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
- Performance Tuning

Definitions

Scalability

- server scalability
 - \rightarrow 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
 - \rightarrow 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

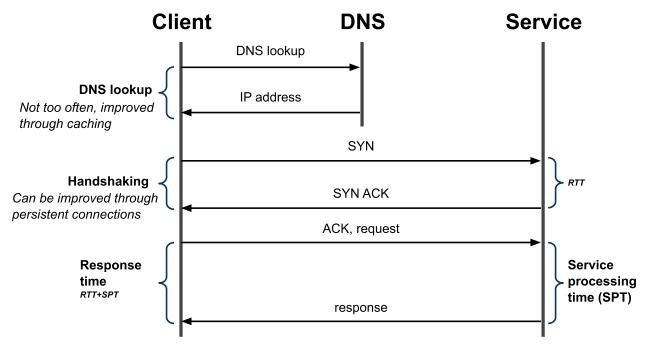
- When an application component performing a job becomes unavailable, a copy of the failed object finishes the job.
- Issues
 - \rightarrow A copy of the failed object must be available
 - \rightarrow A location and operational status of available objects must be available
 - \rightarrow A processing state must be replicated

Load Balancing

- Distribution of incoming requests across server instances

Performance Metrics

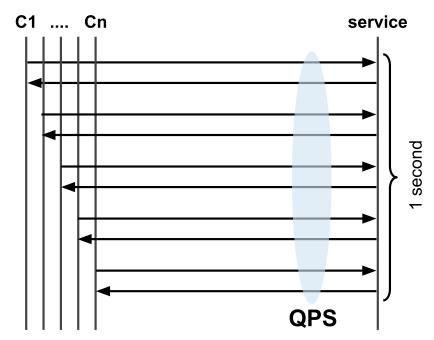
- Response Time
 - A client-side metric



- 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

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Load Balancing

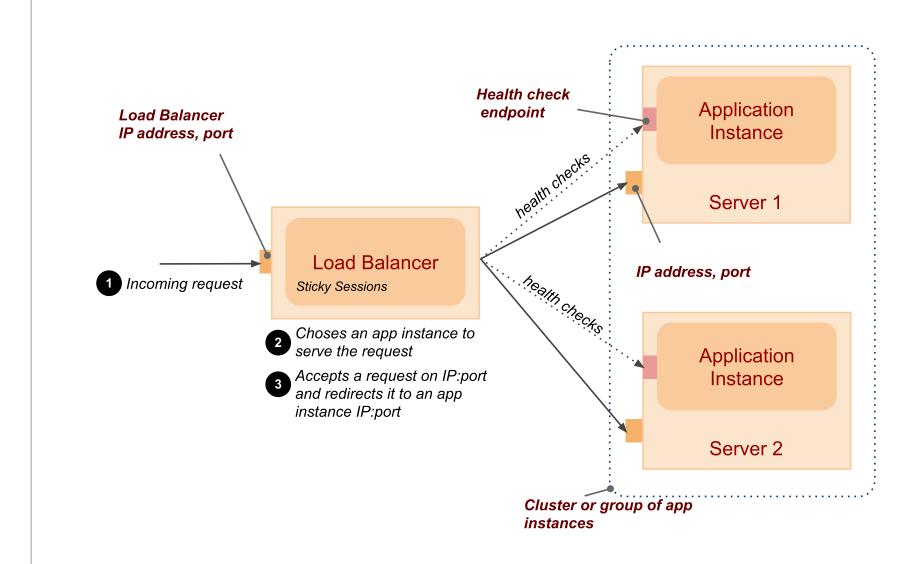
- Distributes a load to multiple app/object instances
 - App instances run on different machines
 - Load sharing: equal or with preferences
 - Health checks
- Types
 - DNS-based load balancer
 - → DNS Round Robin
 - NAT-based load balancer (Layer-4)
 - Reverse-proxy load balancer (Layer-7)
 - \rightarrow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

DNS-based Load Balancer

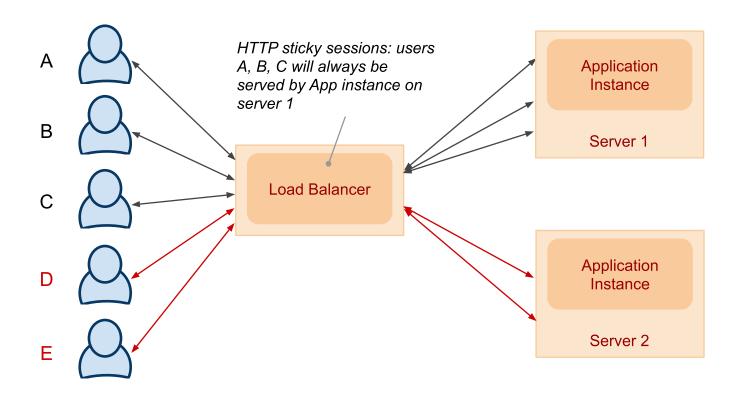
DNS Round Robin

- 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



HTTP Sticky Sessions Example



- 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

/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)
WebLogicCluster specifies the list of backend servers for load balancing

- Hardware
 - Cisco, Avaya, Barracude

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

- $-\mathit{if}$ 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
 - \rightarrow 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
 - ightarrow if a number of failed health checks for the server exceeds the unhealthy_threshold
 - → remove the server from the server_list
 - \rightarrow 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 response time and the lowest number of active connections
 - Time can be:
 - \rightarrow Time to receive the resonse header
 - → Time to receive full response body

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
 - \rightarrow This may cause the server to be marked as failed again.

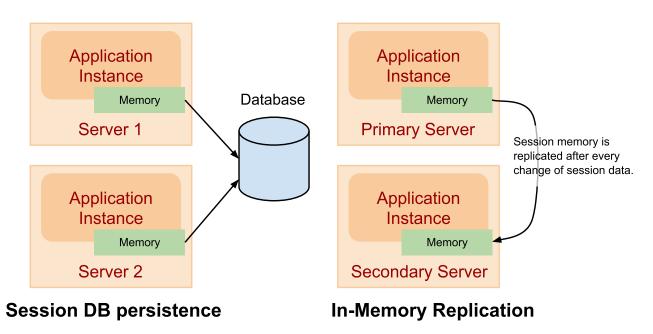
Session Persistence

- Session Persistence
 - Sticky cookie
 - \rightarrow 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
 - \rightarrow LB finds a cookie by inspecting requests and responses
 - \rightarrow 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

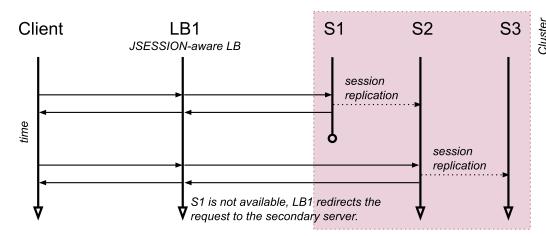
 CREATION_TIME time the session data was created/updated

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

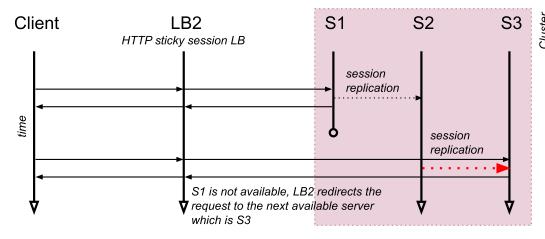
Scenario A: JSession-aware load balancer



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



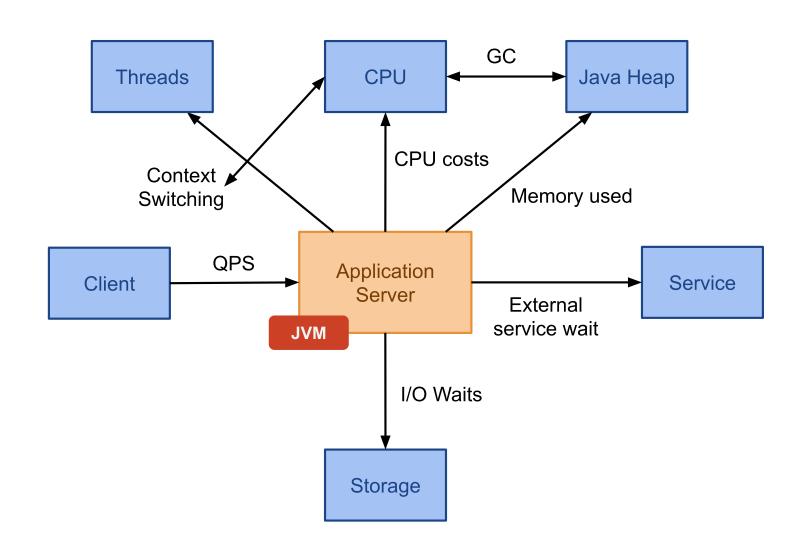
S1 is primary, S2 is secondary; S1 replicates the session to S2

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

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Performance Limiting Factors



Monitoring

- Important to understand performance
 - DevOps monitoring trends
- What you need
 - Collect \rightarrow Filter \rightarrow Store \rightarrow View \rightarrow Tune
 - Metrics, dashboards, alerting, log management, reporting, tracing capabilities
 - It is necessary to organize metrics well in order to understand what is going on
 - Start from a high-level process, detail to technical components
- Source
 - Application server
 - → usually management beans with JMX interfaces
 - \rightarrow log files (access logs, server logs, etc.)
 - OS
 - \rightarrow many utilities available out of the box
 - → open sockets, memory, context switches, I/O performance, CPU usage
 - Database
 - \rightarrow applications may write metrics to the DB
 - \rightarrow SQL scripts to collect metrics

Monitoring Tools

- Commercial Monitoring Solutions
 - Application server vendor usually offers a monitoring solution
 - AppDynamics, Oracle Enterprise Manager, Splunk
 - Google stackdriver, Amazon AWS CloudWatch
- Open source examples
 - Elasticsearch + LogStash + Kibana
 - -InfluxDB + Telegraph + DataGraph