Introduction to Clustering

Objectives

After completing this lesson, you should be able to do describe the following:

- Benefits of Oracle WebLogic cluster
- Basic cluster architecture
- Multitier cluster architecture
- Communication among clustered server instances
- Key criteria for selecting suitable cluster architecture

ORACLE

Road Map

- Oracle WebLogic cluster introduction
    - What is a cluster?
    - Benefits of clustering
    - HTTP clustering and proxy plug-in
    - Introduce EJB clustering
- Cluster architecture
- Cluster communication

ORACLE

What Is a Cluster?

A cluster:

- Is a logical group of managed servers within a domain
- Supports features to provide high availability for:
  - Whole servers
  - Web applications and services
  - EJB applications
  - JDBC resources
  - JMS
- Is transparent to clients

ORACLE
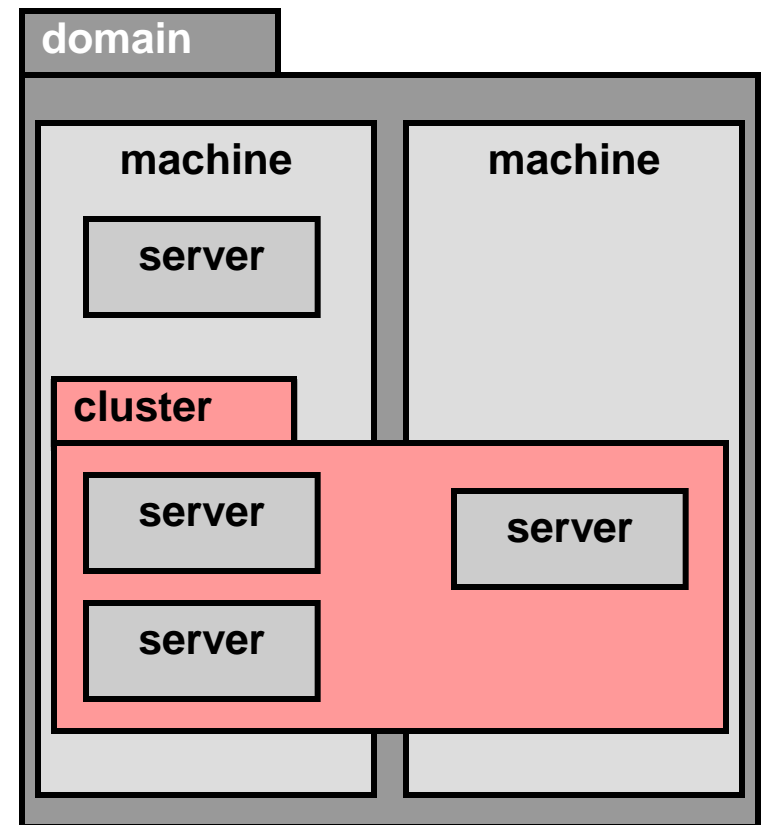
Benefits of Clustering

Concept	Description
Scalability	It provides more capacity for an application by adding servers, without having to make major architectural changes.
Load balancing	It distributes work (client requests and so on) across the members of a cluster.
Application failover	When an object in an application that is performing a task becomes unavailable, the object from the application in another server takes over to finish the job.
Availability	After a system failure on one server, it automatically continues ongoing work on another server.
Migration	After a system failure on one server, it continues ongoing work by moving the component to another server.

ORACLE

What Can Be Clustered

The following types of objects can be clustered:

- Servlets
- JSP
- EJB
- Remote Method Invocation (RMI) objects
- Java Messaging Service (JMS) destinations
- Java Database Connectivity (JDBC) connections

ORACLE

Proxy Servers for HTTP Clusters

- Proxy servers are used to provide load balancing and failover for a cluster. They:
    - Are the client's first level of interaction with the cluster
    - Give the cluster its single server appearance
- A proxy server can be either software based or hardware based.
- A software-based proxy server may be a WebLogic servlet, Web server plug-in, or a third-party application.
- A hardware-based proxy server is typically a physical load balancer.

ORACLE

High Availability for EJBs

- WebLogic provides the EJB client applications with cluster-aware stubs that transparently perform load balancing and failover.

- You can enable and configure clustering for each EJB using the application deployment descriptor `weblogic-ejb-jar.xml`.

ORACLE
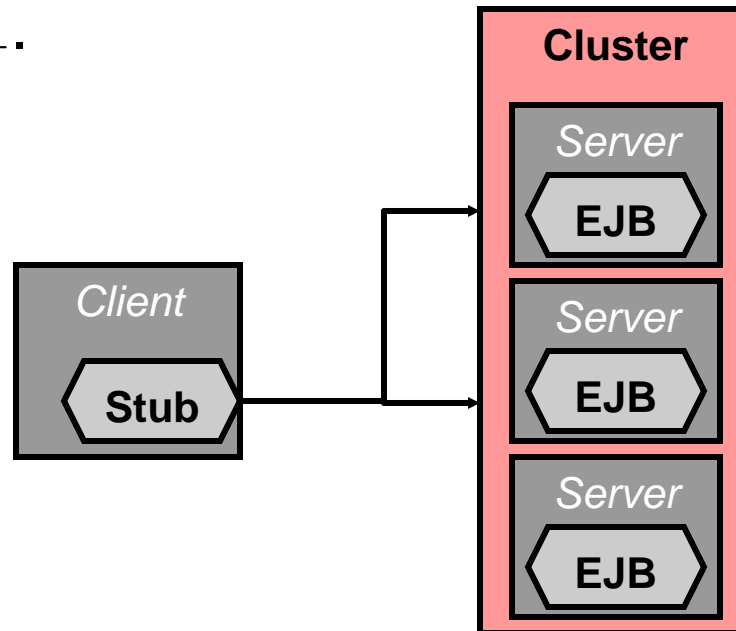
Clustering EJB Objects: Replica-Aware Stub

- Failover and load-balancing of EJBs is done with replica-aware stubs.

- Replica-aware stubs are generated at compile time for clusterable EJBs.
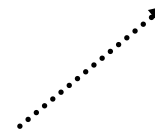
ORACLE
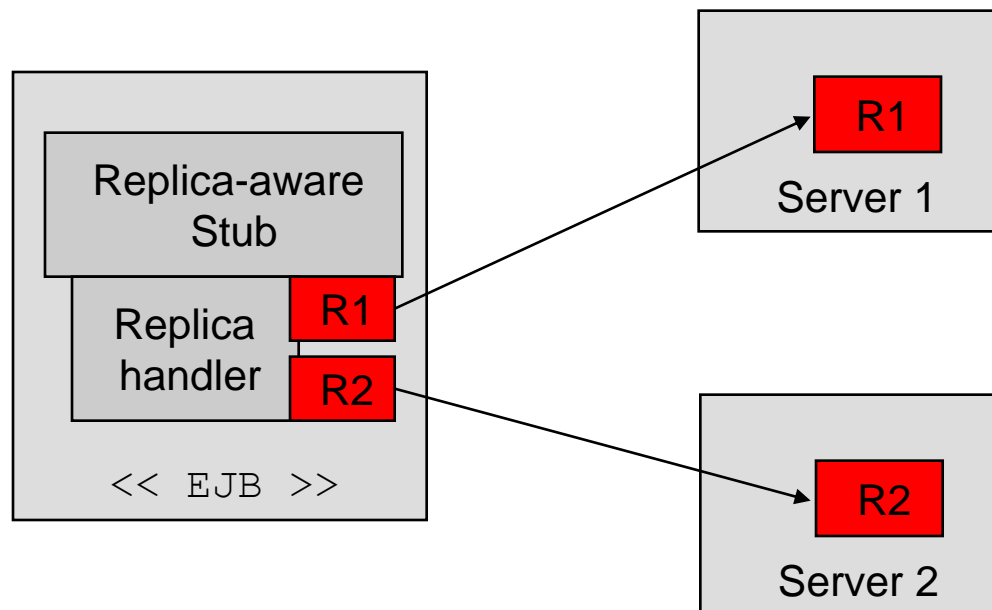
EJB: Server Failure Situations

A replica-aware stub has to detect an invocation failure from the exceptions it receives:

- Application exception
- System exception
- Network or communication exception

> **These are not indicative of a critical failure, as your application handles them.**

> **A network exception would occur if a server, container, or skeleton crashed.**

Note: If a communication exception occurs, the stub does not know if the method started, was currently executing, or finished but was unable to return a response.

Load-Balancing Clustered EJB Objects

- WebLogic Server supports the following load-balancing algorithms for clustered EJB objects:
  - Round-robin
  - Weight-based
  - Random
  - Parameter-based routing (programmatic)
- Server affinity configuration enables calls to objects to remain with the same server and minimizes client-side load balancing.

ORACLE

Stateless Session Bean Failover

A replica-aware stub uses a selection process to implement fault tolerance.

1. Client calls a method on the stub.
2. The stub calls replica-handler to choose server-replica. Load balancing can occur here.
3. The stub calls a method on the replica, (which sends the method to the server).
   - If no exception occurs, the stub returns successfully.
   - If an application or system exception occurs, the stub propagates the exception to the client.
   - If a network or communication exception occurs, the stub calls the replica-handler to choose another replica *if* the method is marked as being idempotent.
   - If a network or communication exception occurs, the stub propagates the exception *if* the method is not marked as being idempotent.

ORACLE

Road Map

- Oracle WebLogic cluster introduction
- **Cluster architecture**
    - Considerations for selecting an appropriate cluster architecture
    - Basic cluster architecture
    - Multitier cluster architecture
    - Proxy servers
- Cluster communication

ORACLE

Selecting a Cluster Architecture

- Consider the following factors when selecting a suitable architecture:
  - Performance
  - Efficient state persistence
  - Optimal load balancing
  - Effective failover
  - Reliable communication
- There are two primary cluster architectures to choose from:
  - Basic cluster architecture
  - Multitier architecture

ORACLE

Cluster Architecture

- Applications are generally deployed in multiple tiers, each tier representing a distinct functionality:
  - Web tier
  - Presentation tier
  - Business or object tier
- WebLogic provides clustering support for all three tiers.
- Other services, such as JMS and JDBC, can take advantage of clusters. The load balancing and failover operations for these services are handled differently.

ORACLE

Basic Cluster Architecture

A basic cluster architecture combines static HTTP, presentation logic, business logic, and objects into one cluster.

ORACLE
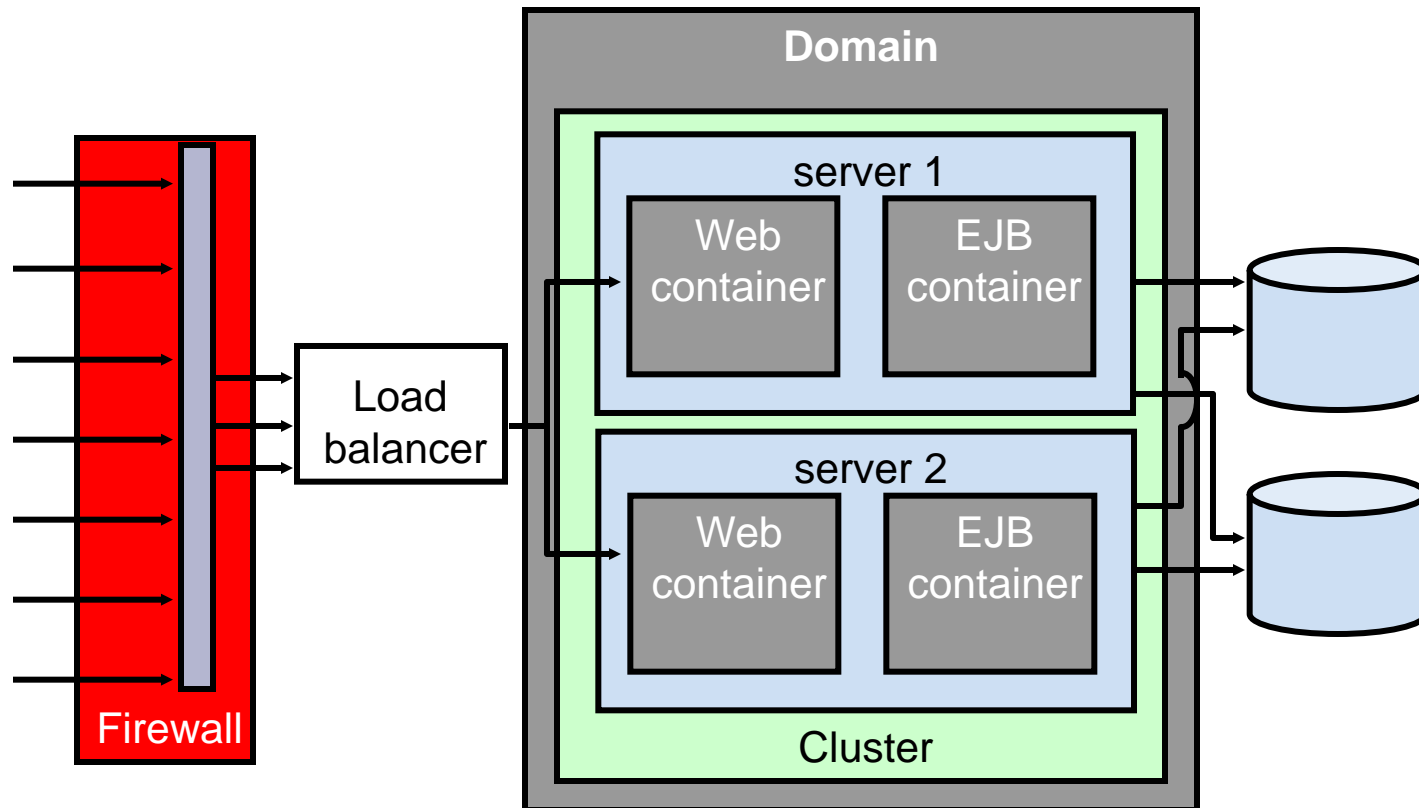
Basic Cluster Architecture: Advantages and Disadvantages

- Advantages:
  - Easy administration
  - Flexible load balancing
  - Robust security

- Disadvantages:
  - It cannot load-balance EJB method calls.
  - Load-balancing across the tiers may become unbalanced.

ORACLE

Multitier Cluster Architecture

The Web tier and the business logic with services can be separated into two clusters.

ORACLE
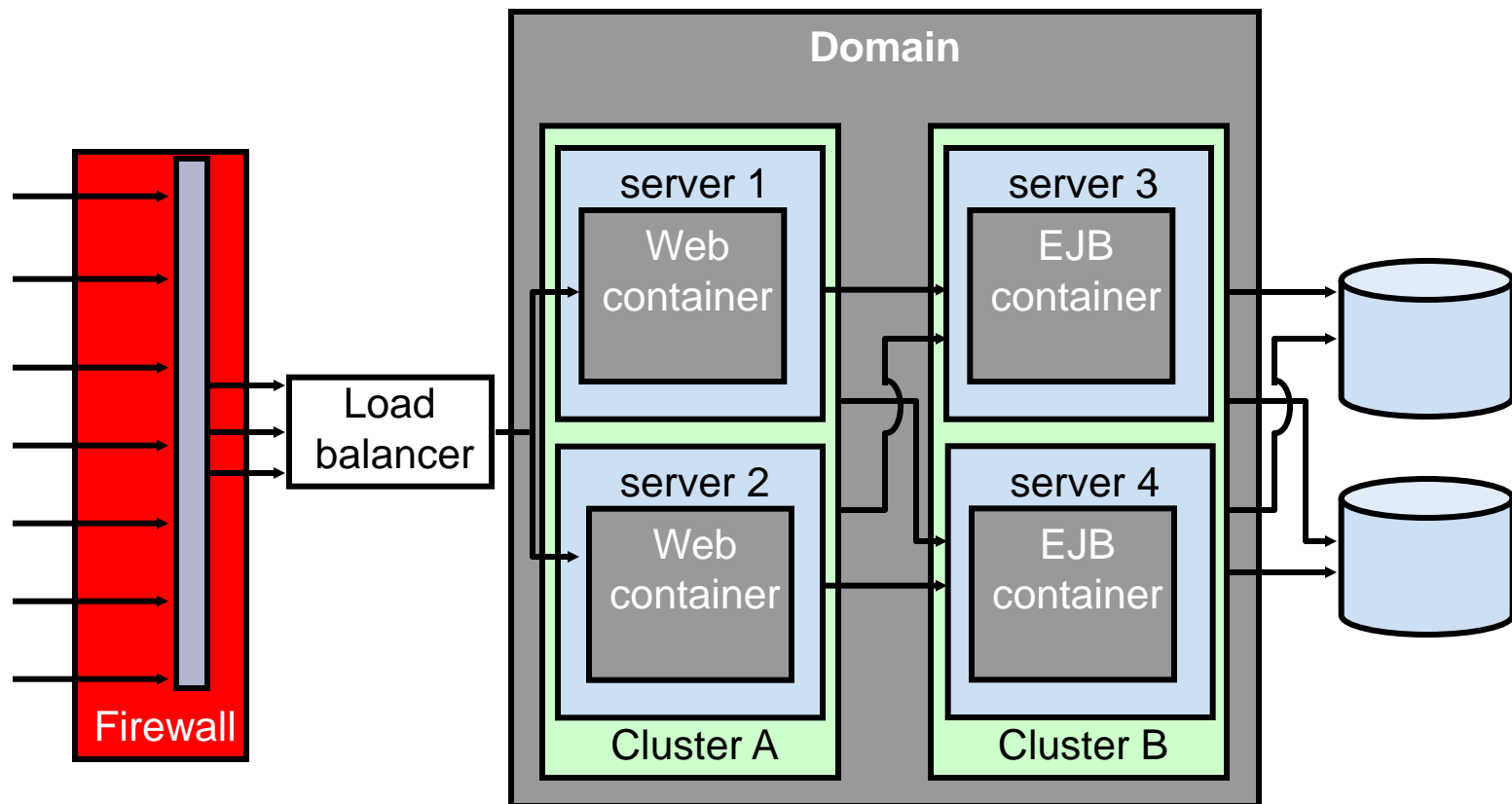
Multitier: Advantages and Disadvantages

- Advantages:
  - Improved load balancing
  - Load balancing of EJB methods
  - Higher availability
  - Improved security options
- Disadvantages:
  - Can create a bottleneck when the presentation tier makes frequent calls to the business logic
  - Can lead to increased licensing cost
 - Can lead to added firewall configuration complexity

ORACLE

Basic Cluster Proxy Architecture

This is similar to the basic cluster architecture, except that static content is hosted on HTTP servers.

ORACLE
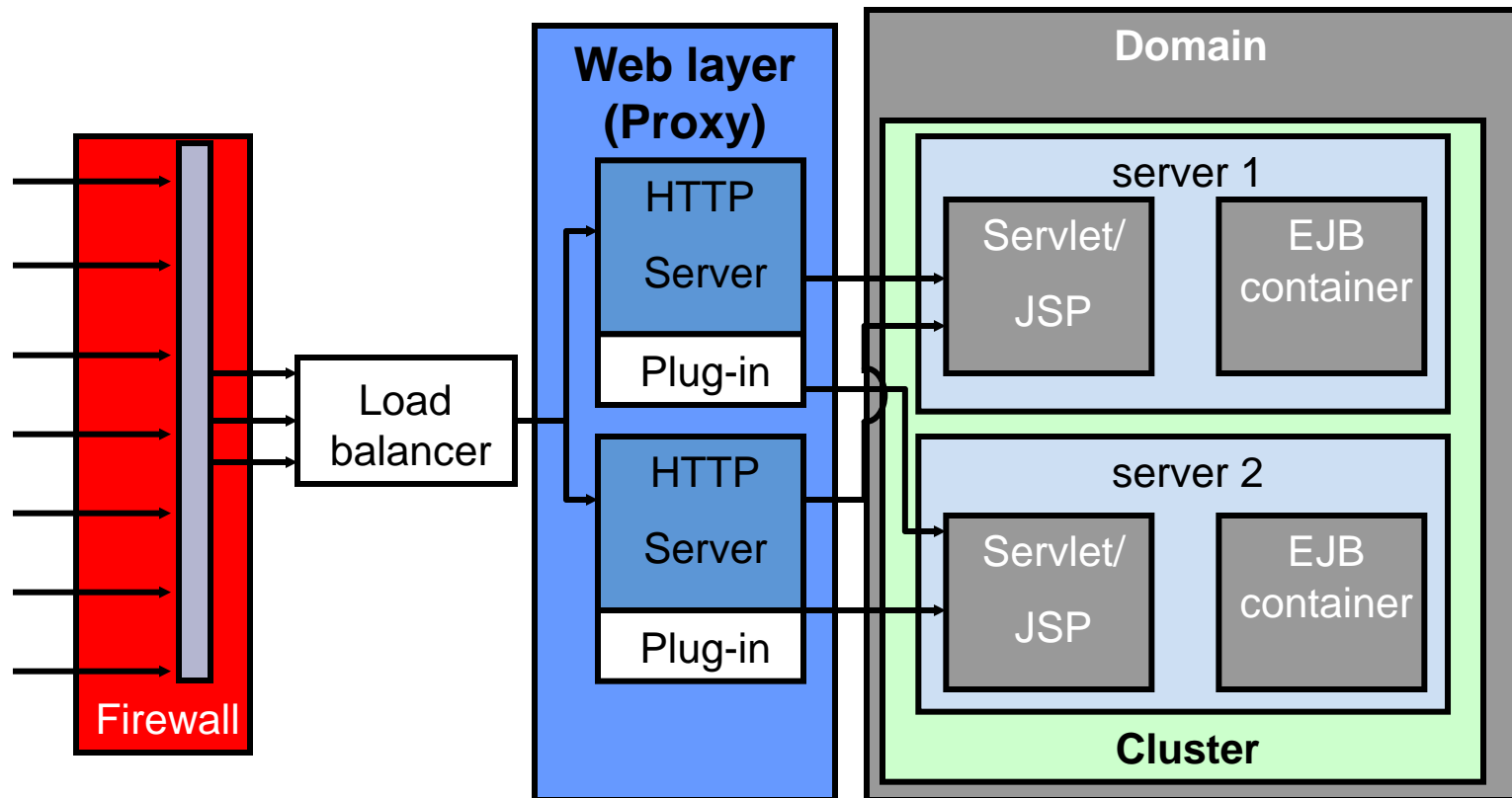
Multitier Cluster Proxy Architecture

This is similar to the multitier cluster architecture, except that static content is hosted on HTTP servers.
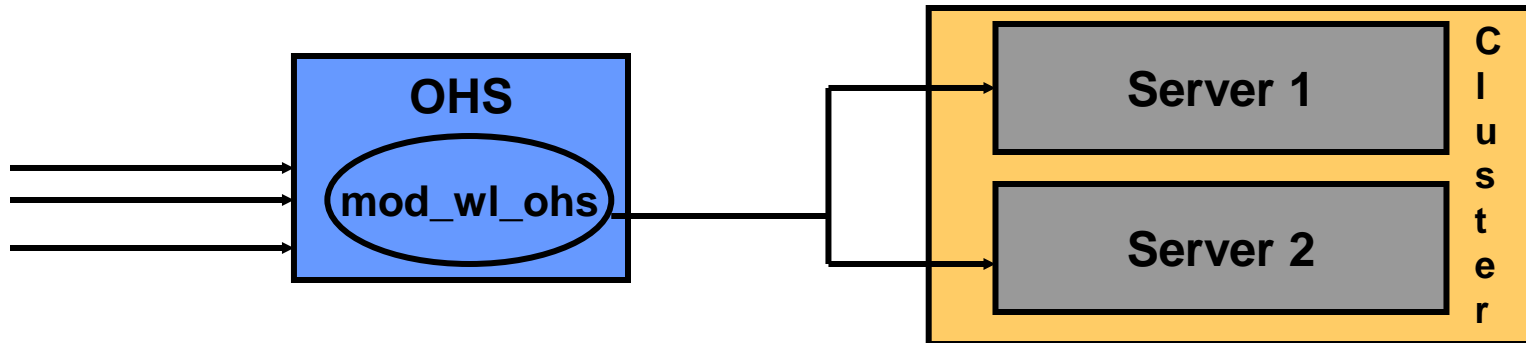
ORACLE
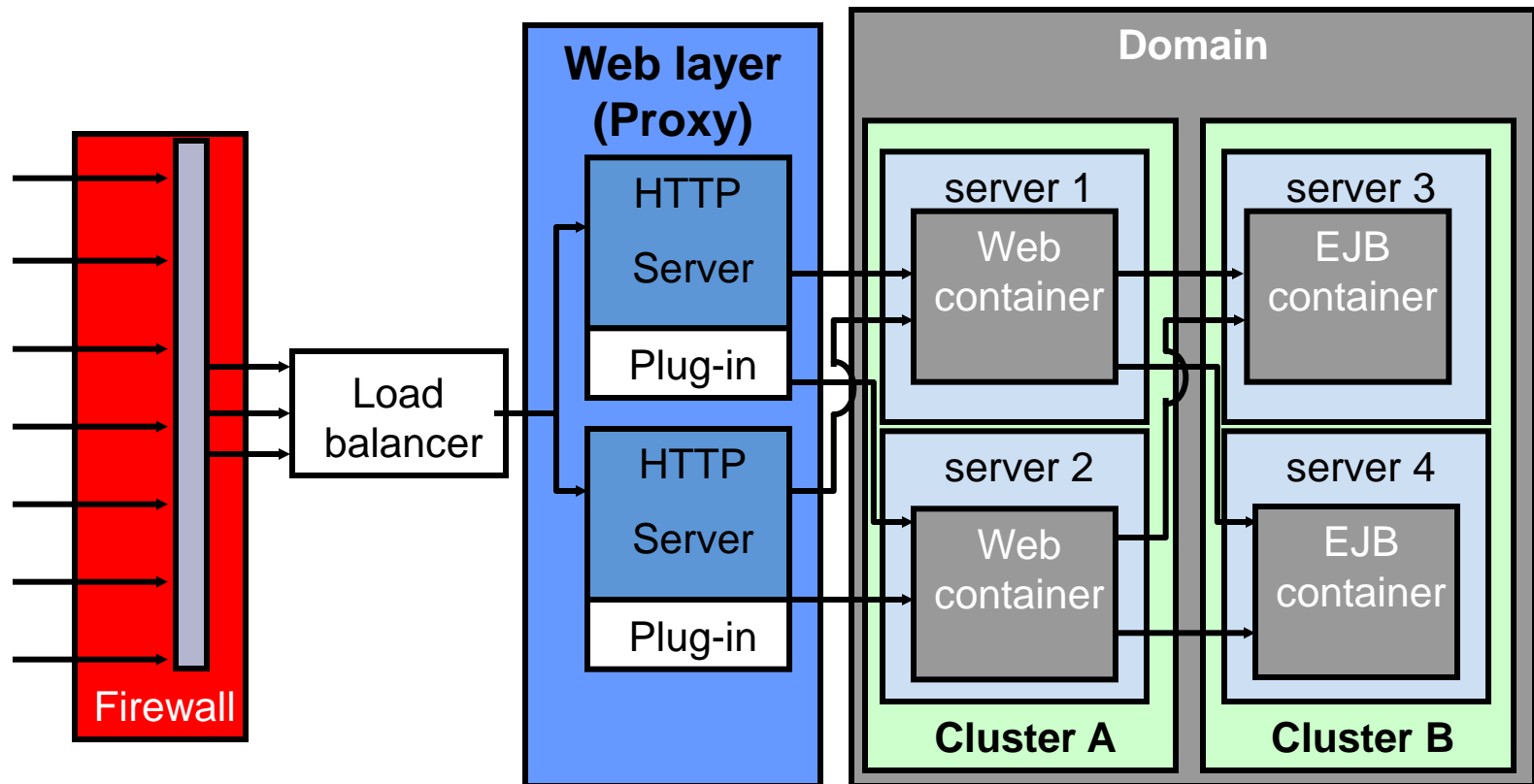
Proxy Web Server Plug-In Versus Load Balancer

- There are many advantages to using a physical load balancer instead of the proxy plug-in:
  - There is no need to configure the client plug-ins.
  - It eliminates the proxy layer, thereby reducing the number of connections.
  - There are more sophisticated load-balancing algorithms.
- There are a number of disadvantages as well:
  - Additional administration
  - Explicit configuration of "sticky" sessions for stateful Web applications

ORACLE

Proxy Plug-Ins

- Proxy plug-ins:
  - Delegate dynamic content requests to WLS servers and balance load across a cluster in a round-robin fashion
  - Route HTTP requests to back-end WLS instances based on session cookie or URL rewriting
  - Avoid routing to failed servers in the cluster
- Oracle HTTP Server contains `mod_wl_ohs`, which is a plug-in for WLS by default.
- WLS provides plug-ins to other major Web servers as well.

OHS

mod_wl_ohs

Server 1

Server 2

Cluster

ORACLE

OHS as Proxy Web Server

Oracle HTTP Server (OHS) is a Web server that:

- Is based on Apache

- Serves static and dynamic content

- Supports content generation in many languages, such as Java, C, C++, PHP, PERL, or PL/SQL

- Contains a WebLogic Server plug-in (`mod_wl_ohs`) by default

- Can be easily integrated with other Oracle Fusion Middleware components

- Can be managed using the Fusion Middleware Control along with other components
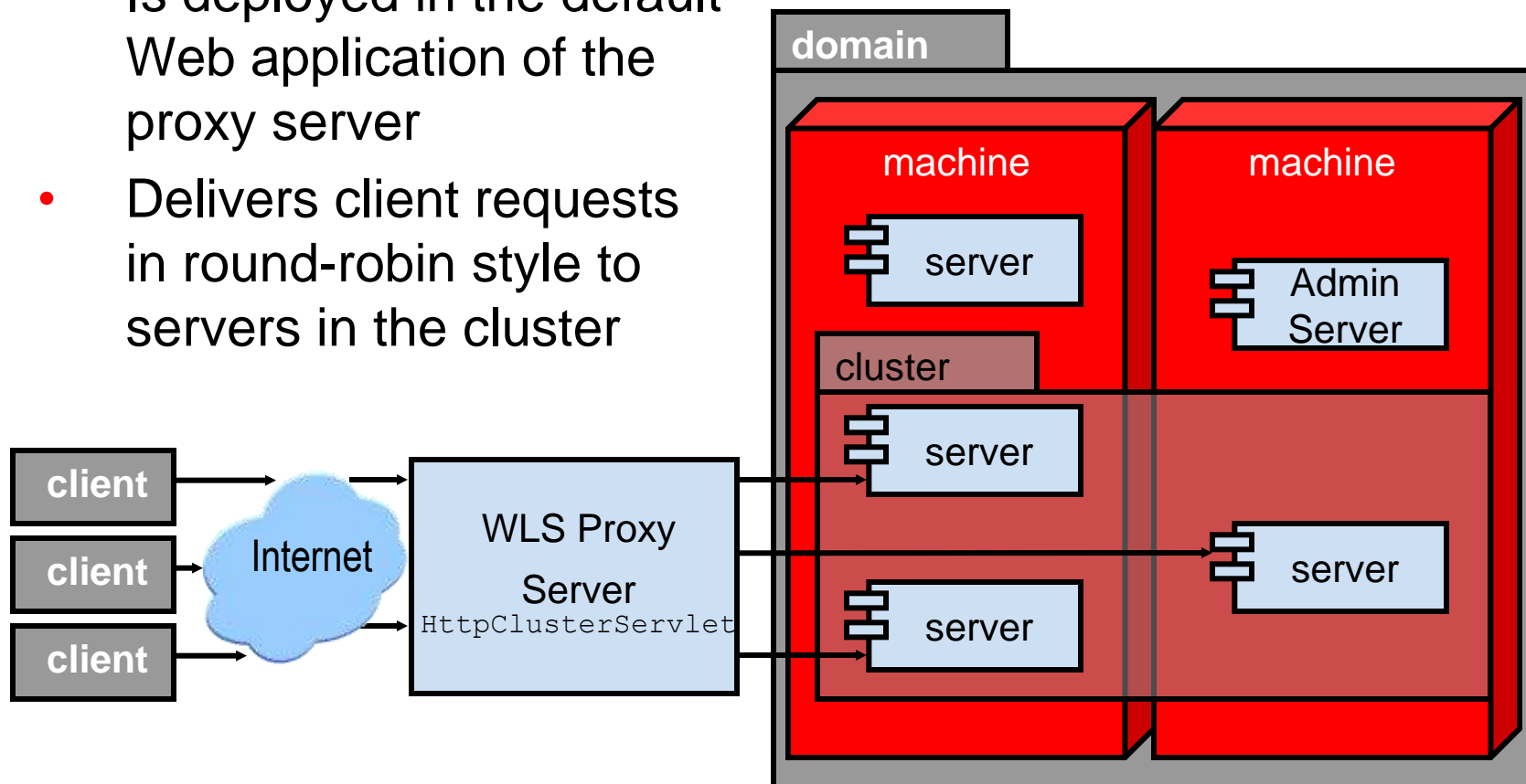
ORACLE

Request Flow When Using OHS

- The client sends an HTTP request to OHS for access to a Java EE application.

- The `mod_wl_ohs` plug-in at OHS receives the request and determines from the cookie (in request) which WLS server should serve the request.

- If no cookie exists, the request is assigned to the next available WLS server in the cluster (round-robin algorithm).

- The WLS server that responds places the appropriate cookie in the response.

- OHS routes the response to the client (with the cookie).

ORACLE

WLS `HttpClusterServlet`

`HttpClusterServlet`:

- Is deployed in the default Web application of the proxy server
- Delivers client requests in round-robin style to servers in the cluster

ORACLE

Road Map

- Oracle WebLogic cluster introduction

- Cluster architecture

- Cluster communication

  - Server communication in a cluster

  - Detecting a failure

  - Multitier communication

ORACLE

Server Communication in a Cluster

- WebLogic Server instances in a cluster communicate with one another using:
  - IP sockets, which are the conduits for peer-to-peer communication between clustered server instances
  - IP unicast or multicast, which server instances use to broadcast availability of services and heartbeats that indicate continued availability

- Multicast broadcasts one-to-many communications among clustered instances.

- Unicast is an alternative to multicast to handle cluster messaging and communications. The unicast configuration is much easier because it does not require cross-network configuration that multicast requires.

ORACLE

One-to-Many Communications

- Oracle WebLogic Server uses one-to-many communication for:
  - Clusterwide JNDI updates
  - Cluster "heartbeats"
- Because all one-to-many communications occur over IP multicast, when you design a cluster, consider the following factors:
  - If your cluster spans multiple subnets, your network must be configured to reliably transmit messages.
  - A firewall can break IP multicast transmissions.
  - The multicast address should not be shared with other applications.
  - Multicast storms may occur.

ORACLE

Considerations When Using Unicast

- Unicast messaging type:

    – Is much easier to configure because it does not require cross-network configuration that multicast requires

    – Reduces potential network errors that can occur from multicast address conflicts

- You cannot mix and match cluster messaging types within a cluster.

Peer-to-Peer Communications

Oracle WebLogic Server uses peer-to-peer communications for:

- Accessing nonclustered or pinned objects that reside on a remote server instance in the cluster

- Replicating HTTP session states and stateful session EJB states between a primary and a secondary server

- Accessing the clustered objects that reside on a remote server instance (typically, in a multitier cluster architecture)

ORACLE

Clusterwide JNDI Naming Service

Each WebLogic Server in a cluster builds and maintains its own local copy of the clusterwide JNDI tree, which lists the services offered by all members of the cluster.

ORACLE
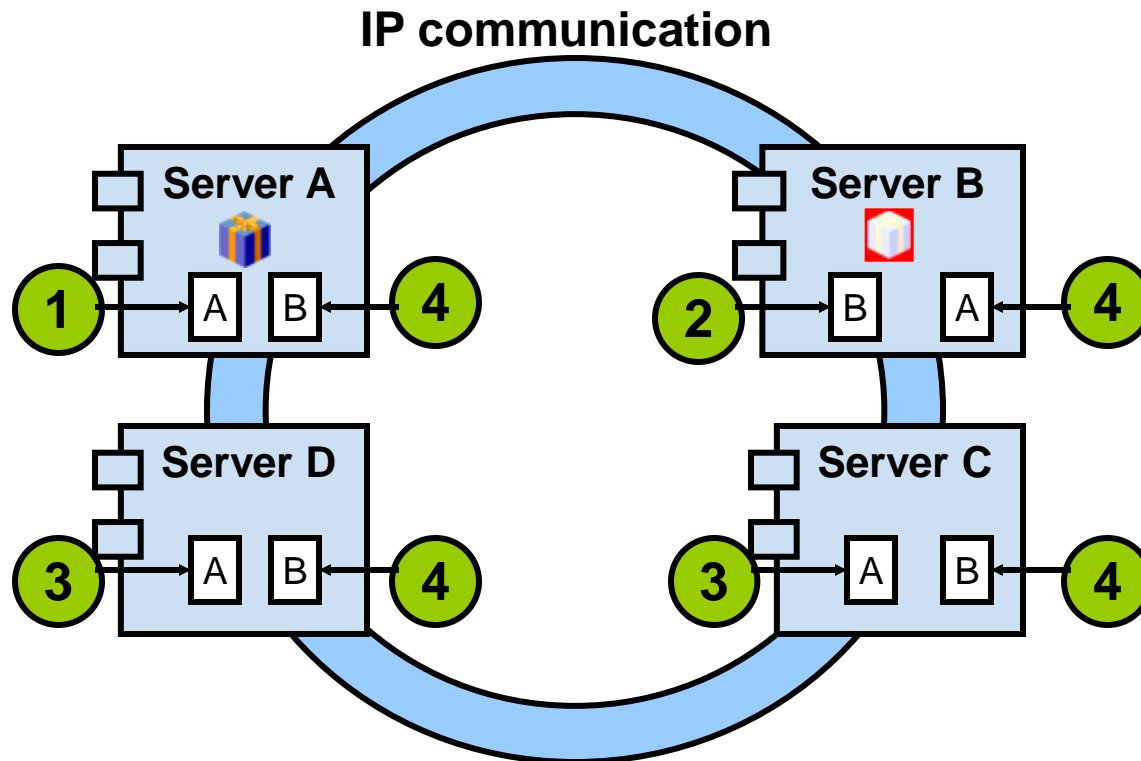
Name Conflicts and Resolution

- Cluster-level JNDI conflicts may occur when new services are added to the cluster.

- In case of name conflicts, local binding may succeed, but the binding of other object names from other servers will fail.

- To avoid cluster-level JNDI conflicts, you must deploy all replica-aware objects to all WebLogic Server instances in a cluster.

ORACLE

Quiz

Which of the following is a benefit of multitier cluster architecture?

1. Requires fewer servers compared to the basic architecture
2. Possibility to load-balance method calls to clustered EJBs
3. Easier security implementation
4. None

ORACLE

Quiz

In a multitier cluster architecture where you want to load-balance EJB objects, you configure them:

1. Within one cluster
2. In different clusters
3. Along with the Web-tier clients in the same server
4. In different domains

ORACLE

Summary

In this lesson, you should have learned about:

- Benefits of the Oracle WebLogic cluster

- Basic cluster architecture

- Multitier cluster architecture

- Communication among clustered server instances

- Key criteria for selecting a suitable cluster architecture

ORACLE