Enterprise Patterns

Jim Yu

IBM
China Development Lab
Greater China Group

Introduction to Enterprise Systems

- Examples of enterprise systems
  - payroll, transaction processing, shipping tracking, accounting, foreign-trade exchange, etc.
- Characteristics
  - Emphasis on data
    - Persistent data
    - High volume of data
    - High complexity of data
    - Concurrent access of data
    - Lots of user interface screens to handle data

Introduction to Enterprise Systems

- The need to integrate with other enterprise applications
- Different definitions and concepts with data between different departments/systems
- Complex business logic
  - may be political and illogical, but they are the rules of doing business

Consider Beyond Functional Requirements

- Nonfunctional requirements have to be considered and addressed in designing enterprise systems:
  - Extensibility
  - Interoperability
  - Performance
  - Reliability
  - Security
  - Usability
  - etc.

Architectural Considerations

- Layering
  - Divide and conquer a complicated system
  - Higher layers make use of lower layers
    - but not vise versa
  - Performance and scalability considerations
  - Principal layers:
    - Presentation: user interface
    - Domain: logic of the problem domain
    - Datasource: database, messaging systems or other remote systems

Architectural Considerations

- Concurrency
  - often the most tricky aspect of the system
  - the system should act correctly on concurrent accesses
    - no deadlocks, corrupted data, lost updates, etc.
  - often provided in
    - database
    - hand-written concurrency control code

Architectural Considerations

- Distribution strategies between layers
  - no distribution: for simple systems
  - inter-process communications (IPC)
    - remote method call style (Java RMI, .Net remoting, RPC in C, Facebook's thrift RPC)
    - serialize yourself (via TCP or HTTP)
    - message-oriented middleware
  - Decide what to transfer
    - more data/more frequent transfers lead to more performance degradation
    - should be minimized

Enterprise/Cloud Computing Patterns

- Resource preparation
  - Singleton instance
  - Prototype images
- Architecture
  - n-Tier web pattern
  - adapter
  - facade
  - proxy & balancer
  - heartbeat
  - Map/Reduce

Enterprise/Cloud Computing Patterns

- Behaviors
  - Queuing
  - Observer/Publish Subscribe
  - Command

Resource Preparation

- Determines how your OS and base system play a role in your application
- Shows how to prepare your virtual images so that you can provide virtual instances on demand

Singleton Instance

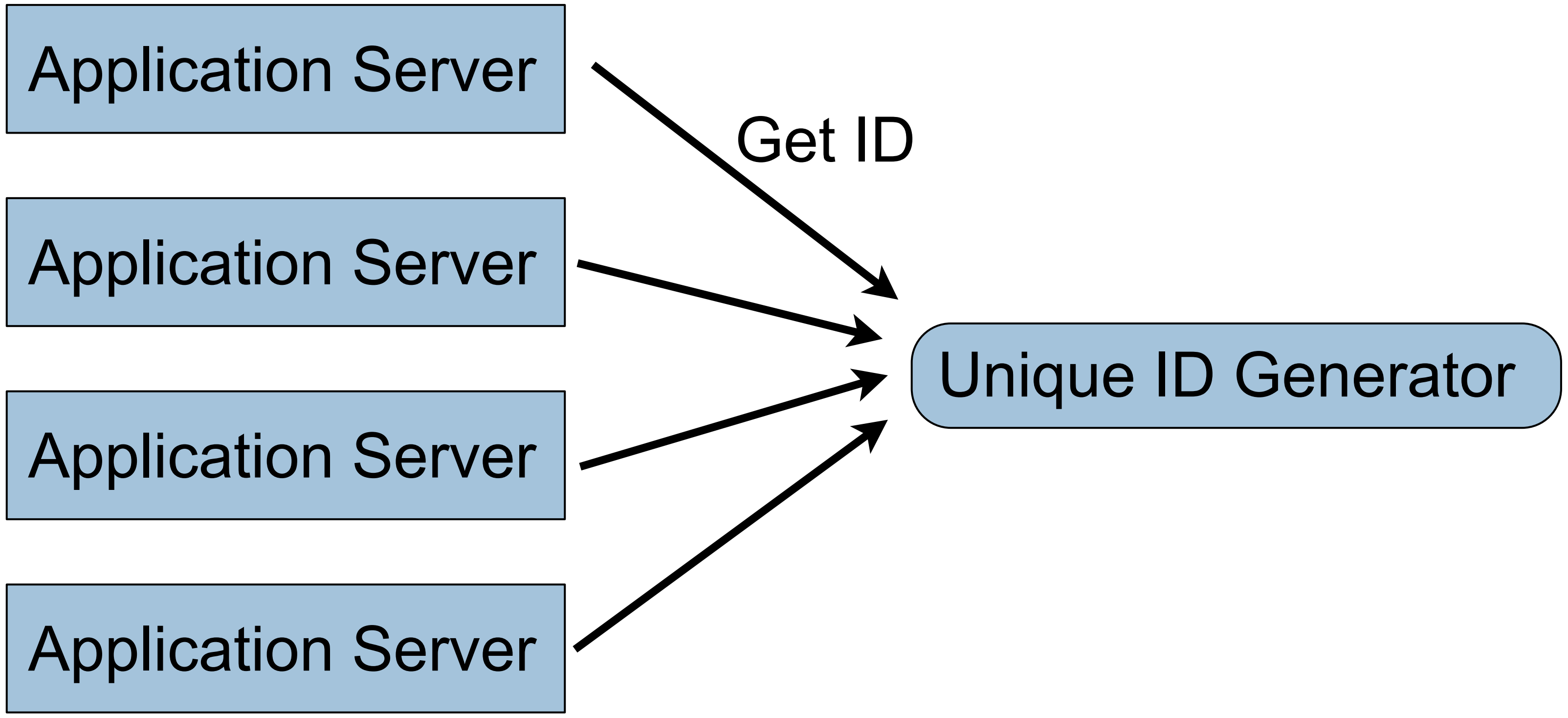
- What it is
  - The instance (real host, virtual machine, or software service) that is a singleton
  - There is only one instance in the environment
- When to use
  - To ensure only one copy of your software is running
  - Consistency is more important than reliability, scalability and performance
  - The load is low that the system can handle

Singleton Instance

- Make preparations to ensure the system downtime is minimized
  - Backups
  - Standby instance

Singleton Instance

- Example



Prototype Images

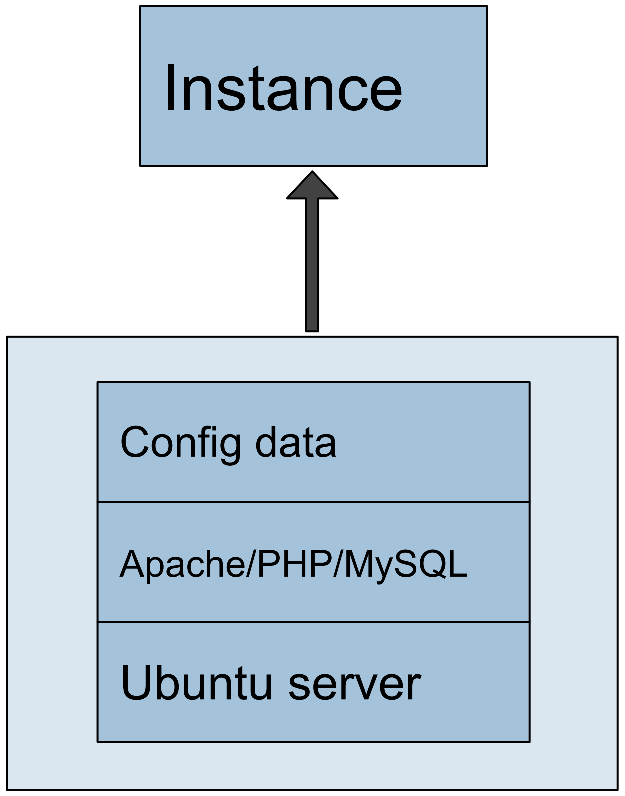
- What it is
  - A VM (virtual machine) image that serves as the prototype
  - When new VM instance is needed, it is cloned from the prototype image
  - The prototype image is built with software packages and configuration data common to the instances

Prototype Images

- When to use
  - The basic principle of prototype: when cloning is cheaper than building from scratch
  - You want to maintain a single copy of the image for multiple purposes
  - You want to apply updates when launching a new instance
  - You want to provide expandability to your system by creating new VM instances

Prototype Images

- Example



Architectures

- Determines how your application works with the rest of the world
- Determines how to spread and delegate the requests to your instances

N-Tier Web Pattern

- What it is
  - An architecture that helps your application to scale vertically or horizontally
  - By dividing the application into different modular and swappable tiers (layers)
  - Typically has presentation, application, and database tiers
    - mapped to view, controller, and model in the MVC pattern

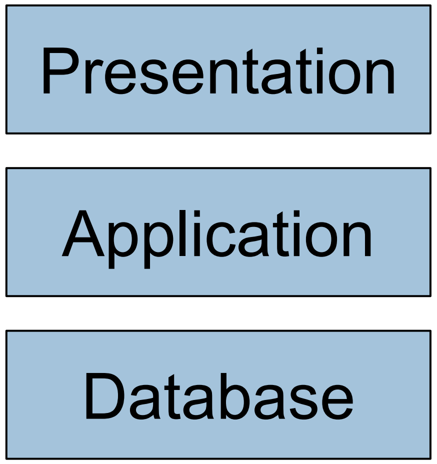
N-Tier Web Pattern

- When to use
  - When building a modular web application
  - When providing multiple interfaces to your application
  - When integrating multiple systems with each other

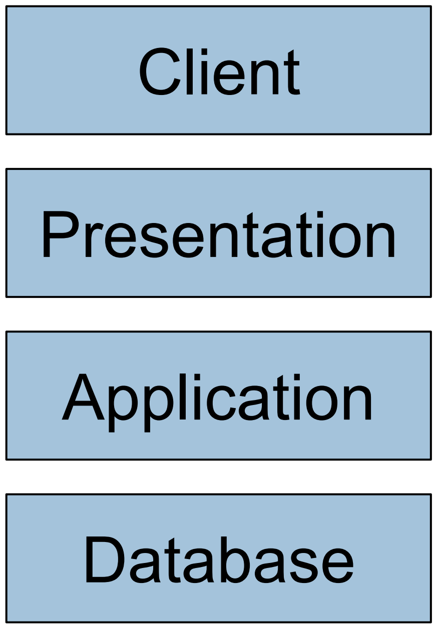
N-Tier Web Pattern

- Conceptual design

Typical 3 tiers

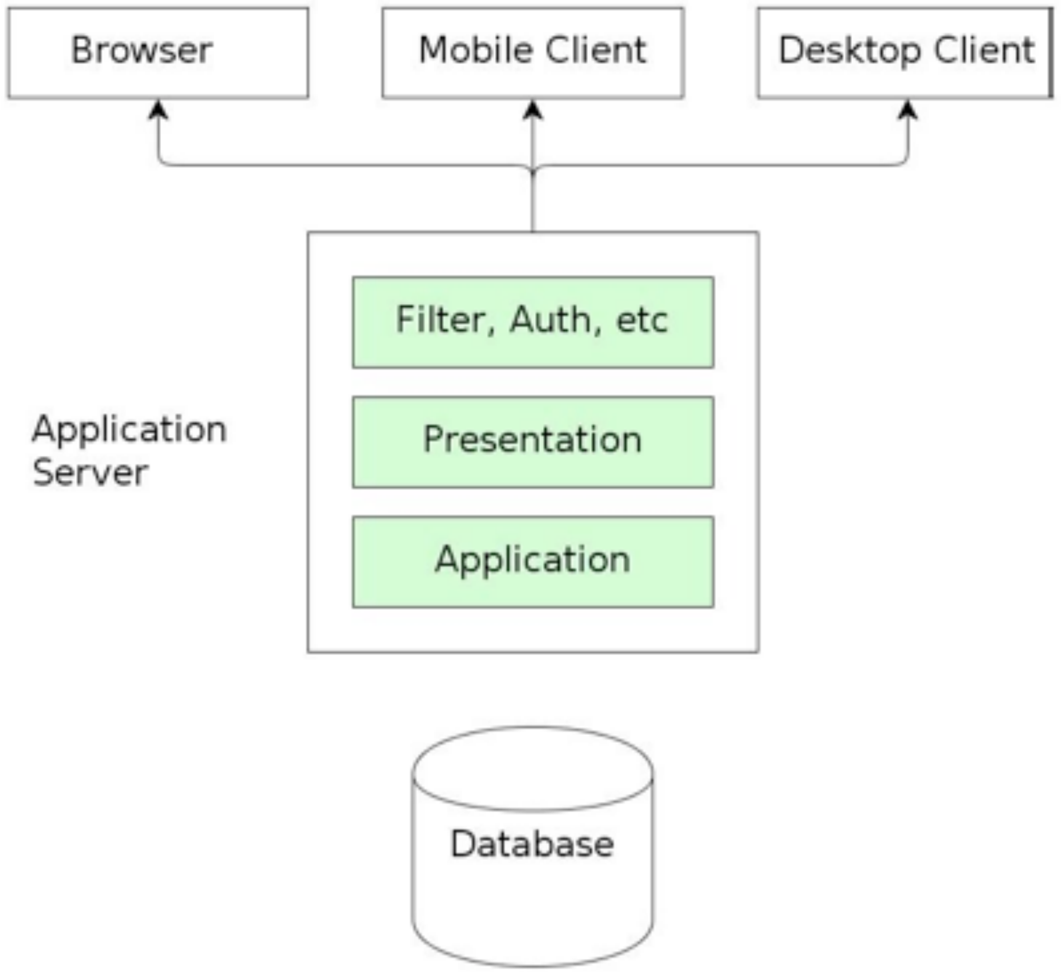


Adding rich client



N-Tier Web Pattern

- Physical deployment

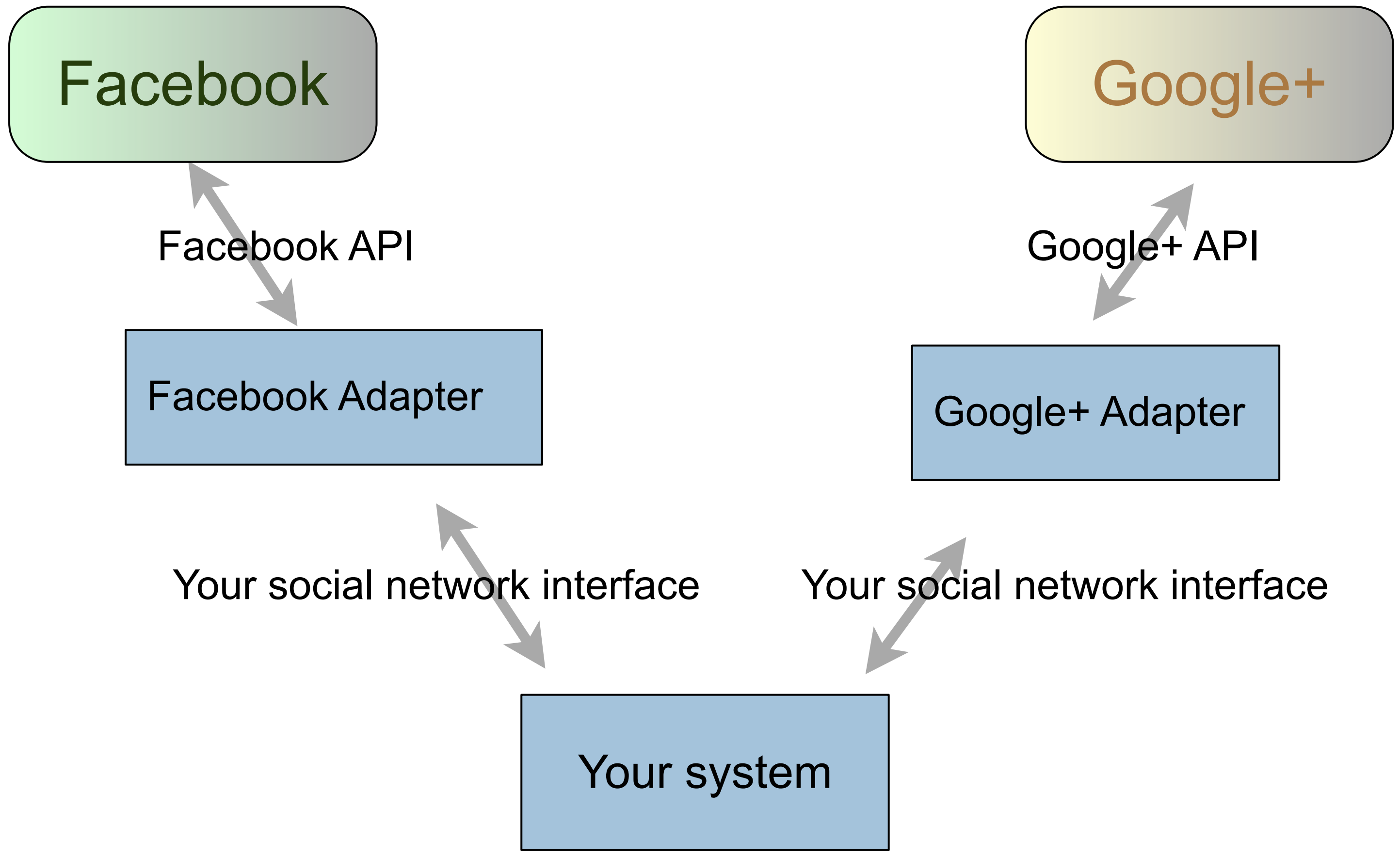


Adapter

- What it is
  - The converter that converts another system’s interface to what you expect
- When to use
  - When you need to interop with multiple systems
  - And you don’t want to ‘speak’ each system’s language
  - It’s better to adapt the outside API to your system than to build your whole system using the outside API

Adapter

- Example

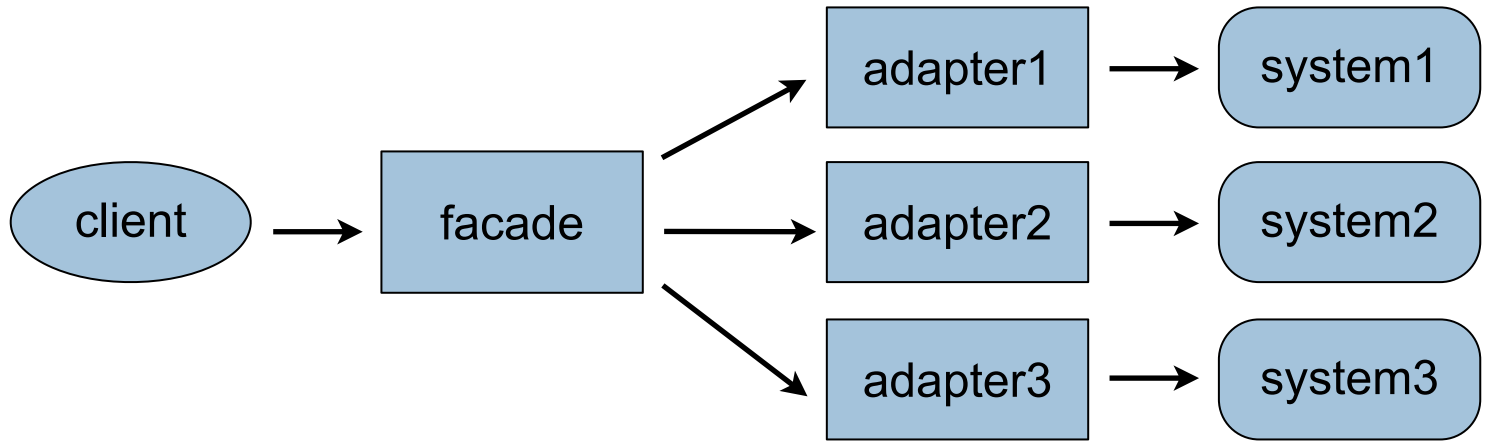


Facade

- What it is
  - A high level interface that unifies multiple interfaces
- When to use
  - When you want to provide a service that makes use of other services
  - For web-based applications, it’s better to provide one-stop service than to redirect the user to different systems

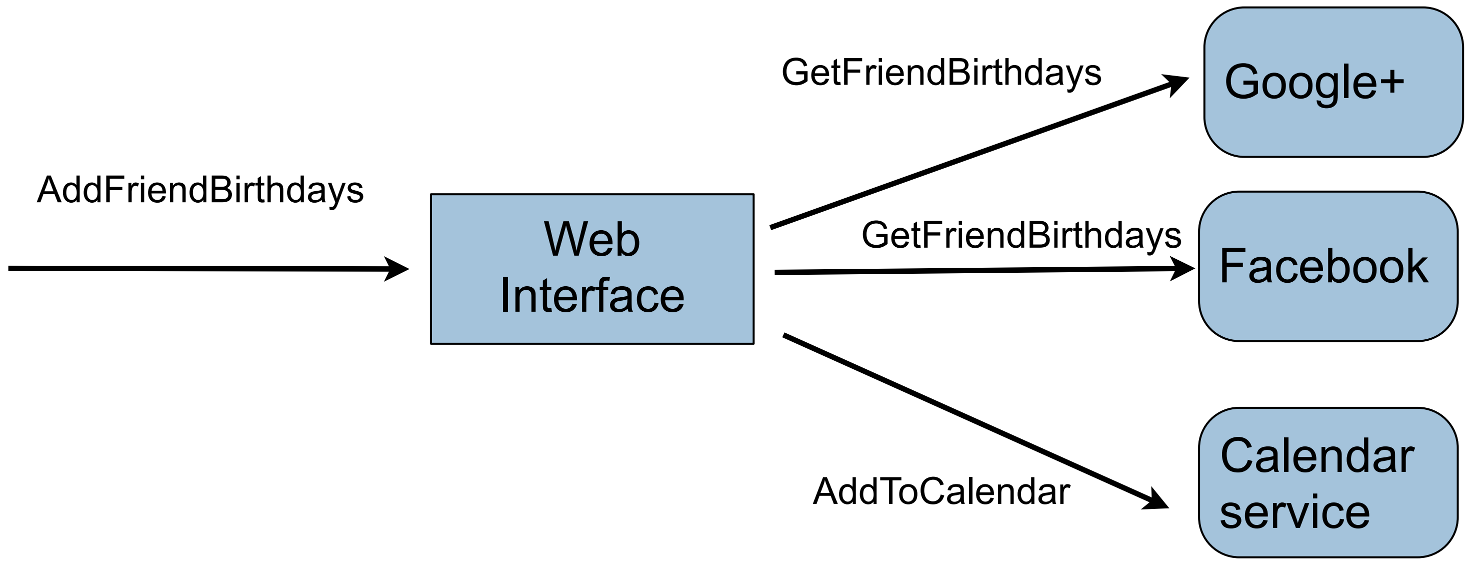
Facade

- Note: facade often makes use of adapters to interact with multiple systems



Facade

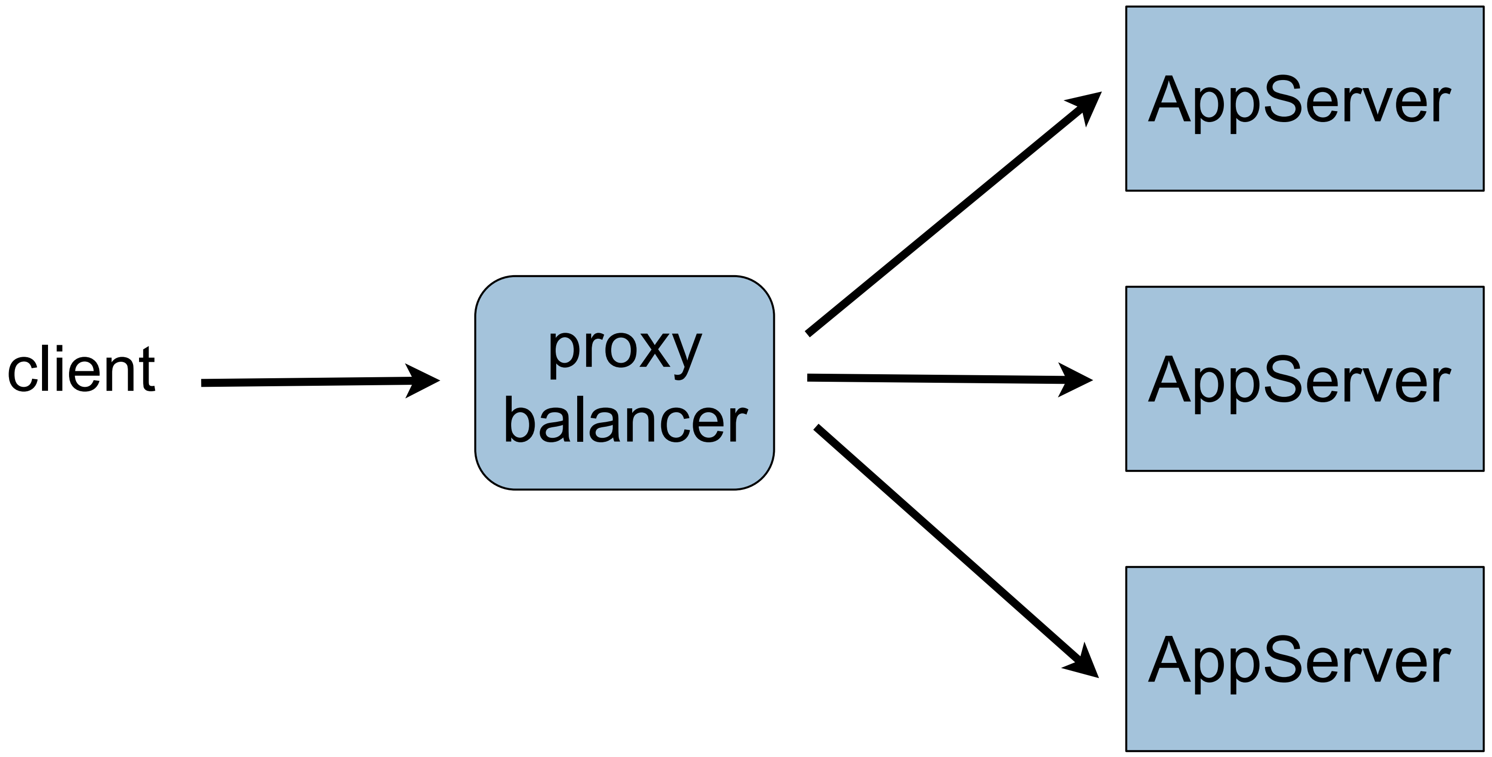
- Example
  - A new request: add friend birthdays to my calendar



Proxy & Balancer

- What it is
  - A host to transparently direct the requests to the application servers
  - To provide reliability and stability for your application
- When to use
  - You need to run multiple copies of the application for availability and performance
  - You need to scale your application seamlessly

Proxy & Balancer

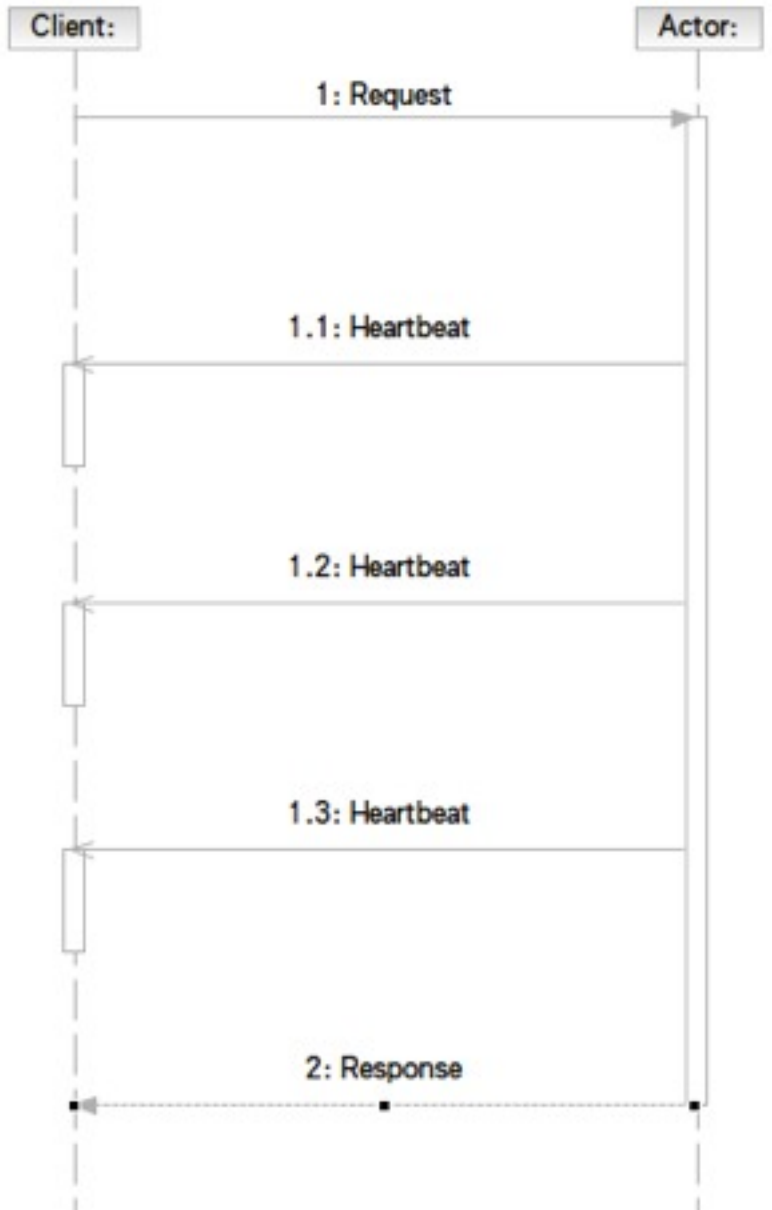


Heartbeat

- What it is
  - A lightweight message the remote host sends back to the client periodically
  - Used to tell the client that the remote host is still alive
- When to use
  - You need to decide that the remote operation will not complete
  - The time to complete the operation is variable or not known a priori

Heartbeat

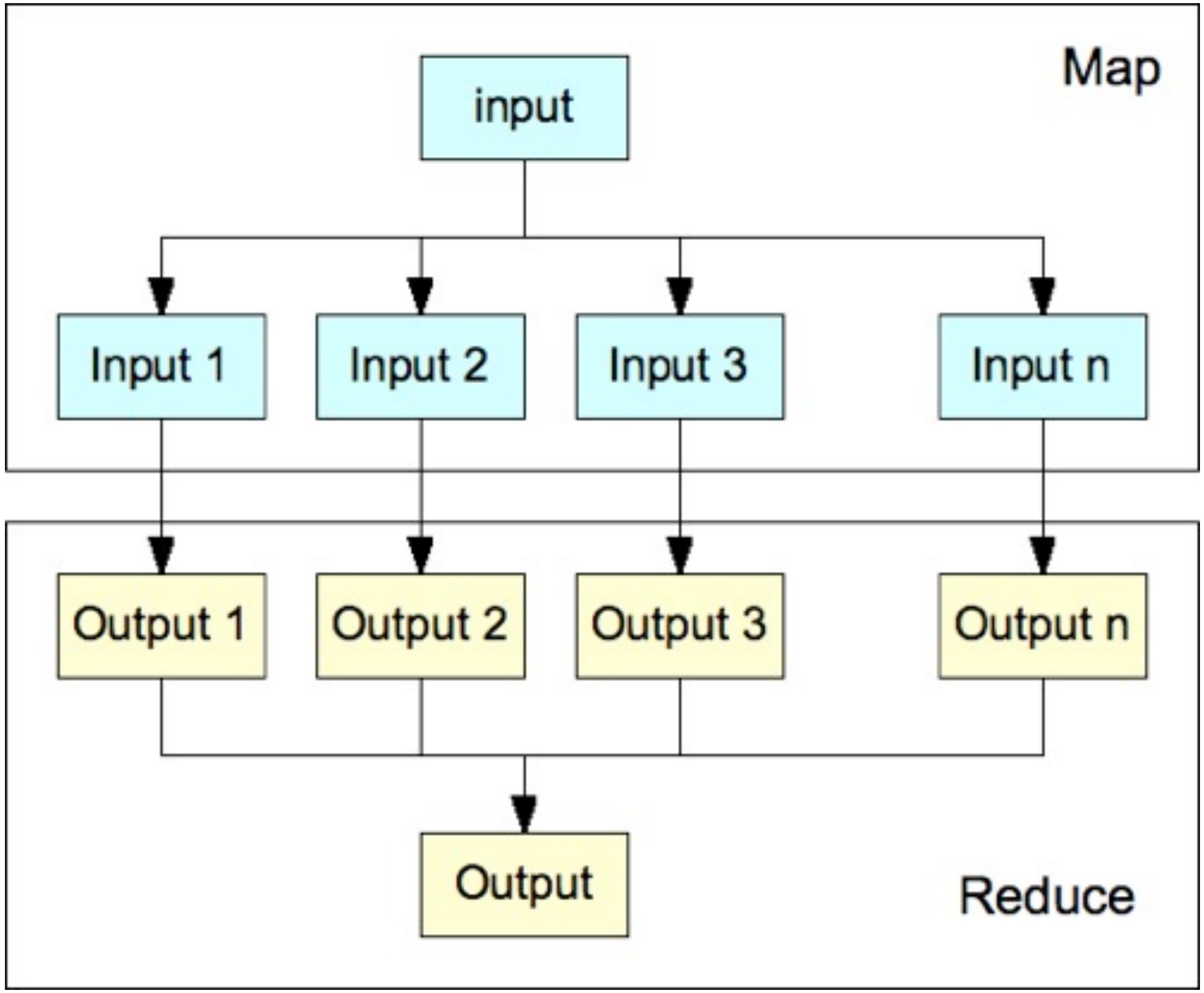
- The pattern



Map/Reduce

- What it is
  - A divide-and-conquer pattern
    - Split a large task into small pieces that are manageable and distributable
    - Run the small pieces in parallel
    - Combine the processed pieces into the final result
- When to use
  - You have a large input set to process
  - The input is splittable
  - The data need to be processed quickly

Map/Reduce


Map
input
Input 1
Input 2
Input 3
Input n
Output 1
Output 2
Output 3
Output n
Output
Reduce

Map/Reduce

- Implementations
  - Google’s services
  - Apache Hadoop
  - Nokia Disco
  - Mapreduce.Net
  - Skynet

Behaviors

- Determine object interactions in the system with exterior systems
- Determine how to execute actions on data
  - Synchronous or asynchronous
- Reduce coupling in the system

Queuing

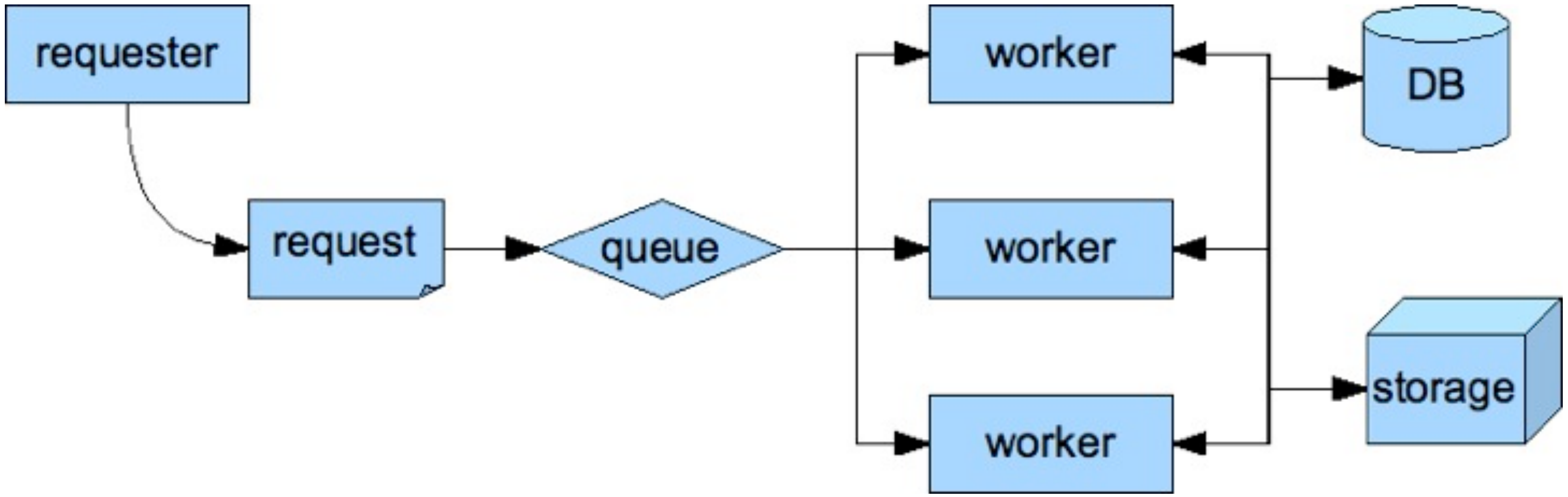
- What it is
  - The subsystems (colleagues) communicate with each other using the message queue system
  - A subsystem sends a message to the queue for requesting services
  - Another subsystem receives and removes the message to handle the request
  - Asynchronous request handling
  - Supports multicast requests
  - Is fault tolerant

Queuing

- When to use
  - You need fault tolerance for requests
  - You need to scale by adding workers at runtime
  - You need to decouple and hide the request sender and receiver

Queuing

- The pattern



Observer/Publish-Subscribe

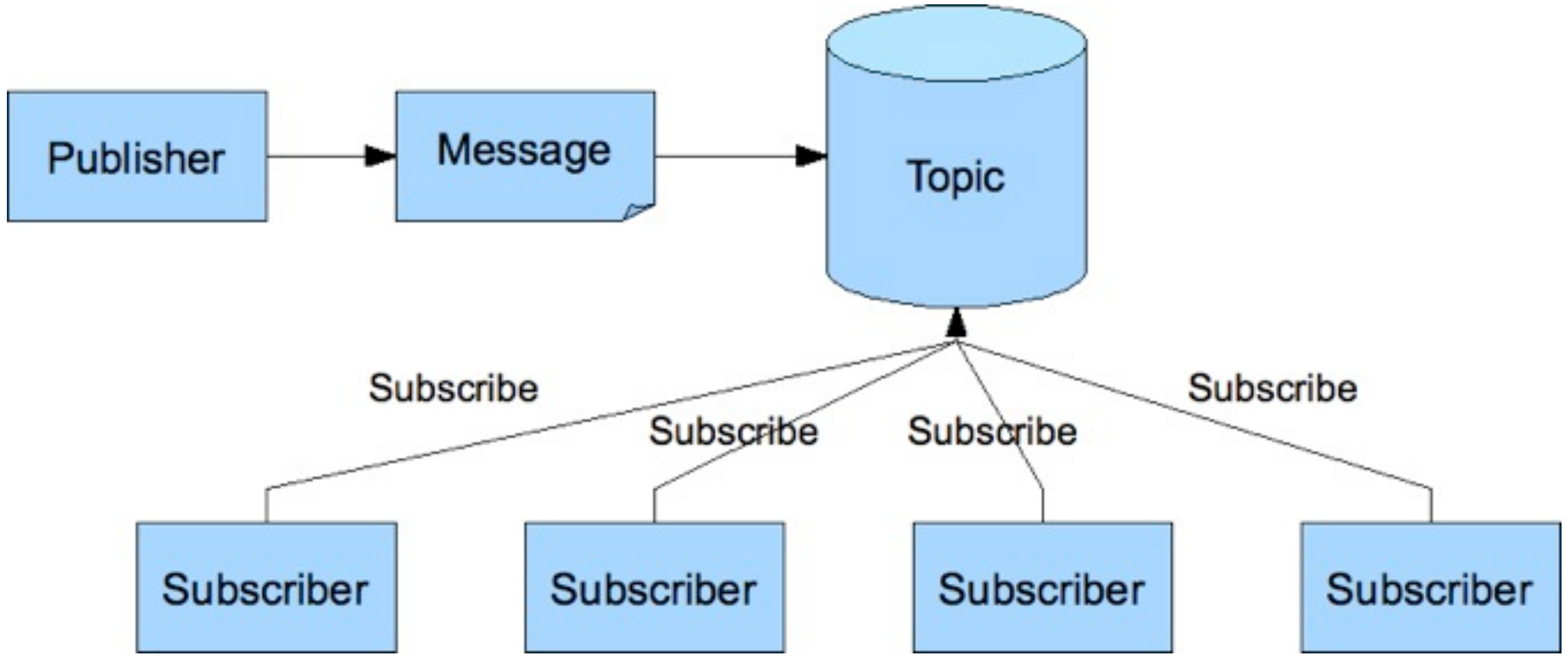
- What it is
  - The observer pattern implemented in a distributed environment
  - One-to-many messaging pattern
  - Publisher sends a message to the “topic”
  - The subscribers receive the message from the “topic”
  - Asynchronous in nature
  - Often provided by messaging middleware

Observer/Publish-Subscribe

- When to use
  - You need a more scalable alternative to periodical polling of the remote service
  - Multicast messages must be delivered to the recipients
    - In a reliable manner
  - You need to decouple and hide the request sender and receiver

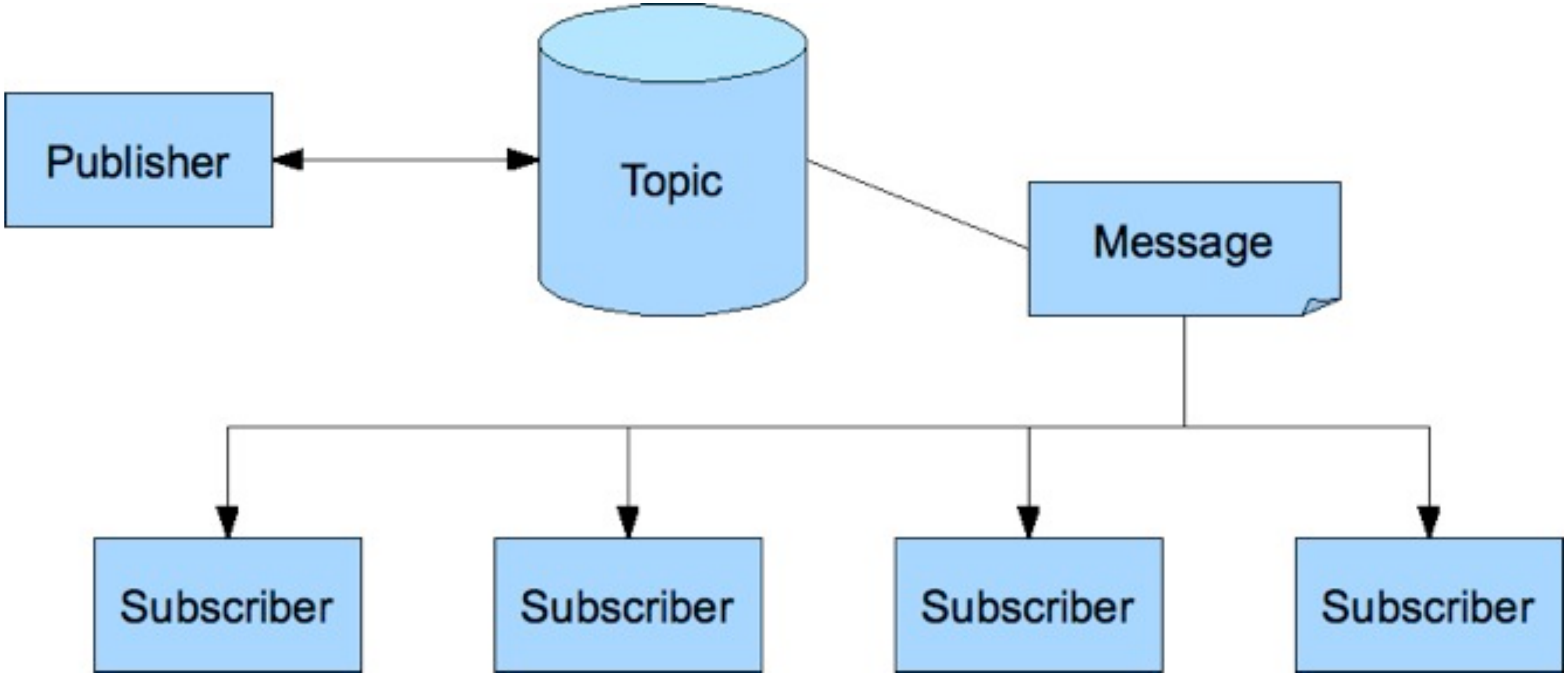
Observer/Publish-Subscribe

- Publisher sends the message



Observer/Publish-Subscribe

- Each subscriber gets a copy of the message



Command

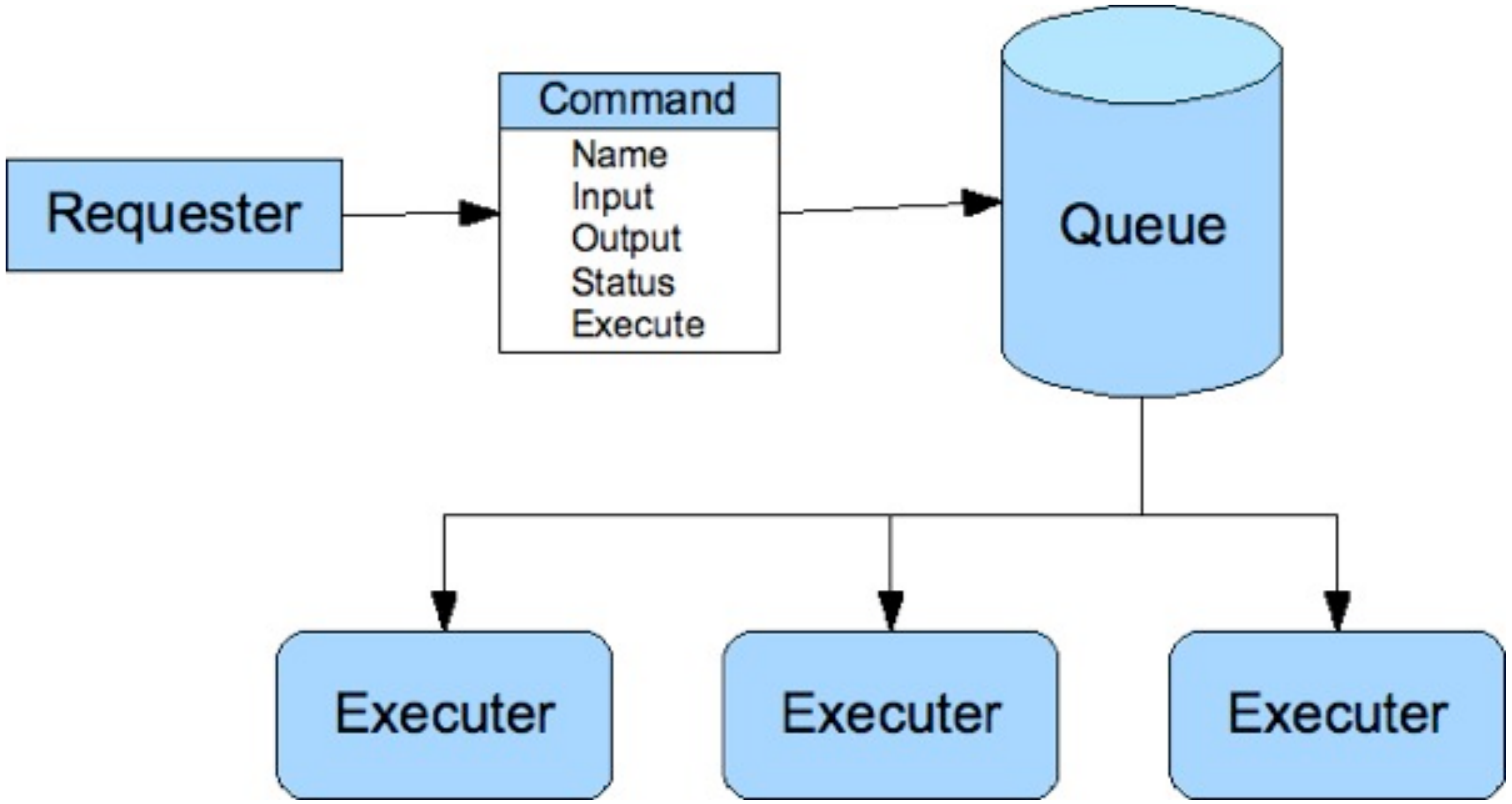
- What it is
  - A request/action encapsulated as an object
  - The object can be passed to other hosts for execution
  - Supports queueing, logging, rollback operations (with the Memento pattern)
  - Often used with the queue pattern
    - To support high availability, scalability

Command

- When to use
  - You have multiple types of executable jobs to perform
  - You want to track statistics of the jobs
  - You want to specifically define how the job is executed

Command

- The pattern



Command

- Implementation
  - The capability of
    - serializing an object
    - transmitting the object over the network
    - optionally storing the object
    - deserializing the object on another host to process
  - Example
    - Java Hadoop cluster
      - Submit the action packaged as a jar file to the cluster

Summary

- Characteristics and requirements of enterprise systems
- Architectural considerations
- Think beyond functional requirements
- GoF patterns applied in distributed/ enterprise computing

References

- Christopher M. Moyer, *Building Application in the Cloud: Concepts, Patterns and Projects*, Addison-Wesley, 2011
- Mark Grand, *Java Enterprise Design Patterns*, John Wiley & Sons, 2002
- Martin Fowler, *Patterns of Enterprise Application Architecture*, Addison Wesley, 2002