

# Middleware Architectures 1

## Lecture 5: Application Server Architecture

**doc. Ing. Tomáš Vitvar, Ph.D.**

tomas@vitvar.com • @TomasVitvar • <https://vitvar.com>



Czech Technical University in Prague

Faculty of Information Technologies • Software and Web Engineering • <https://vitvar.com/lectures>



Modified: Sun Nov 19 2023, 19:53:57  
Humla v1.0

# Overview

- Application Server Architecture
- Serving Requests
- Objects Distribution

# Application Server Overview

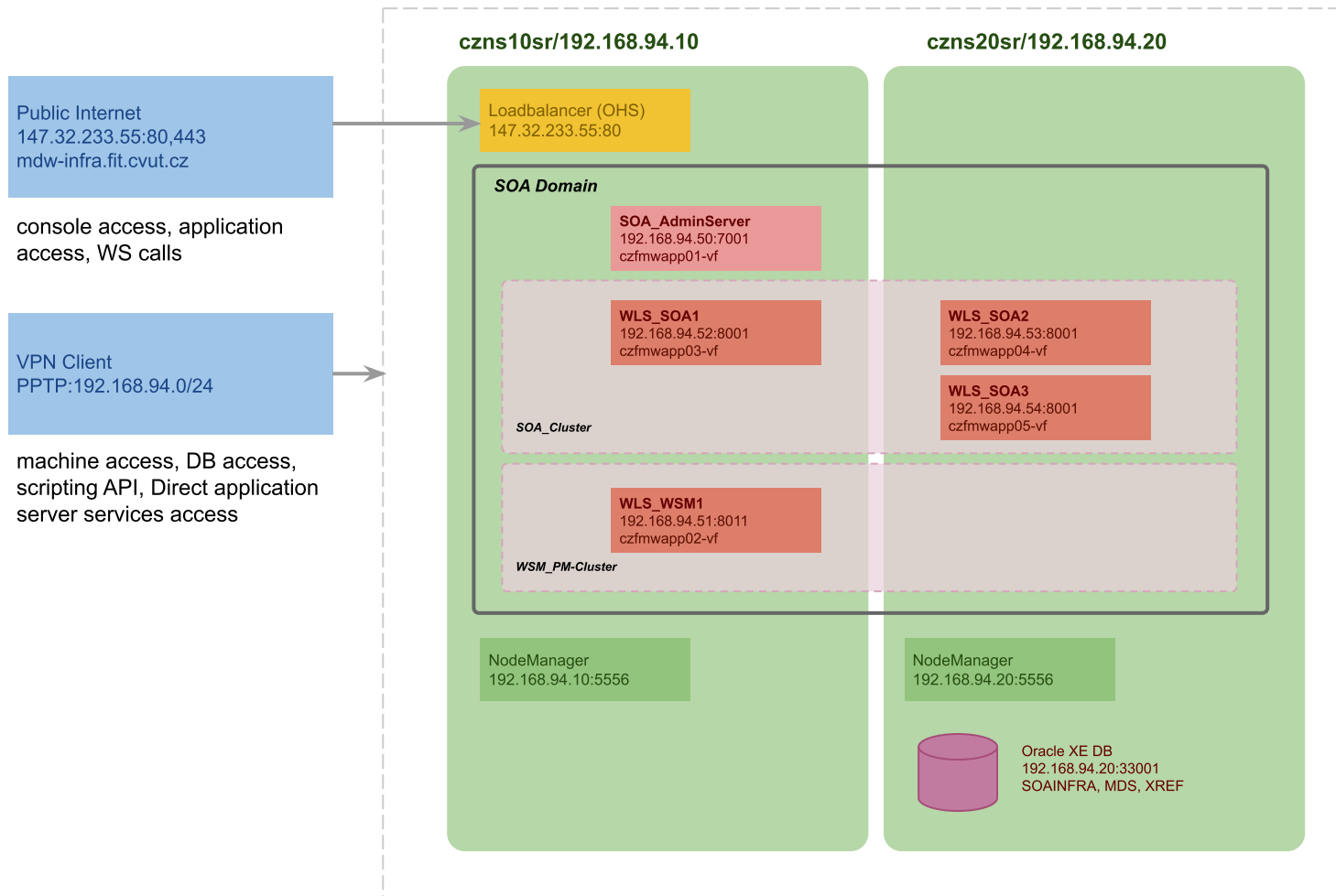
- An environment that runs an application logic
  - *A client communicates with the server using an application protocol*
- Application Server
  - *A modular environment*
    - *provides technology to realize enterprise systems*
    - *JEE containers – Java technology for AS components*
    - *Supports a variety of objects such as Servlets, JSPs, JMS*
  - *Provides services such as naming and directory, performance, failover*
  - *Provides Web server capabilities*
  - *Can be a single server or multiple servers*
- Web Tier – HTTP Server
  - *Web Server supports HTTP only*
  - *HTTP request/response, security, proxy, caching*

# Application Server Layers



- Features
  - *AS instance appears as a single process in the OS*
    - you can use standard OS commands to investigate its operation
    - AS listens on a single or multiple IPs (VIPs) and a tcp port
  - *AS is a Java process*
    - you can use Java tools to investigate its operation
    - Garbage collector stats, thread dumps, memory allocations, etc.

# Example Weblogic Infrastructure



# Terminology

- Domain
  - *A group of servers with specific configuration of applications and objects*
- Administration Server
  - *An instance of application server that manages the domain*
- Managed Server
  - *An instance of application server running instances of applications and objects*
- Cluster
  - *A group of managed servers; they contain the same copy of applications and objects*
- Machine
  - *A physical machine and OS running one or more servers (Admin or Managed)*
- Node Manager
  - *A process that provides an access to admin and managed servers on the machine*
- Load Balancer
  - *A network element that distributes client requests to managed servers based on a specific algorithm*

# Servlet Technology

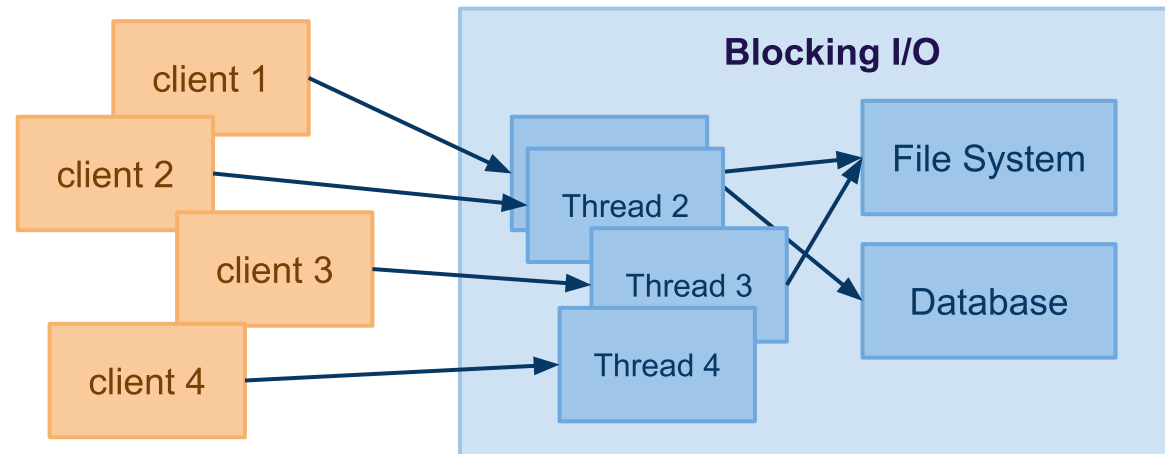
- Technology to extend application server functionalities
  - *A Java class that can respond to any type of requests*
    - *A servlet defines an interface for a specific protocol*
    - *Your application implements the servlet's interface*
- Commonly used to respond to HTTP requests
  - *A basis for an application running on an application server*
  - *HTTP Servlet Java classes*
    - **HttpServlet** – *provides HTTP protocol interface*
    - **HttpServletRequest** – *represents HTTP request*
    - **HttpServletResponse** – *represents HTTP response*

# Overview

- Application Server Architecture
- **Serving Requests**
- Objects Distribution

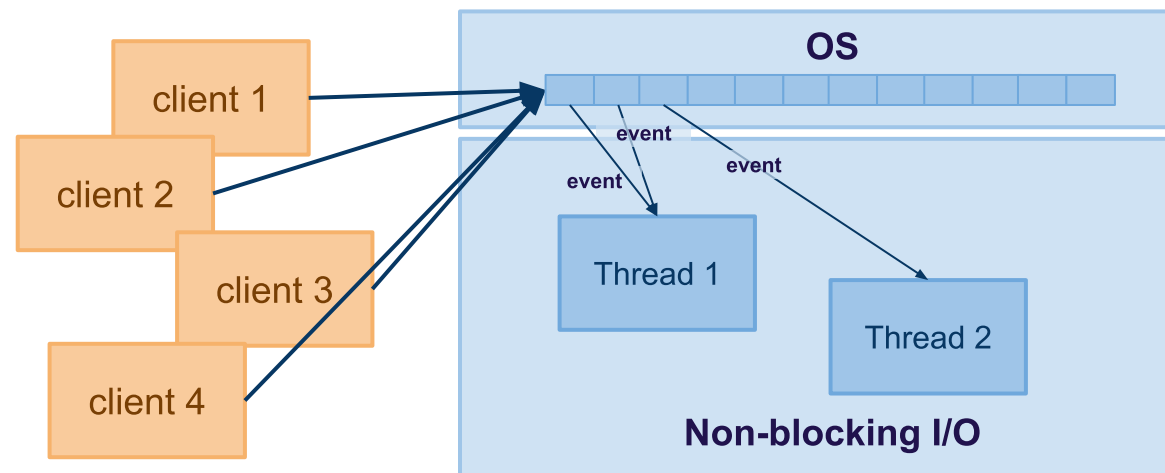


# Blocking (Synchronous) I/O



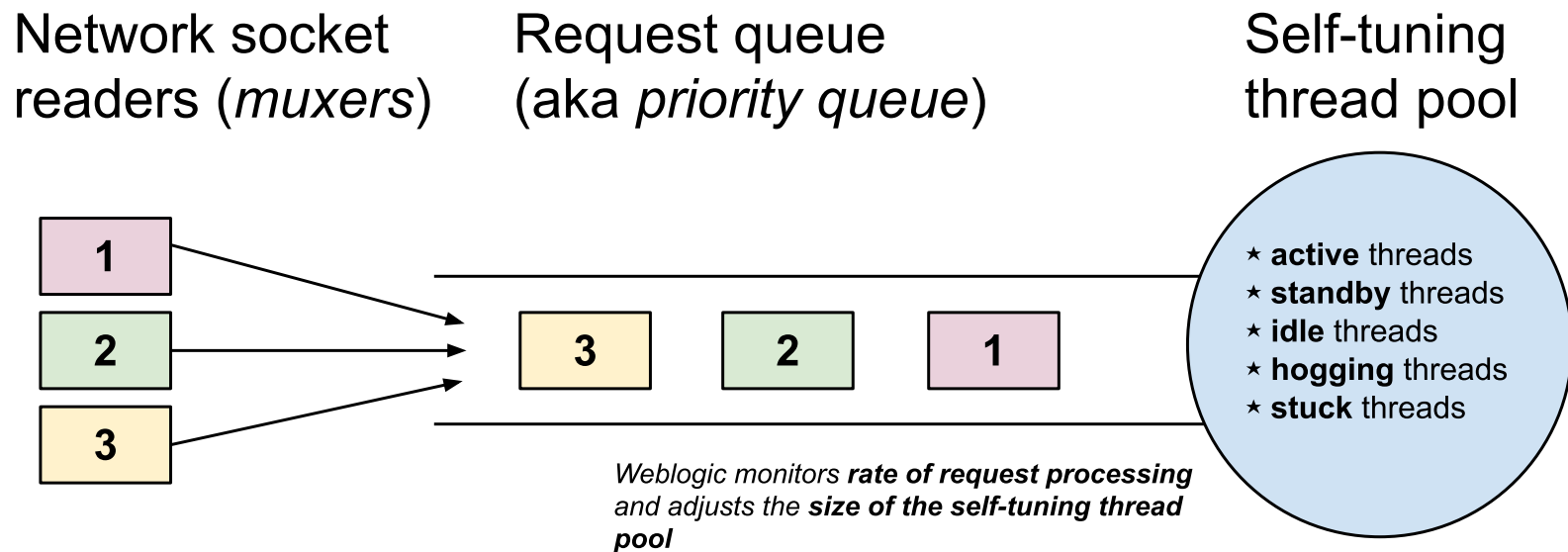
- Inbound connection
  - A server creates a thread for every inbound connection
  - For example, 1K connections = 1K threads, big overhead
  - A thread is reserved for the entire duration of the request processing
- Outbound connection
  - A thread is blocked when outbound connection is made
  - When outbound connection is slow, the scalability is poor

# Non-Blocking (Asynchronous) I/O



- Inbound connections
  - *The connection is maintained by the OS, not the server app*
  - *The Web app registers events, OS triggers events when they occur*
  - *The app may create working threads and controls their number*
- Outbound connections
  - *The app registers a callback that is called when the data is available*
  - *Event loop*

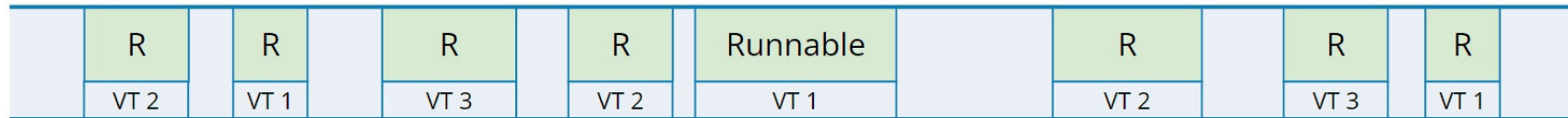
# Components



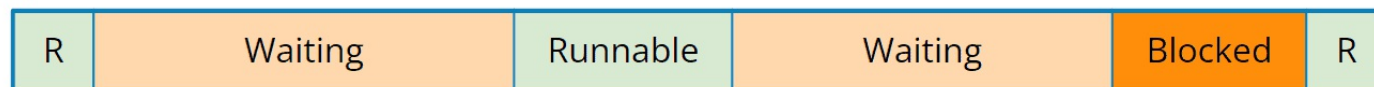
- **Muxer** – component that handles communication via network sockets.
- **Request queue** – queue of requests to be processed.
- **Self-tuning thread pool** – a pool of threads in various states.
- **Work manager** – a configuration of **maximum threads** and a **capacity** that can be used to handle requests for a specific application/service.

# Java Virtual Threads

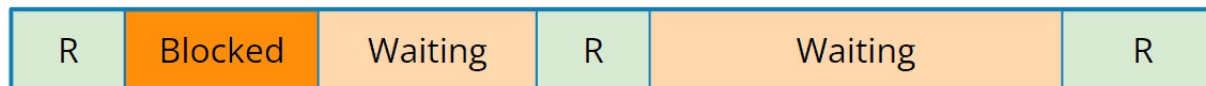
Carrier thread:



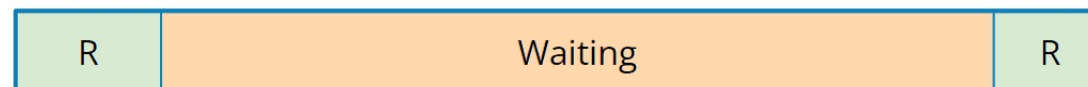
Virtual thread 1:



Virtual thread 2:



Virtual thread 3:



- Virtual threads mapped to a platform threads (carrier threads)
- Blocking operations do not block carrier threads

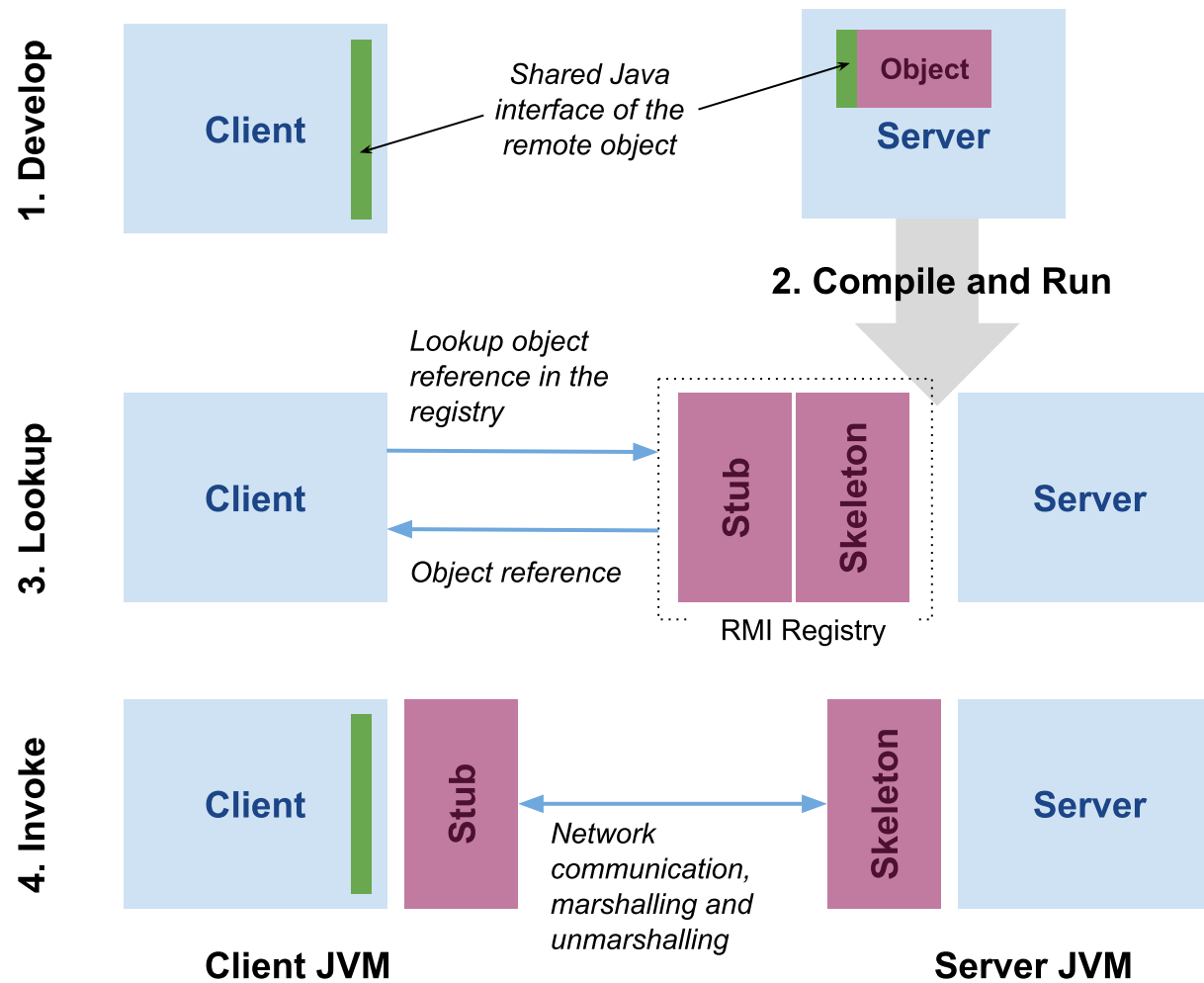
# Overview

- Application Server Architecture
- Serving Requests
- Objects Distribution

# Remote Method Invocation

- Communication among Java-based applications
  - *Methods of a Java class can be invoked by other Java class remotely*
  - *Uses Java Remote Method Protocol (JRMP)*
    - *Java-specific application protocol over TCP/IP*
  - *Basis for JEE technologies, such as JMS*
- Terminology
  - **Client** – *a program that invokes a remote method*
  - **Server** – *a program that exports a remote object*
  - **Stub** – *a representation of the client-side object for communication*
  - **Skeleton** – *a representation of the server-side object for communication*
  - **Registry** – *a component that holds a stub*
  - **Marshalling/Unmarshalling** – *a process of transforming memory representation of the object to a form suitable for network transmission and vice-versa*

# RMI Stubs and Skeletons

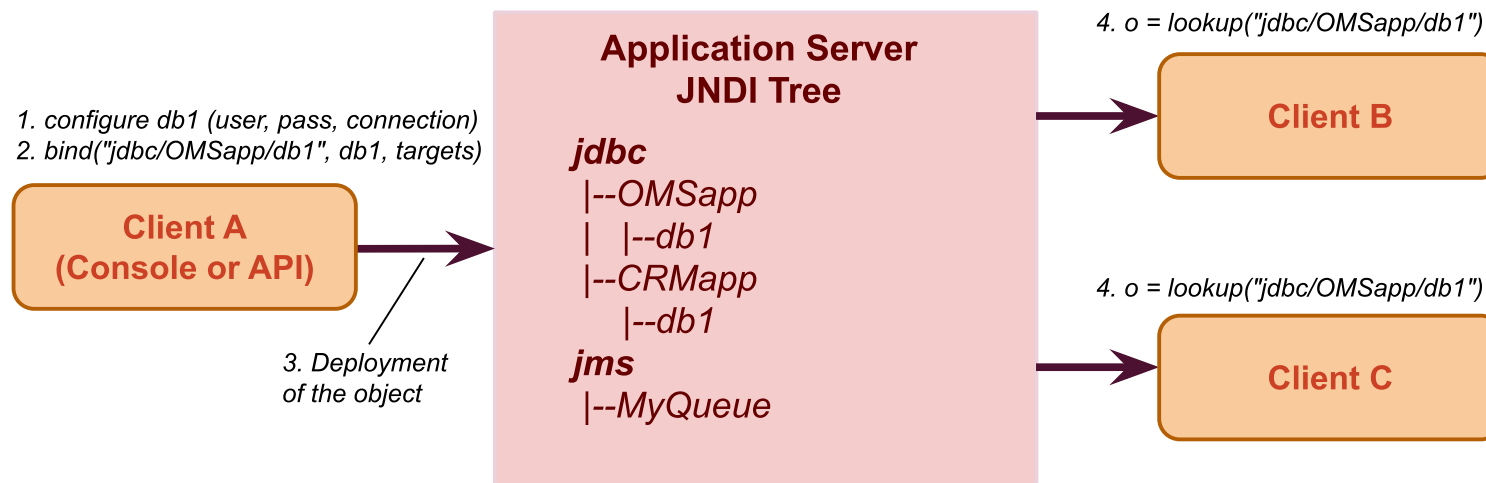


# Java Naming and Directory Interface

- Distribution of objects
  - *Application Server is a central directory for various objects*
    - *Datasources, JMS queues, etc.*
  - *Clients store objects in the central directory*
    - *Administrator configures objects using a console or API*
  - *Clients retrieve objects from the central directory*
- Benefits
  - *replication of objects across clients*
  - *central configuration of objects' parameters*
  - *scalability – allowing/disabling connections as required*



# JNDI Example

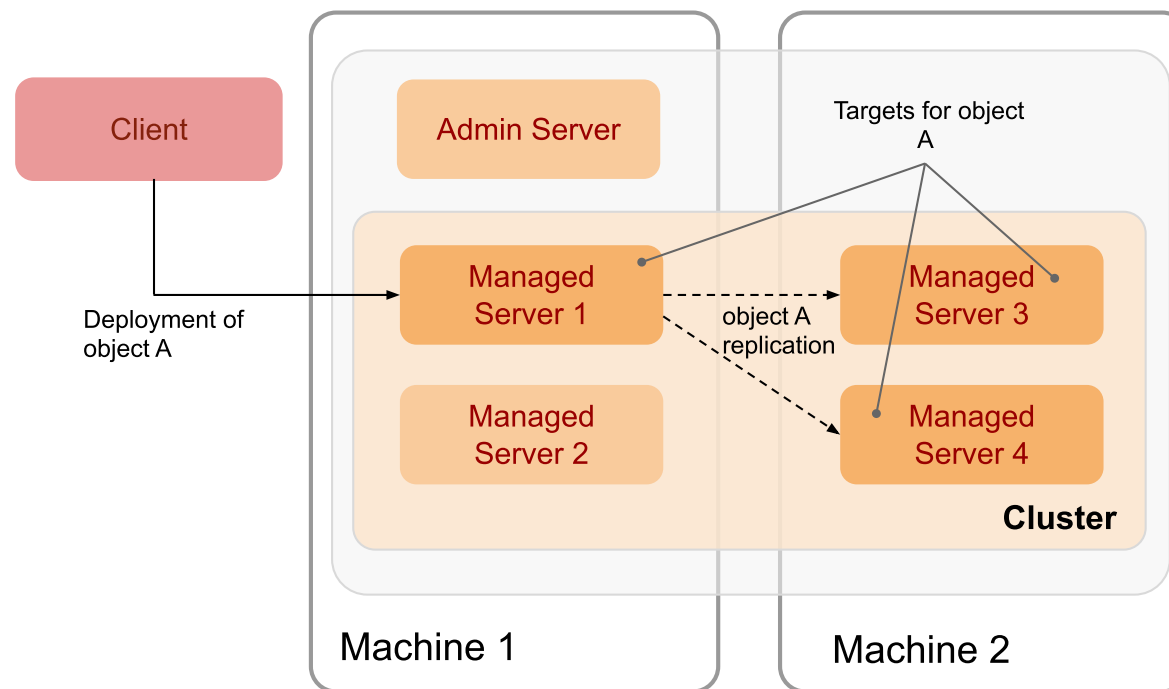


- Example Scenario

- Client A creates a datasource, configures it and registers it in the JNDI tree
  - Client A is a Admin server console app
- Client B and C lookup the object under specific JNDI name and retrieves the object from the tree
  - They get the object from the tree and use it to connect to the DB
  - They do not need to know any DB specific details
  - The object is pre-configured from the server

# Deployment to Cluster

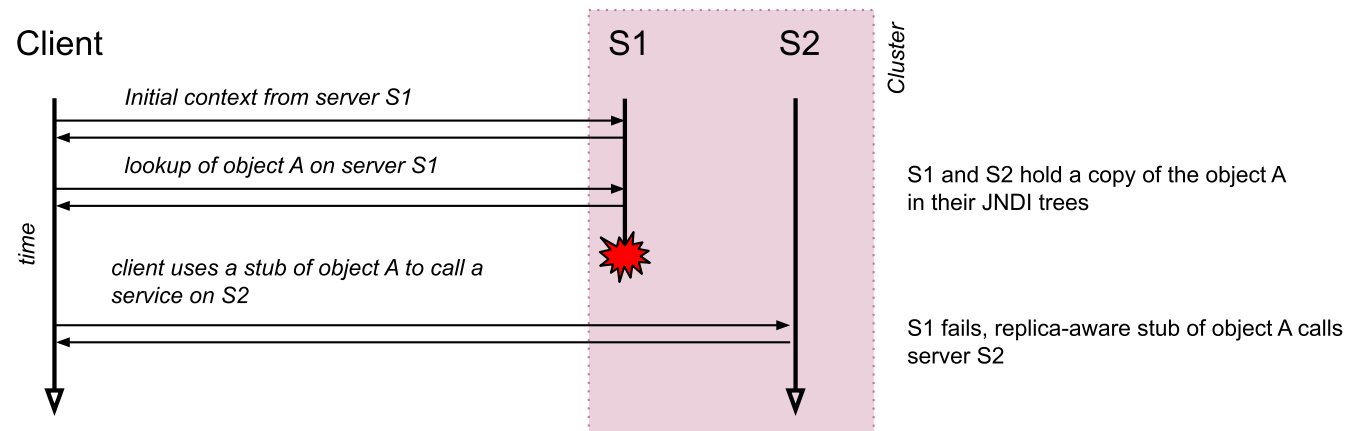
- Deployment of an object
  - Client deploys to one managed server in the cluster
  - Object gets replicated to its targets
    - Targets can be configured for the object, usually all servers but can be selected servers



# Object Failover

- Failover
  - *Failover = ability to locate an object on another server that holds a copy of the object without impact on the performance and configuration*

## Replica-aware stub of object A, failover in cluster



- A client gets a stub of the object by calling **lookup** on the context
- A client uses the stub of the object to access the object on the server
- When a server fails, **replicate-aware stub** calls the next server that holds the object copy