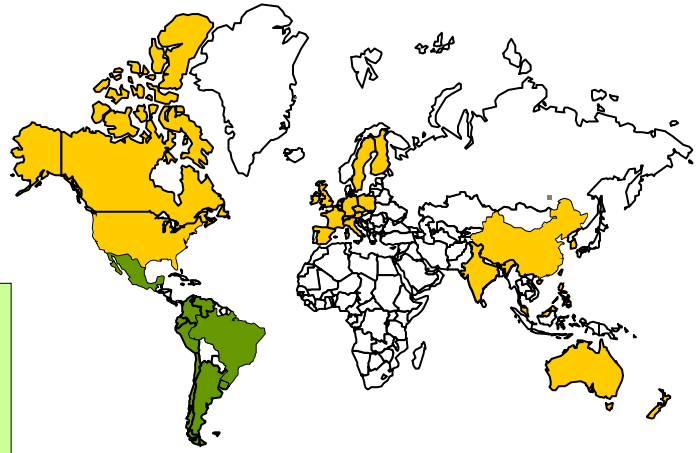
Randy Shoup
eBay Distinguished Architect

QCon Asia 2009

Challenges at Internet Scale

- eBay manages …
  - 86.3 million active users worldwide
  - 120 million items for sale in 50,000 categories
  - Over 2 billion page views per day
  - eBay users trade over $2000 in goods every second -- $60 billion per year
  - eBay site stores over 2 PB of data
  - eBay processes 50 TB of new, incremental data per day
  - eBay Data Warehouse analyzes 50 PB per day
- In a dynamic environment
  - 300+ features per quarter
  - We roll 100,000+ lines of code every two weeks
- In 39 countries, in 8 languages, 24x7x365

>48 Billion SQL executions/day!



Architectural Forces at Internet Scale

- Scalability
  - Resource usage should increase linearly (or better!) with load
  - Design for 10x growth in data, traffic, users, etc.
- Availability
  - Resilience to failure (MTBF)
  - Rapid recoverability from failure (MTTR)
  - Graceful degradation
- Latency
  - User experience latency
  - Data latency
- Manageability
  - Simplicity
  - Maintainability
  - Diagnostics
- Cost
  - Development effort and complexity
  - Operational cost (TCO)

Best Practices for Scaling

1. Partition Everything
2. Asynchrony Everywhere
3. Automate Everything
4. Remember Everything Fails
5. Embrace Inconsistency

Best Practice 1: Partition Everything

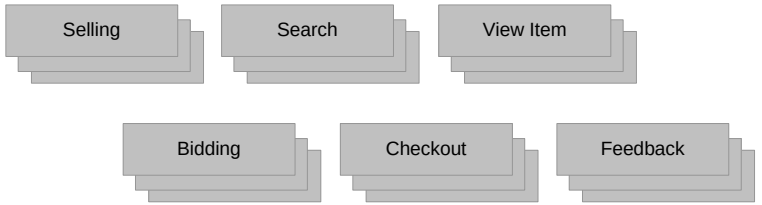
- Split every problem into manageable chunks
  - By data, load, and/or usage pattern
  - *"If you can't split it, you can't scale it"*

- Motivations
  - Scalability: can scale horizontally and independently
  - Availability: can isolate failures
  - Manageability: can decouple different segments and functional areas
  - Cost: can use less expensive hardware

Best Practice 1: Partition Everything

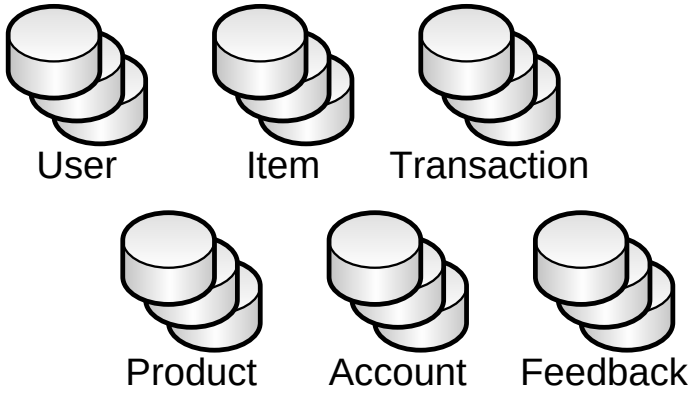
Pattern: Functional Segmentation

- Segment processing into pools, services, and stages
- Segment data along usage boundaries



Pattern: Horizontal Split

- Load-balance processing
  - Within a pool, all servers are created equal
- Split (or "*shard*") data along primary access path
  - Partition by range, modulo of a key, lookup, etc.



Corollary: No Session State

- User session flow moves through multiple application pools
- Absolutely no session state in application tier

Best Practice 2: Asynchrony Everywhere

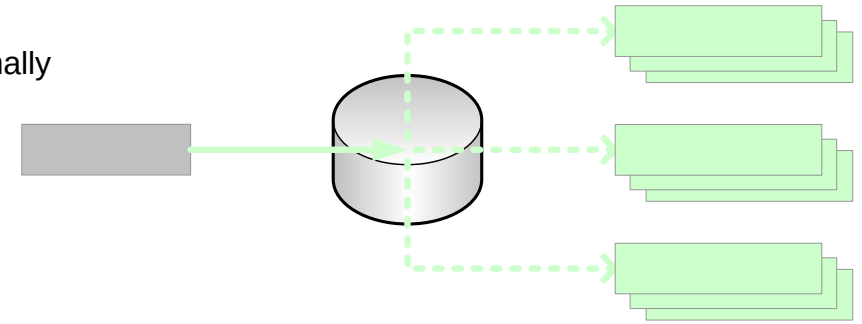
- Prefer Asynchronous Processing
  - Move as much processing as possible to asynchronous flows
  - Where possible, integrate disparate components asynchronously

- Motivations
  - Scalability: can scale components independently
  - Availability
    - Can decouple availability state
    - Can retry operations
  - Latency
    - Can significantly improve user experience latency at cost of data/execution latency
    - Can allocate more time to processing than user would tolerate
  - Cost: can spread peak load over time

Best Practice 2: Asynchrony Everywhere

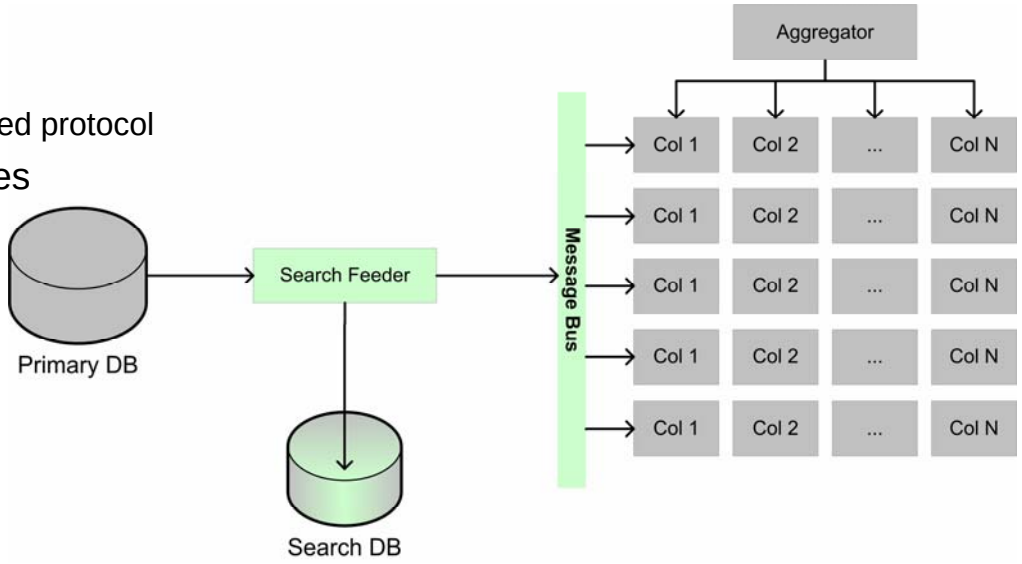
Pattern: Event Queue

- Primary use-case produces event
  - Create event (*ITEM.NEW*, *ITEM.SOLD*) transactionally with primary insert/update
- Consumers subscribe to event
  - At least once delivery
  - No guaranteed order
  - Idempotency and readback



Pattern: Message Multicast

- Search Feeder publishes item updates
  - Reads item updates from primary database
  - Publishes sequenced updates via SRM-inspired protocol
- Nodes listen to assigned subset of messages
  - Update in-memory index in real time
  - Request recovery (NAK) when messages are missed



Best Practice 3: Automate Everything

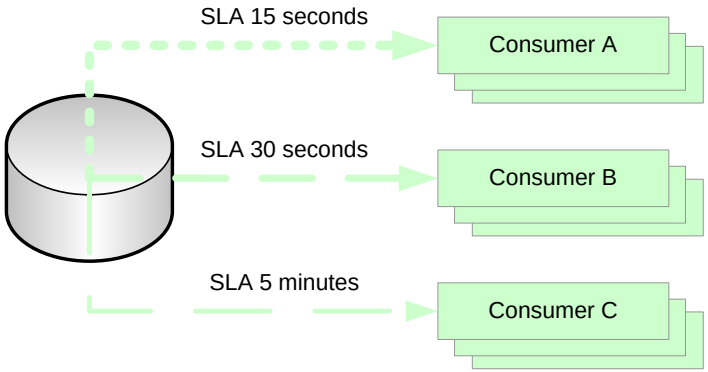
- Prefer Adaptive / Automated Systems to Manual Systems

- Motivations
  - Scalability
    - Can scale with machines, not humans
  - Availability / Latency
    - Can adapt to changing environment more rapidly
  - Cost
    - Machines are far less expensive than humans
    - Can learn / improve / adjust over time without manual effort

Best Practice 3: Automate Everything

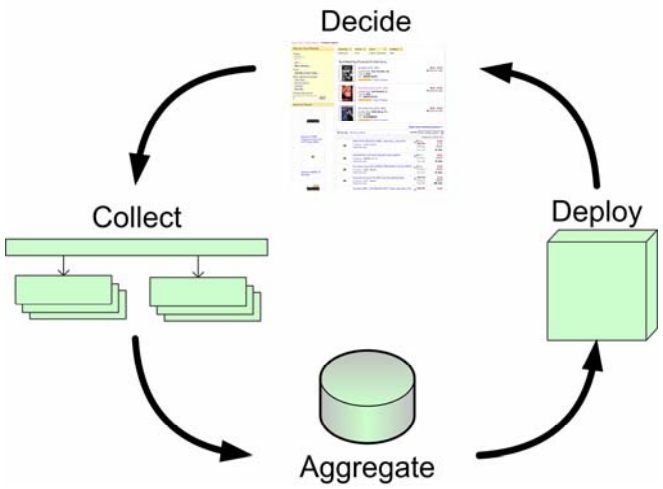
Pattern: Adaptive Configuration

- Define SLA for a given logical consumer
  - E.g., 99% of events processed in 15 seconds
- Dynamically adjust config to meet defined SLA



Pattern: Machine Learning

- Dynamically adapt search experience
  - Determine best inventory and assemble optimal page for that user and context
- Feedback loop enables system to learn and improve over time
  - Collect user behavior
  - Aggregate and analyze offline
  - Deploy updated metadata
  - Decide and serve appropriate experience
- Perturbation and dampening



Best Practice 4: Remember Everything Fails

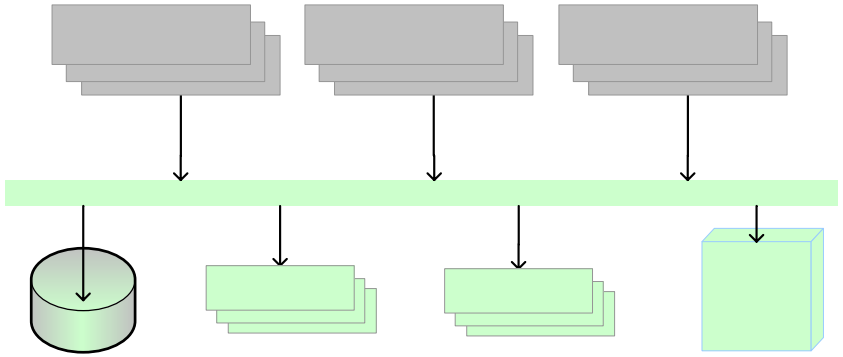
- Build all systems to be tolerant of failure
  - Assume every operation will fail and every resource will be unavailable
  - Detect failure as rapidly as possible
  - Recover from failure as rapidly as possible
  - Do as much as possible during failure

- Motivation
  - Availability

Best Practice 4: Remember Everything Fails

Pattern: Failure Detection

- Servers log all requests
  - Log all application activity, database and service calls on multicast message bus
  - ***Over 2TB of log messages per day***
- Listeners automate failure detection and notification



Pattern: Rollback

- *Absolutely no changes to the site which cannot be undone (!)*
- Every feature has on / off state driven by central configuration
  - Feature can be immediately turned off for operational or business reasons
  - Features can be deployed “wired-off” to unroll dependencies

Pattern: Graceful Degradation

- Application “marks down” an unavailable or distressed resource
- Non-critical functionality is removed or ignored
- Critical functionality is retried or deferred

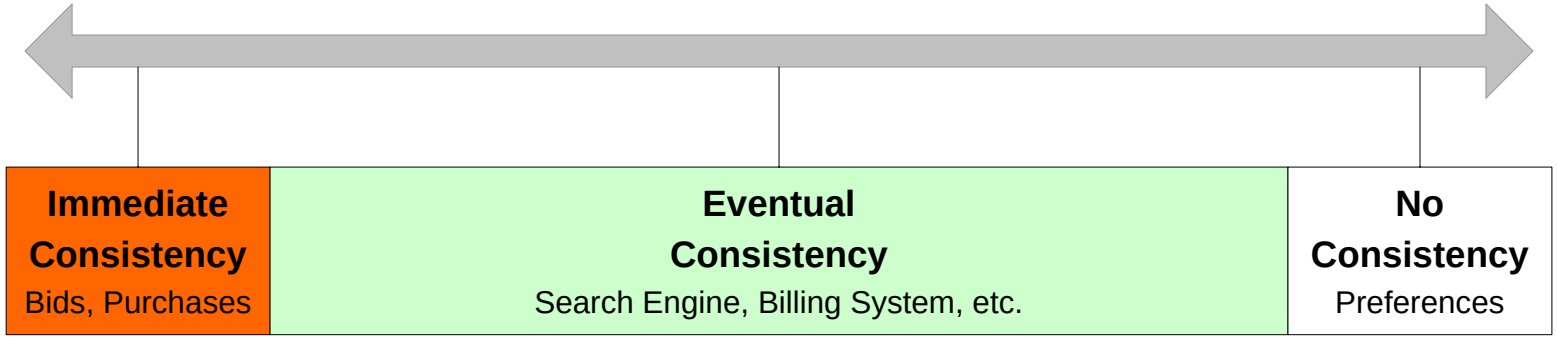
Best Practice 5: Embrace Inconsistency

- Brewer's CAP Theorem
  - Any shared-data system can have at most two of the following properties:
    - ***C**onsistency: All clients see the same data, even in the presence of updates*
    - ***A**vailability: All clients will get a response, even in the presence of failures*
    - ***P**artition-tolerance: The system properties hold even when the network is partitioned*
  - This trade-off is fundamental to all distributed systems

Best Practice 5: Embrace Inconsistency

Choose Appropriate Consistency Guarantees

- To guarantee availability and partition-tolerance, we trade off immediate consistency
- Most real-world systems (even financial systems!) do not require immediate consistency
- Consistency is a spectrum
- Prefer eventual consistency to immediate consistency



Avoid Distributed Transactions

- eBay does absolutely no distributed transactions – no two-phase commit
- Minimize inconsistency through state machines and careful ordering of operations
- Eventual consistency through asynchronous event or reconciliation batch

Recap: Best Practices for Scaling

1. Partition Everything
2. Asynchrony Everywhere
3. Automate Everything
4. Remember Everything Fails
5. Embrace Inconsistency

Questions?

About the Presenter

Randy Shoup has been the primary architect for eBay's search infrastructure since 2004. Prior to eBay, Randy was Chief Architect and Technical Fellow at Tumbleweed Communications, and has also held a variety of software development and architecture roles at Oracle and Informatica.

rshoup@ebay.com