Middleware Architectures 1

Lecture 6: High Availability and Performance

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Good Performance

- What influences good performance?
  - *Number of users and concurrent connections*
  - *Number of messages and messages' sizes*
  - *Number of services*
  - *Infrastructure – capacity, availability, configuration, ...*
- How can we achieve good performance?
  - *Infrastructure*
    → *Scalability, failover, cluster architectures*
  - *Performance tuning*
    → *Application Server, JVM memory, OS-level tuning, Work managers configuration*
  - *Service configuration*
    → *Parallel processing, process optimization*

Overview

- Definitions
- Load Balancers

Definitions

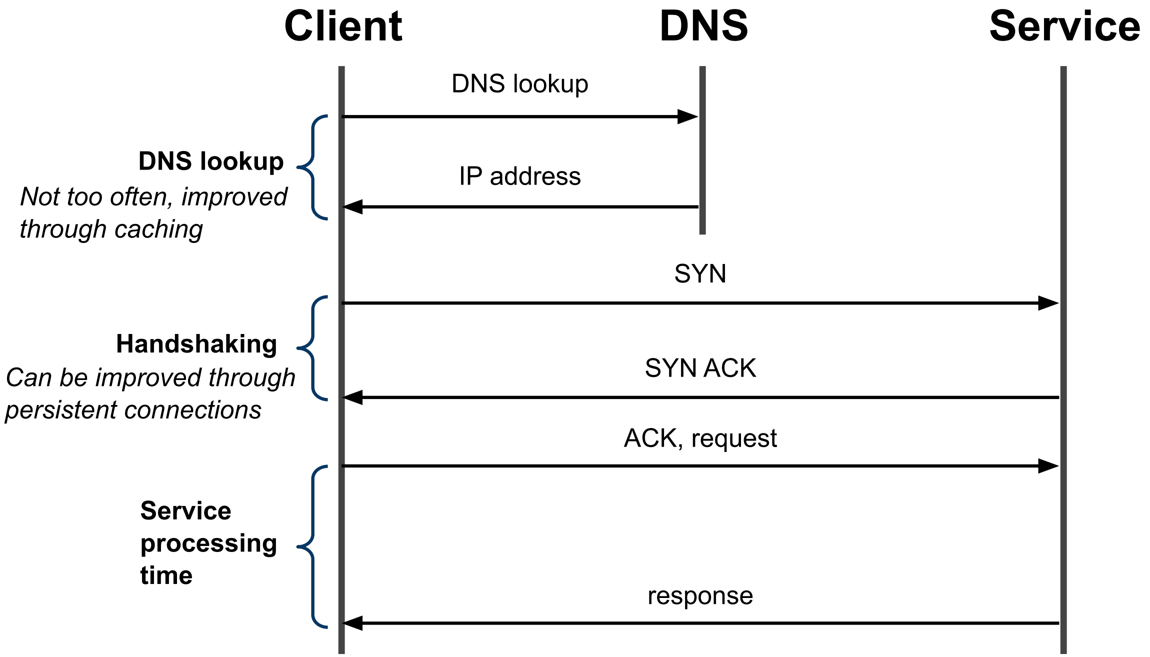
- Scalability
  - *server scalability*
    - → *ability of a system to scale – when input load changes*
    - → *users should not feel a difference when more users access the same application at the same time*
    - → ***horizontal scaling***
      - → *adding new instances of applications/servers*
    - → ***vertical scaling***
      - → *adding new resources (CPU, memory) to a server instance*
  - *network traffic*
    - → *bandwidth capacity influences performance too*
    - → *service should limit the network traffic through caching*
- Availability
  - *probability that a service is operational at a particular time*
    - → *e.g., 99.9987% availability – downtime ~44 seconds/year*
- SLA – Service Level Agreement
  - *Guarantee of service availability*
  - *When availability is below a guaranteed value, a customer can get a discount*

Definitions (Cont.)

- High Availability
  - *When a server instance fails, operation of the application can continue*
  - *Failures should affect application availability and performance as little as possible*
- Application Failover
  - *When an application component performing a job becomes unavailable, a copy of the failed object finishes the job.*
  - *Issues*
    - → *A copy of the failed object must be available*
    - → *A location and operational status of available objects must be available*
    - → *A processing state must be replicated*
- Load Balancing
  - *Distribution of incoming requests across server instances*

Performance Metrics

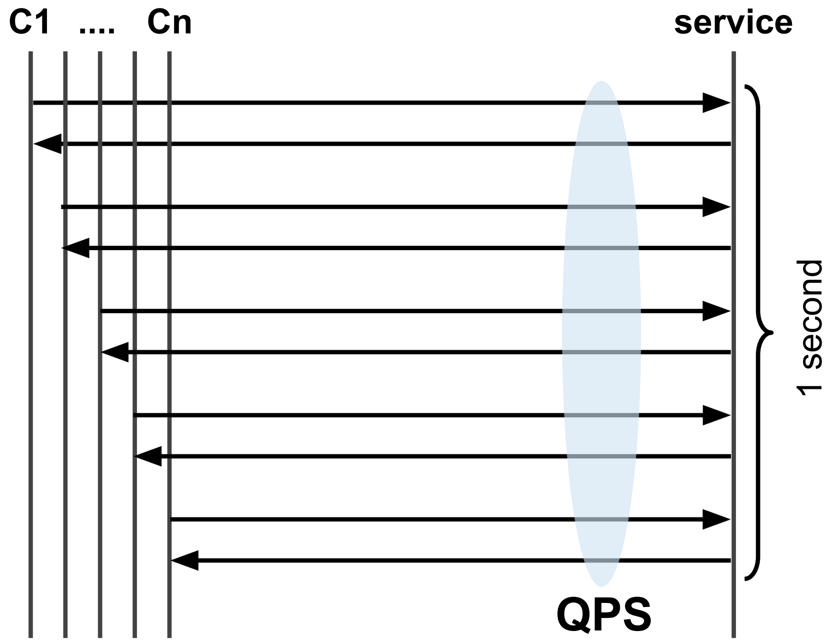
- Response Time
  - *A client-side metric*



  - *CPU intensive service or a bad configuration of a service*
    → consider asynchronous processing when CPU intensive
  - *Writing to a data store*

Performance Metrics

- Queries/Requests per Second (QPS)
  - *A server-side metric*



  - *Caching may improve performance*
    → *even if data changes often, with high QPS caching improves a lot*

Overview

- Definitions
- Load Balancers

Load Balancing

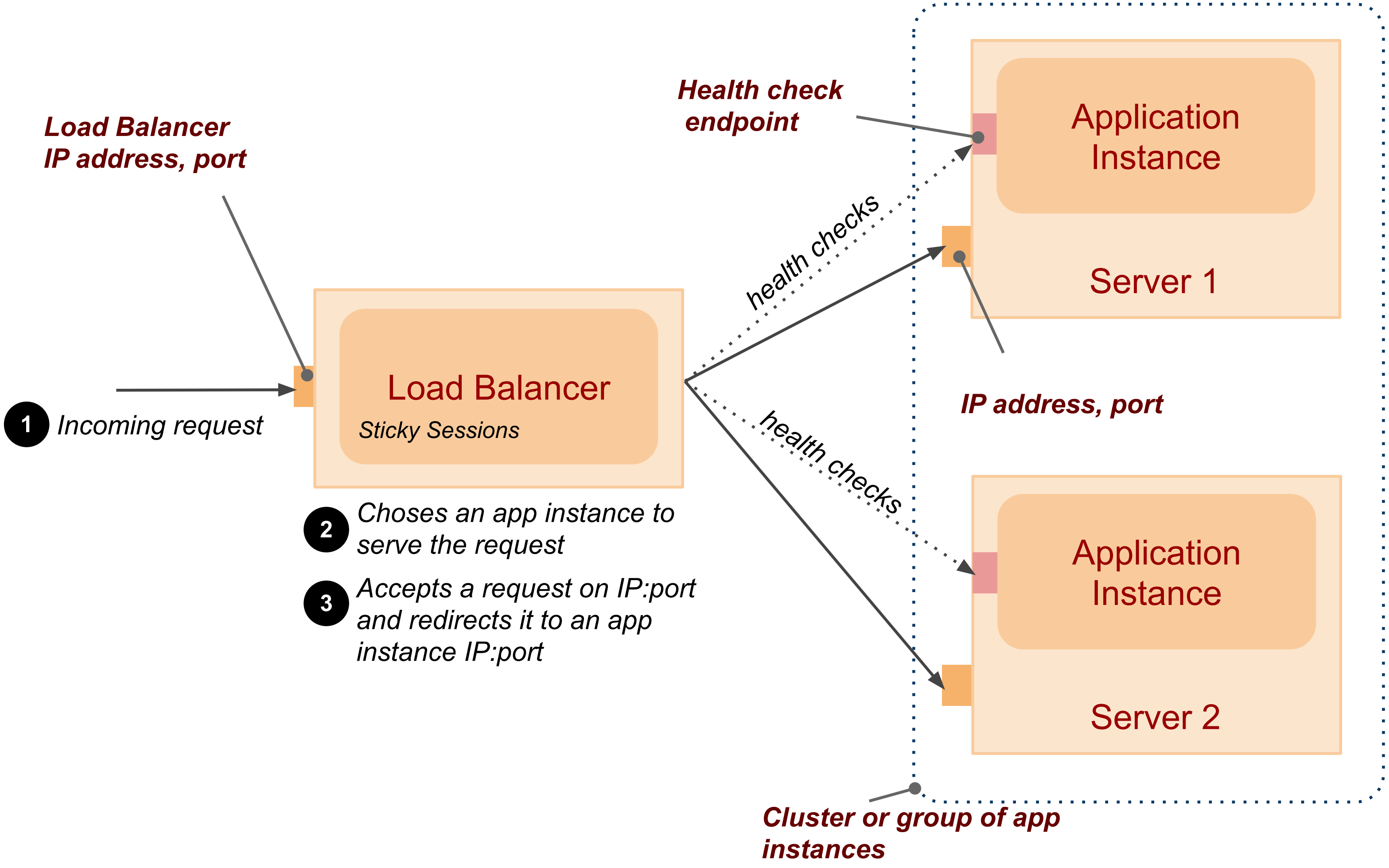
- Distributes a load to multiple app/object instances
  - *App instances run on different machines*
  - *Load sharing: equal or with preferences*
  - *Health checks*
- Types
  - *DNS-based load balancer*
    - → *DNS Round Robin*
  - *NAT-based load balancer (Layer-4)*
  - ***Reverse-proxy load balancer** (Layer-7)*
    - → *application layer*
    - → *Sticky sessions*
      - → *JSession, JSession-aware load balancer*
  - *Client-side load balancer*
    - → *LB run by a client*
    - → *a client uses a replica-aware stub of the object from the server*

DNS-based Load Balancer

- DNS Round Robin
  - *A DNS record has multiple assigned IP addresses*
  - *DNS system delivers different IP addresses from the list*
  - *Example DNS A Record:*

    `company.com A 147.32.100.71 147.32.100.72 147.32.100.73`
- Advantages
  - *Very simple, easy to implement*
- Disadvantages
  - *IP address in cache, could take hours to re-assign*
  - *No information about servers' loads and health*

Reverse Proxy Load Balancer



Load Balancer IP address, port

Health check endpoint

Application Instance

Server 1

health checks

Load Balancer

Sticky Sessions

1 *Incoming request*

IP address, port

health checks

Application Instance

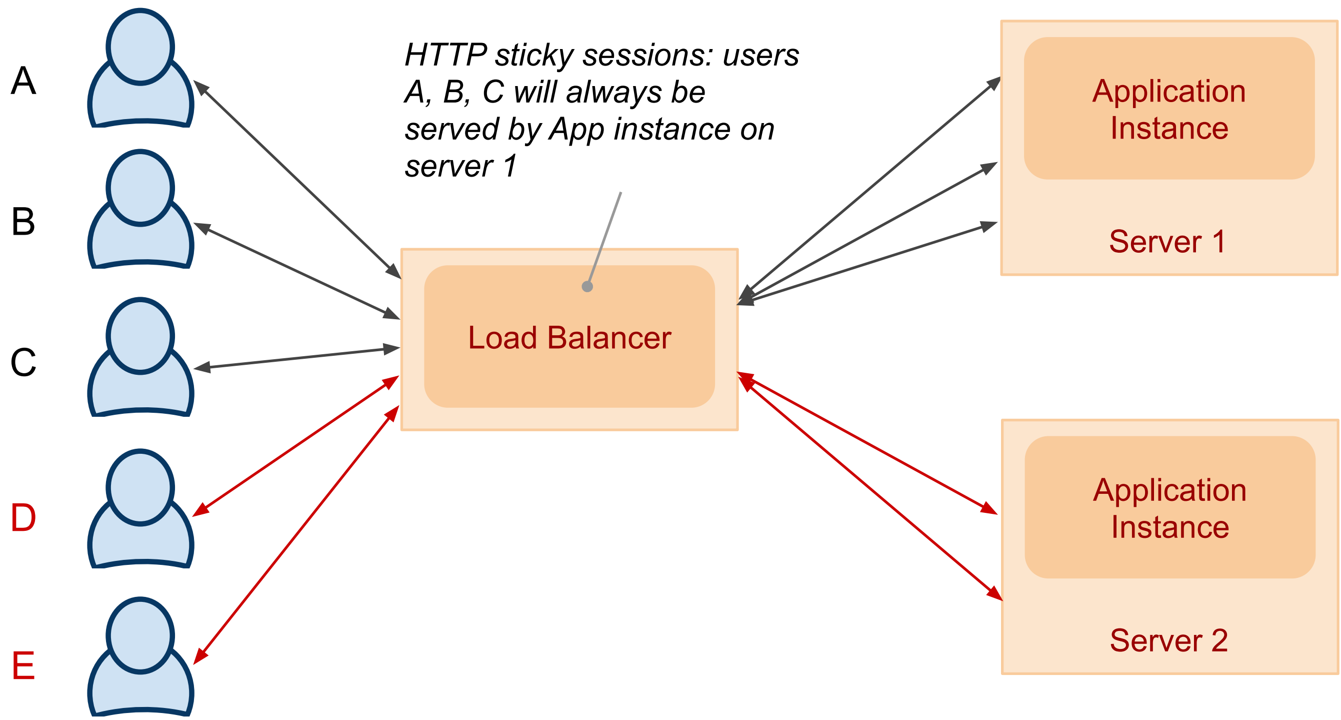
Server 2

2 *Choses an app instance to serve the request*

3 *Accepts a request on IP:port and redirects it to an app instance IP:port*

Cluster or group of app instances

HTTP Sticky Sessions Example


A
B
C
D
E
HTTP sticky sessions: users A, B, C will always be served by App instance on server 1
Load Balancer
Application Instance
Server 1
Application Instance
Server 2

- How to identify a server that hosts the session state
  - *Passive cookie persistence – LB uses a cookie from the server*
  - *Active cookie persistence – LB adds its own cookie*

Types of Load Balancers

- Software
  - *Apache* `mod_proxy_balancer`*, NGINX*
    - → *HTTP Session persistence – sticky sessions*
    - → *Various configuration options*
  - *WebLogic proxy plug-in*

```
<Location /soa-infra>
    SetHandler weblogic-handler
    WebLogicCluster czfmwapp03-vf:8001,czfmwapp04-vf:8001,czfmwapp05-vf:8001
</Location>

```

`/soa-infra` *is a first part of an URL path that rules in this* `Location` *will be applied (this is a standard Apache configuration mechanism)* `czfmwapp{N}` *is a hostname that corresponds to a virtual IP to which the managed server JVM processes is bounded (using the tcp port* `8001`*).*

`WebLogicCluster` *specifies the list of servers for load balancing*

- Hardware

Round-Robin Algorithm

- Uses

  `request` – *client request with or without a cookie information*

  `server_list` – *a list of backend servers that can process the request*

  `rbinx` – *round robin index*

  `sticky_sessions` – *associative array of pairs* `<session_id,server>`

  `unhealthy_treshhold` – *a number of negative consecutive health checks before moving the server to the "unhealthy" state.*

- Round Robin Algorithm
  - *if* `session_id` *exist in the* `request` *and in* `sticky_sessions`
    - → *send the* `request` *to the server* `sticky_sessions[session_id]`
  - *otherwise*
    - → *send the* `request` *to the* `rbinx` *server in the* `server_list`
    - → *extract* `session_id` *from the response from the server*
    - → *if the* `session_id` *exist, add a pair* `<session_id;server_list[rbinx]>` *to* `sticky_sessions`
    - → *increase* `rbinx` *by one or reset it to* `0` *if it exceeds the length of* `server_list`

Health Check

- Health Check
  - *For each server in the* `server_list`
    - → *call the server's heatlhcheck endpoint*
    - → *if a number of failed health checks for the server exceeds the* `unhealthy_threshold`
      - → *remove the server from the* `server_list`
    - → *if the server was unhealthy and a there was a successful healthcheck*
      - → *add the server back to the* `server_list`

Backend Server Selection Options

- Backend server with a weight and a backup server
  - *NGINX example:*

```
http {
    upstream backend {
        server backend1.example.com weight=5;
        server backend2.example.com;
        server 192.0.0.1 backup;
    }

    server {
        location / {
            proxy_pass http://backend;
        }
    }
}
```

- Least connections
  - *A request is sent to a server with the least number of active connections*
- Least time
  - *A request is sent to a server with the lowest average latency and the lowest number of active connections*

Backend Server Selection Options (Cont.)

- Limiting the Number of Connections
  - *Maximum number of connections per backend server*
  - *Number of connections in the queue*

```
upstream backend {
  server backend1.example.com max_conns=3;
  server backend2.example.com;
  queue 100 timeout=70;
}
```

- Hash (ip hash, generic hash)
  - *A server to which a request is sent is determined from the client IP address or an arbitrary value (string, request URL, etc.)*
- Server Slow-Start
  - *This prevents a recently recovered server from being overwhelmed*
  - *During server slow-start, connections may time out*

    → *This may cause the server to be marked as failed again.*

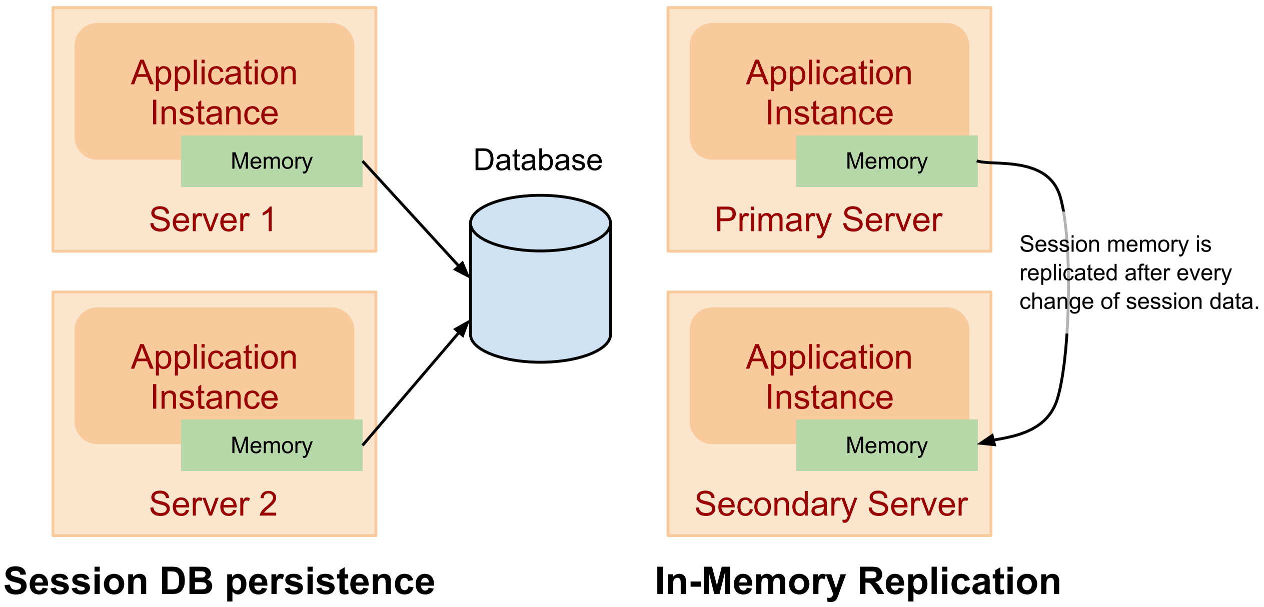
Session Persistence

- Session Persistence
  - *Sticky cookie*
    - → *A cookie defined by the load balancer for every client*

```
upstream backend {
    server backend1.example.com;
    server backend2.example.com;
    sticky cookie srv_id expires=1h domain=.example.com path=/;
}
```

  - *Sticky learn*
    - → *LB finds a cookie by inspecting requests and responses*
    - → *LB uses the cookie for subsequent redirection*

Session State Persistence and Replication



- Session DB persistence
  - *Session information is maintained in the database*
  - *Does not require sticky sessions in LB*
  - *Implements* `HttpSession` *interface that writes data to the DB*
- In-memory replication
  - *A **primary server** holds a session state, the **secondary server** holds its replica.*
  - *Information about primary and secondary servers are part of JSession*

In-Memory Replication

- Session format
  - *It's a cookie*
  - `JSESSIONID=SESSION_ID!PRIM_SERVER_ID!SEC_SERVER_ID!CREATION_TIME`

    `SESSION_ID` – *session id, generated by the server to identify memory associated with the session on the server*

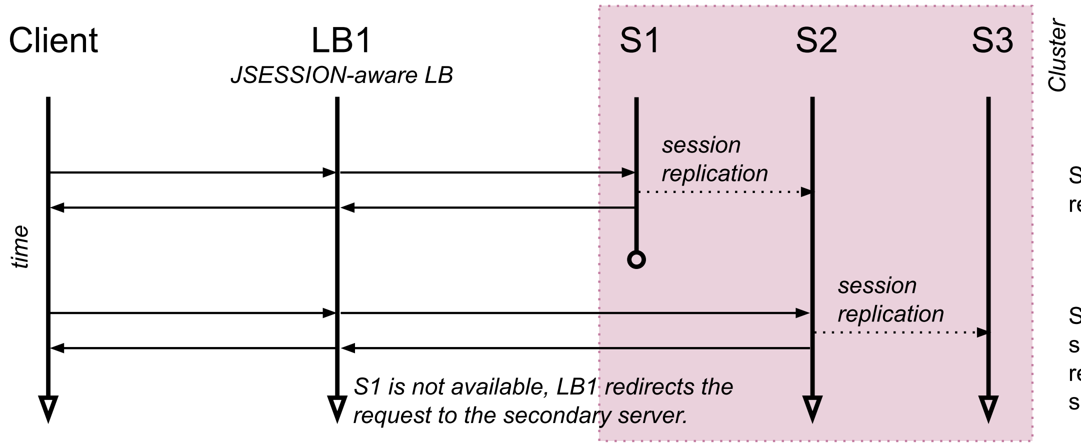
    `PRIM_SERVER_ID` – *ID of the managed server holding the session data*

    `SEC_SERVER_ID` – *ID of the managed server holding the session replica*

    `CREATION_TIME` – *time the session data was created/updated*
- How LB uses this information
  - *LB has information whether the server is running or not (via healthchecks)*
  - *if the primary server is running, it redirects the request there*
  - *if the primary server is not running, it redirects the request to the secondary server directly*
  - *if primary and secondary servers are not running, it redirect the request to any other server it has in the list – this may cause side effects!*

In-Memory Replication Scenarios

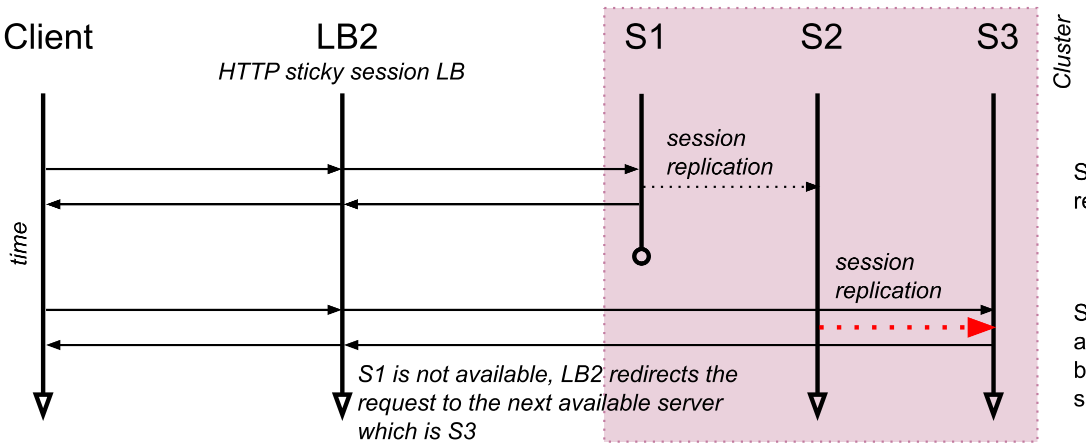
Scenario A: JSession-aware load balancer



S1 is primary, S2 is secondary; S1 replicates the session to S2

S1 fails, S2 becomes primary, S3 becomes secondary; LB1 directly redirects the request to S2 as it knows the secondary server from the first request.

Scenario B: HTTP sticky session load balancer


Client
LB2
HTTP sticky session LB
S1
S2
S3
Cluster
time
session replication
session replication
S1 is not available, LB2 redirects the request to the next available server which is S3

S1 is primary, S2 is secondary; S1 replicates the session to S2

S1 fails, S3 discovers that S2 has a session and gets the session data from it. S3 becomes primary and S2 becomes secondary.