

## Cloud Design Patterns

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## Load Balancing

- Improves the distribution of workloads across multiple computing resources
  - Some resources will be busy while others are idle
- Aims to
  - Optimize resource use
  - Maximize throughput
  - ☐ Minimize response time
  - Avoid overload of any single resource

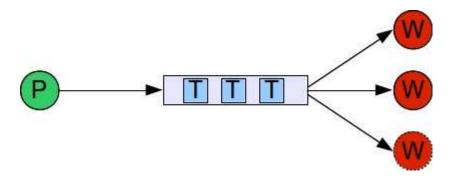
## Load Balancing

- Counter by distributing load equally
  - □ When cost of problem is well understood (e.g., matrix multiplication, known tree walk) this is possible
- Some other problems are not that simple
  - Hard to predict how workload will be distributed
  - dynamic load balancing used
  - But require communication between tasks

- 2 methods for dynamic load balancing
  - □ Task queues vs. work stealing

## Task Queues

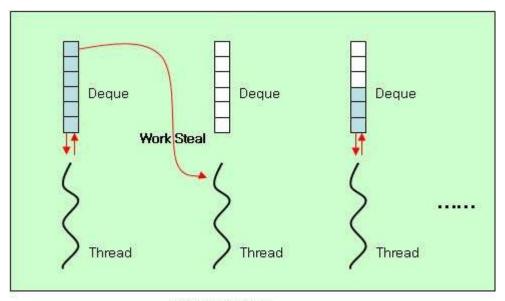
- Multiple instance of task queues (producer
  - consumer)
- Threads comes to the task queue after finishing a task & grab next task
- Typically run with a pool of workers



Source: http://blog.zenika.com

## Work Stealing

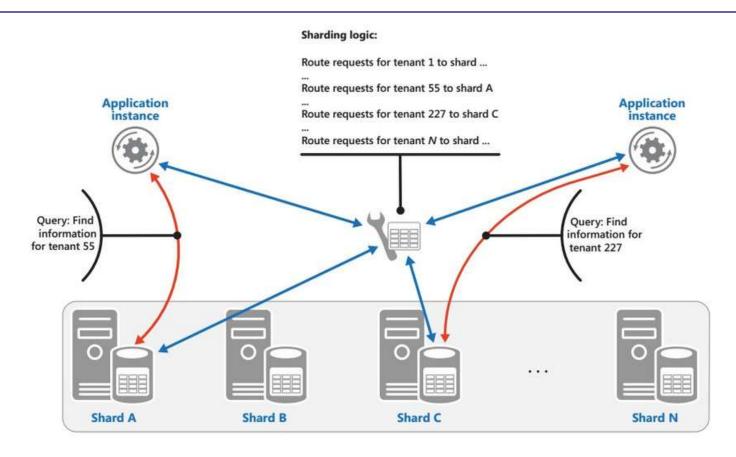
- Every worker has a task queue
- When 1 worker runs out of work, it goes to other worker's queue & "steal" the work



ThreadPool

Source: http://karlsenchoi.blogspot.com

## **Sharding Pattern**

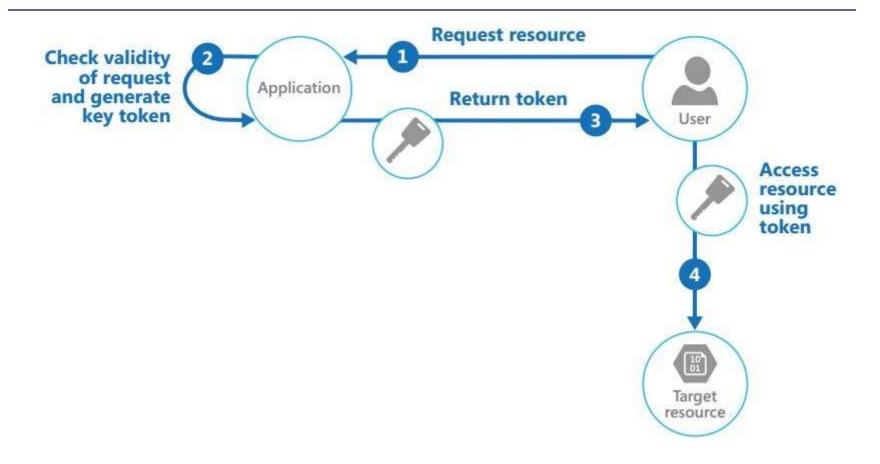


 Divide a data store into a set of horizontal partitions or shards to improve scalability

## Sharding Pattern (Cont)

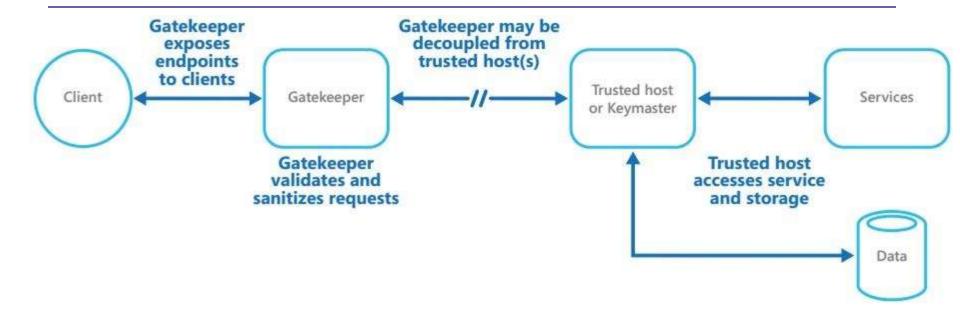
- When
  - Limited storage space
  - Large computation requirement
  - Network bandwidth
  - Geographical constraints
- Sharding Strategies
  - Lookup Strategy map request using a shard key
  - Range Strategy groups related items together in the same shard
  - Hash Strategy shard decided based on hashing data attributes

## Valet Key Pattern



 Use a token or key that provides client with restricted direct access to a specific resource or service

## Gatekeeper Pattern

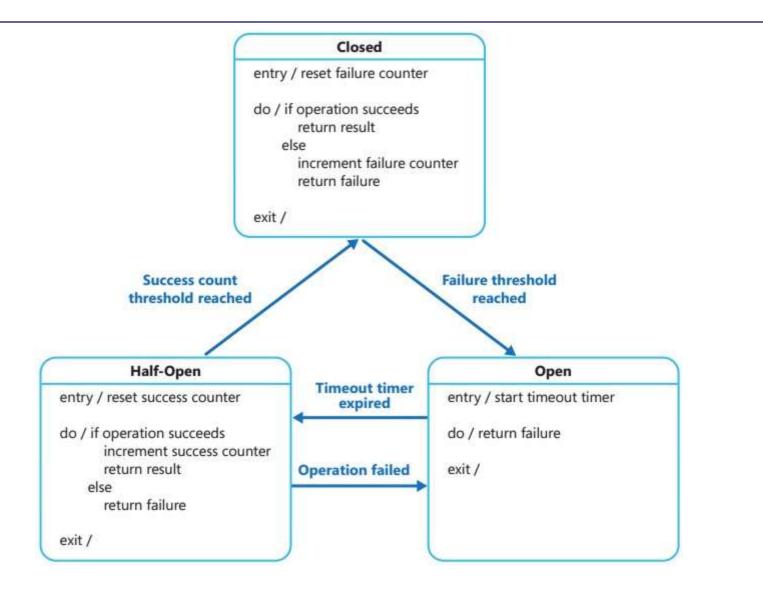


- Protect applications & services using a dedicated host instance that acts as a broker
  - Validates & sanitizes requests
  - Passes requests & data between them

## Gatekeeper Pattern (Cont.)

- Only function is to validate & sanitize requests
- Should use secure communication between gatekeeper & trusted hosts
- Internal end point must connect only to gatekeeper
- Gatekeeper must run in limited privilege mode
- May use multiple gatekeepers for availability

## Circuit Breaker Pattern



## Circuit Breaker Pattern (Cont.)

#### When

- Handle faults that may take a variable amount of time to rectify when connecting to a remote service/resource
- ☐ When a simple retry will not work
- Prevent application from getting tied-up due to retry

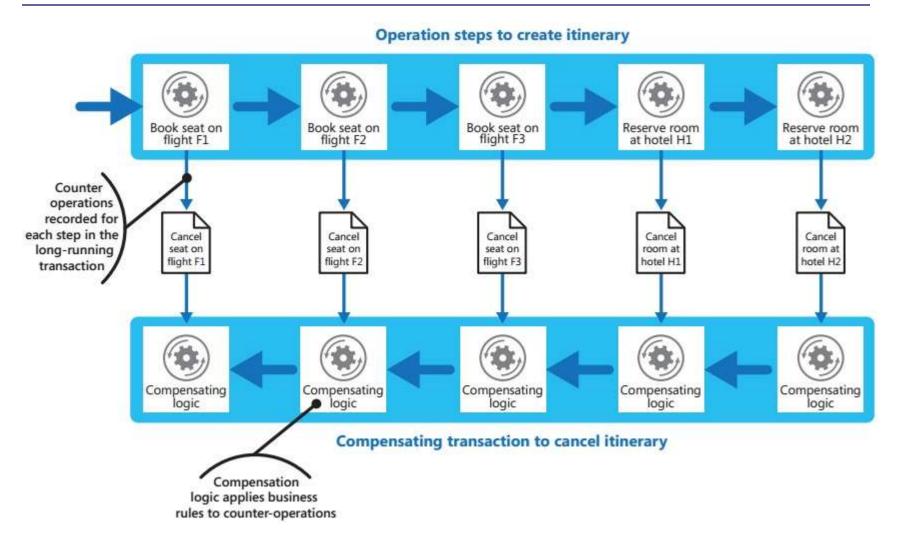
### Half-Open State

- Allow checking whether service is responding by issuing a limited set of requests
- Prevent repeated system failures due to rapid load/volume

## Circuit Breaker Pattern (Cont.)

- Parameters
  - Types of exceptions
  - Handling exceptions
  - Logging & replay
  - Testing failed operations
  - □ Manual reset

## Compensating Transaction Pattern



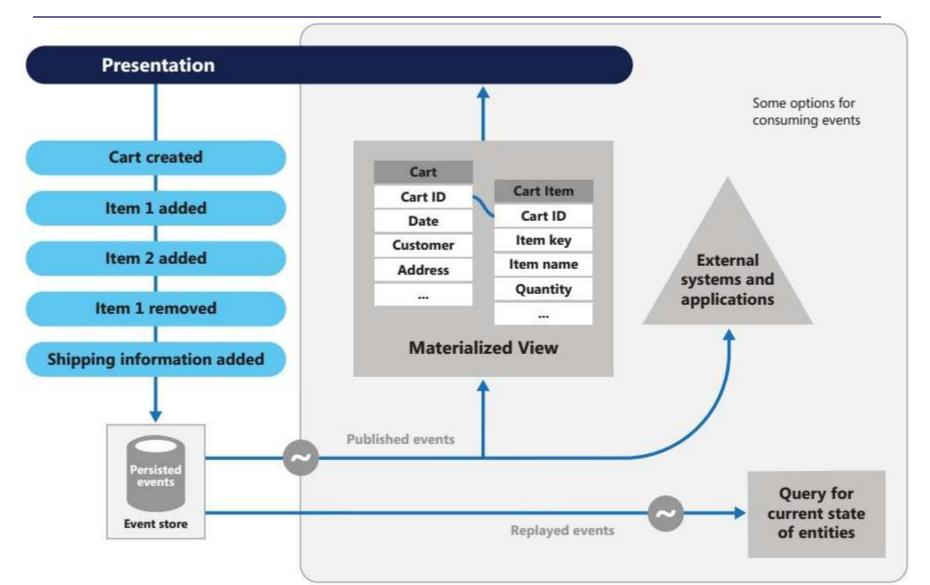
# Compensating Transaction Pattern (Cont.)

Undo work performed by a series of steps, which

together define an eventually consistent operation

- Implement a workflow
  - As operation proceeds, system records information about each step & how the work by that step can be undone
  - □If operation fails at any point, workflow rewinds back through steps it has completed while performing work that reverses each step

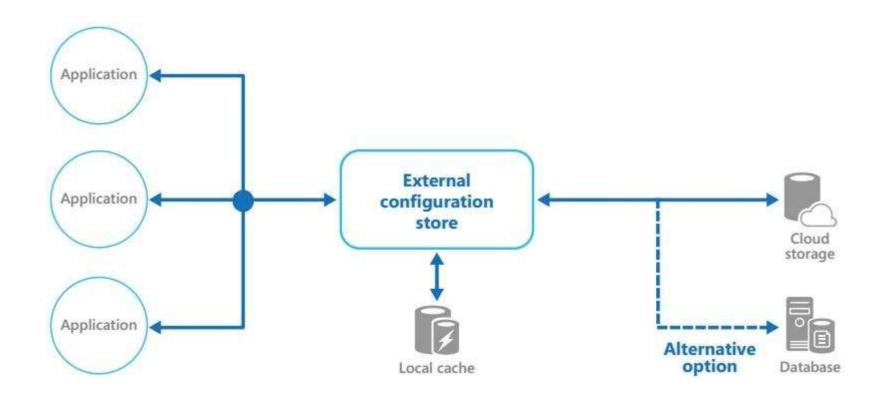
# **Event Sourcing Pattern**



## Event Sourcing Pattern (Cont.)

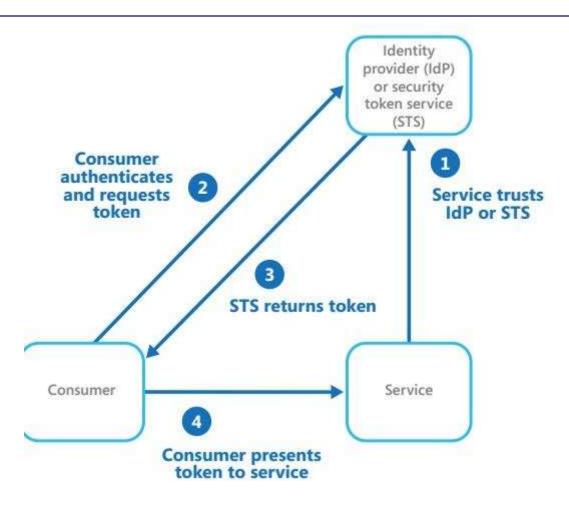
- Record full series of events than current state
- Pros
  - Avoid requirement to synchronize data
    - Traditional Create, Read, Update, & Delete (CRUD) model too slow
    - Improve performance with eventual consistency
  - Scalability
  - Responsiveness
  - Provide consistency for transactional data
  - ☐ Full audit trails
- Cons
  - Consistency relaxed

## External Configuration Store Pattern



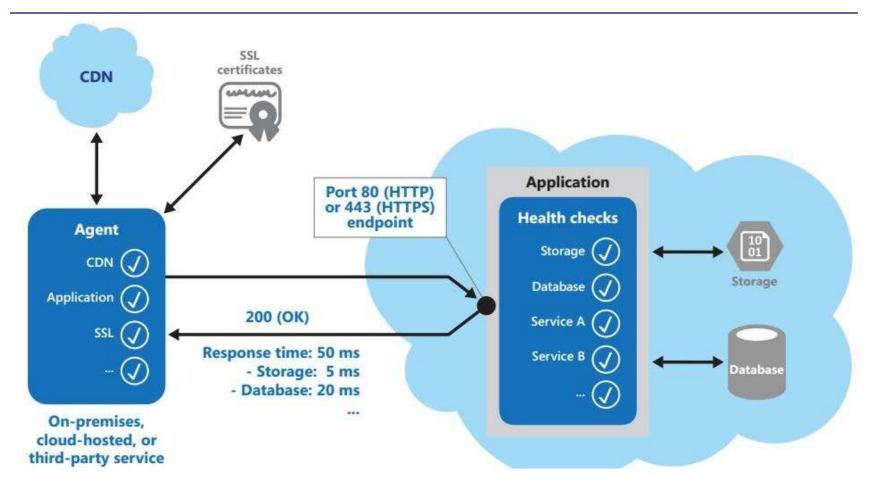
 Move configuration information out of application deployment package to a central location

## Federated Identity Pattern



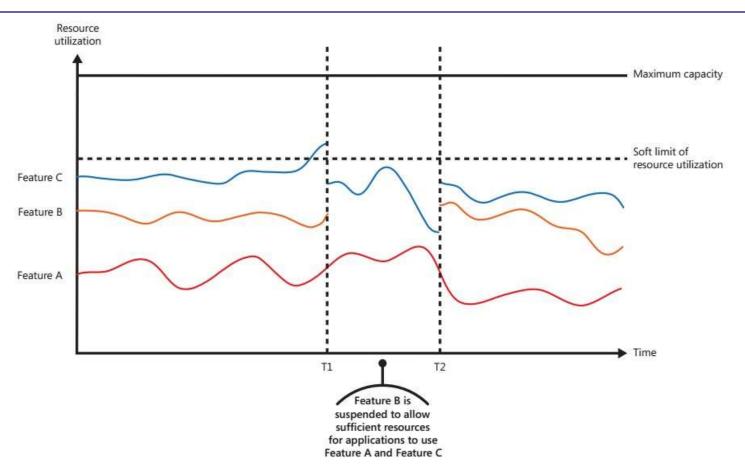
Delegate authentication to an external identity provider

## Health Endpoint Monitoring Pattern



 Functional checks within an application that external tools can access through exposed endpoints at regular intervals

# Throttling Pattern



- Control consumption of resources used by an instance
- Allow system to continue to function & meet SLA even when an increase in demand places an extreme load on resources