Oracle Net Services 12c

Best Practices for Database Performance and Scalability

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ORACLE OPEN WORLD

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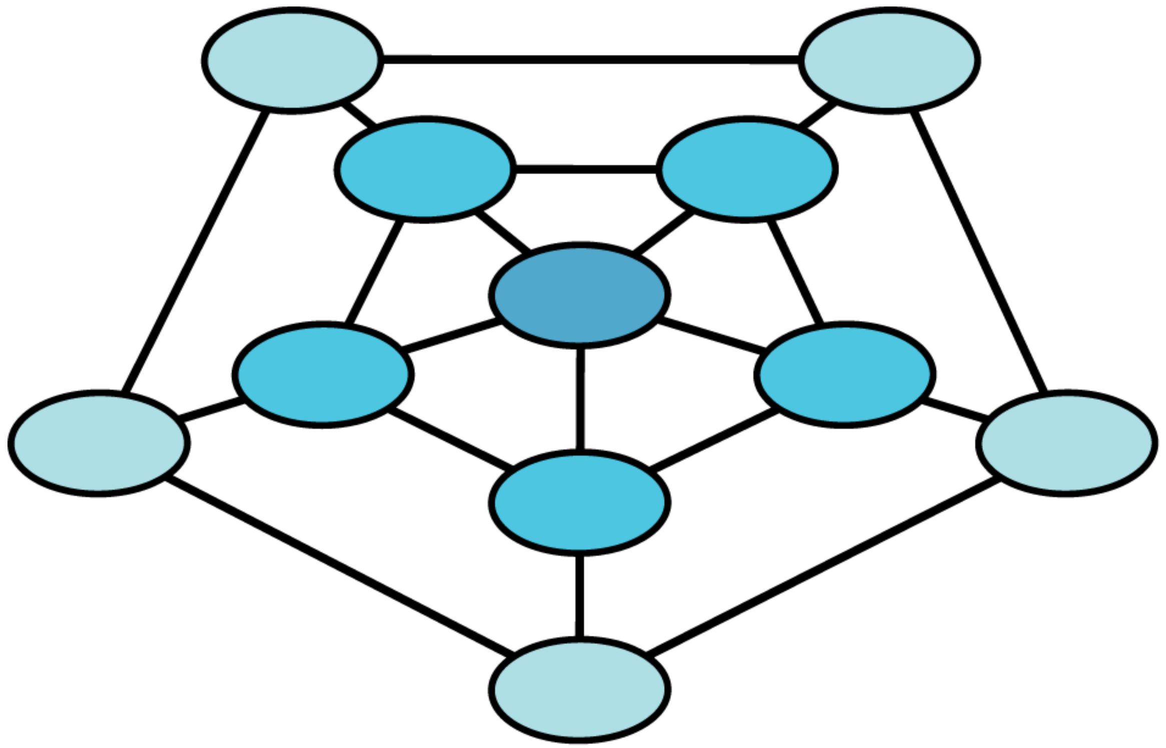
Program Agenda

- Overview of Oracle Net
  - Why Optimize Oracle Net?
- Best Practices
  - Database Client
  - Listener and Connection Manager
  - Database Server
- Q/A



Oracle Net Overview

- Primary Communication Foundation for Oracle DB
- Also known as SQL*Net
- Oracle’s Family of Networking Features:
  - Oracle Net
  - Oracle Net Listener
  - Connection Manager
  - Configuration Tools

Why Optimize Oracle Net?

- High Availability
  - Better respond to database/host/network failures
- Network Scalability and Performance
  - Scale better with more client connections
  - Load-balance to improve application experience
  - Increase Network bandwidth utilization
  - Lower database CPU utilization
- Network Security
  - Protect and recover from Denial of Service attacks

Net Configuration Files

- sqlnet.ora
  - Main Oracle Net configuration file
  - On both Client and Server
- listener.ora
  - Configuration for the Net Listener
  - On Server only
- tnsnames.ora
  - Contains Connect Name to Descriptor mappings
  - Used by the TNSNames Naming adapter
  - On both Client and Server
- ldap.ora
  - Contains LDAP configuration information
  - Used the LDAP Naming adapter
  - On both Client and Server

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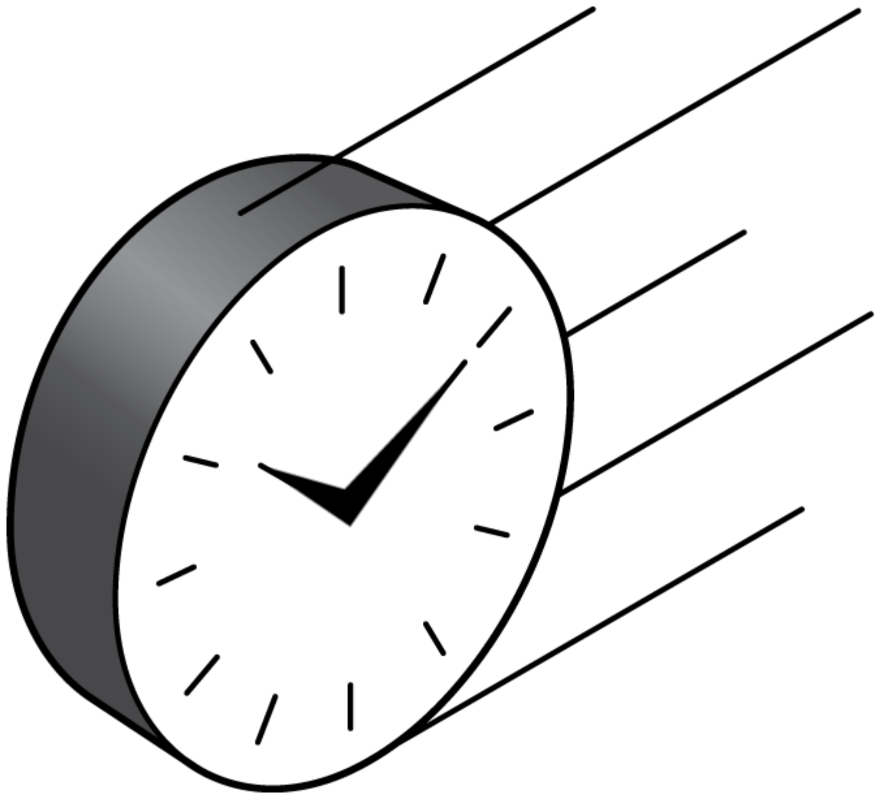
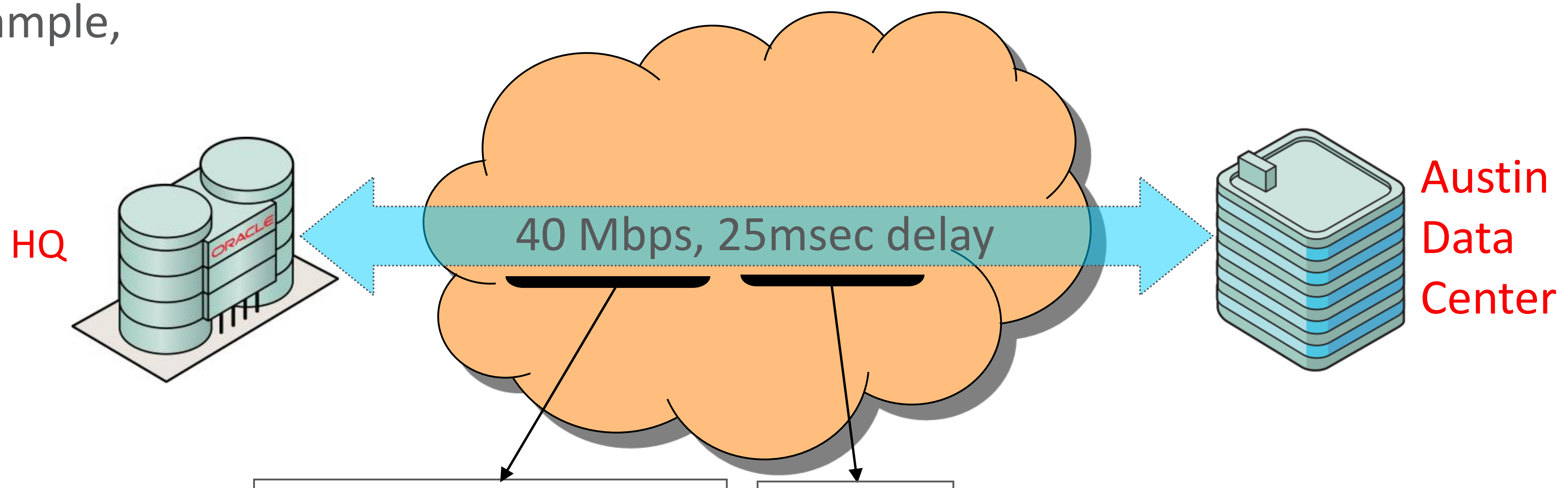


Tuning the Socket Buffers
What is BDP?

- Bandwidth x Delay Product (BDP)
  - Amount of data on the "wire" at any given point in time
  - Default Operating System buffers do not hold enough data to fill the wire
  - For example,



BDP = $\boxed{(40 \times 1000 \div 8 \text{ Kbytes/sec})} \times \boxed{(0.025 \text{ sec})}$ ~ 128 Kbytes

Tuning the Socket Buffers

- Set send and receive socket buffer sizes using:
  - SEND_BUF_SIZE – OS send buffer size
  - RECV_BUF_SIZE – OS receive buffer size
- Set this size to accommodate the BDP (2x)
- Set on both the server and the client
- Large buffer sizes help
  - Application queue more data to the OS
  - Have more data on the wire
  - Better utilize available bandwidth
  - In WAN deployments

Where to configure?

Client : sqlnet.ora and/or
tnsnames.ora or LDAP

Server: sqlnet.ora and
listener.ora

Tuning the Session Data Unit

- Controls SQL*Net packet size
  - Default: 8K
  - Max: 2MB (12c), 64K (11.2), 32K (pre-11.2)
- Set in
  - sqlnet.ora: DEFAULT_SDU_SIZE
  - tnsnames.ora: SDU in address
- Larger SDU gives
  - Better Network throughput
  - Fewer system calls to send and receive data
  - Less CPU usage – system and user
- Side-effect of larger SDU: Network buffers take up more memory

Where to configure?

Client : sqlnet.ora and/or
tnsnames.ora or LDAP

Server: sqlnet.ora

SDU Recommendations

- Optimal SDU varies with application
- Increase SDU on both client and server
  - SDU for a connection negotiated down to the lower of the two peers
- Increase SDU to 8k (for pre-11g clients)
  - Good default value for most users
- For bulk data transfer scenarios, increase to 64k
  - Large array fetch
  - LOB transfers
  - XML DB
- Do not set to MTU value
  - SDU and MTU are independent

Connect-time Failover for Applications
Oracle Net Timeouts

- Connection establishment timeouts
  - Timeout for TCP connection establishment
    - TCP.CONNECT_TIMEOUT
    - Enabled by default to 60 seconds since 11gR2
  - Timeout for connection to a DB server process
    - SQLNET.OUTBOUND_CONNECT_TIMEOUT
    - Set if session establishment takes a long time
- Configurable at connect string level
- Can be used individually or at the same time
  - Outbound Connect Timeout must be greater than TCP Timeout
- Option to enable connection retries and retry delay

Where to configure?

Client: sqlnet.ora and/or
tnsnames.ora or LDAP

Single Client Access Name (SCAN)

Easy Connect + Address List

- Available since 11gR2
- Single name for clients to access an Oracle Database in a cluster
- Configured during the installation of Grid Infrastructure
- Typically resolves to three IP addresses in the cluster, each associated with a SCAN Listener

```
For example, if DNS resolves
sales-scan to
{10.1.1.1, 10.1.1.2, 10.1.1.3}
```

```
sales-scan:10240/sales
```

is equivalent to

```
(DESCRIPTION=
  (ADDRESS_LIST=
     (ADDRESS=(PROTOCOL=tcp)
         (HOST=10.1.1.1)(PORT=10240))
    (ADDRESS=(PROTOCOL=tcp)
         (HOST=10.1.1.2)(PORT=10240))
    (ADDRESS=(PROTOCOL=tcp)
         (HOST=10.1.1.3)(PORT=10240)))
   (CONNECT_DATA=
      (SERVICE_NAME=sales)))
```

SCAN in Connect Descriptors

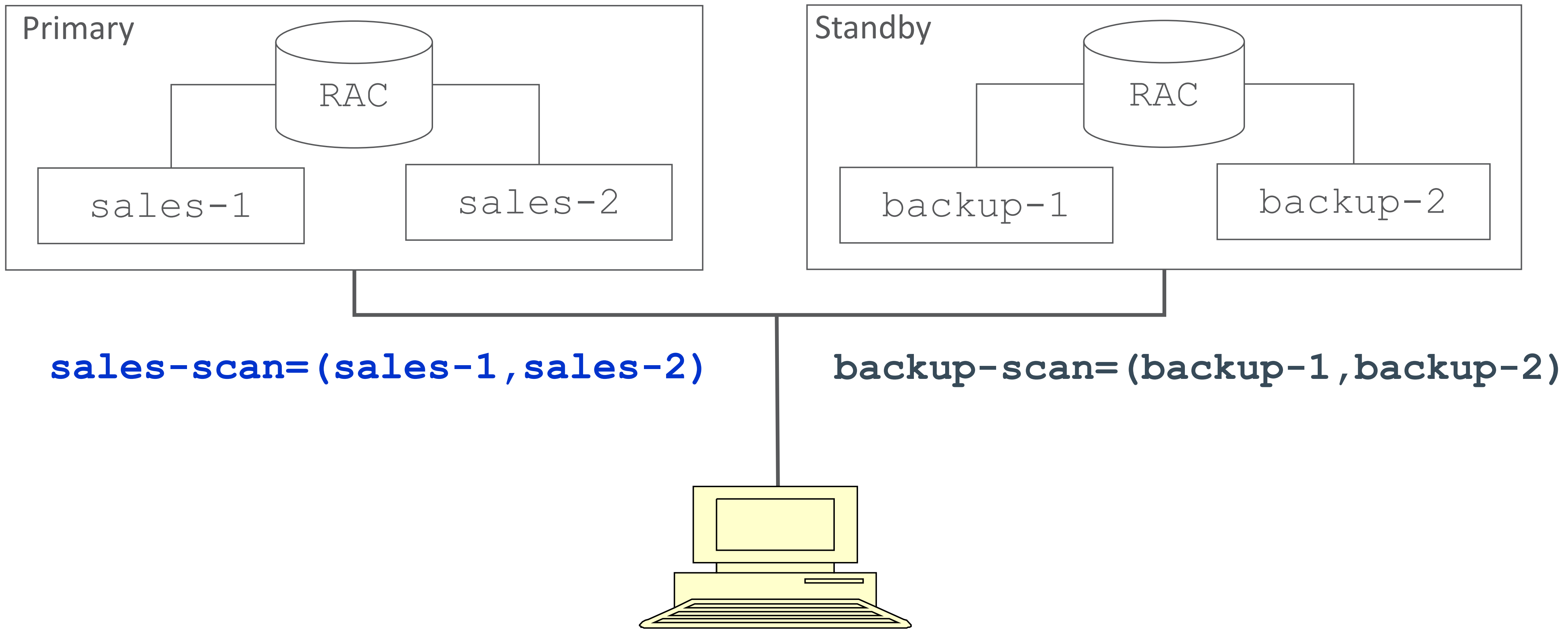
```
sales=
   (DESCRIPTION=
      (ADDRESS_LIST=
         (LOAD_BALANCE=on)
         (ADDRESS=
               (PROTOCOL=tcp)
               (HOST=sales-scan)
               (PORT=10240)))
      (CONNECT_DATA=
          (SERVICE_NAME=sales)))
```

sales-scan:

```
      10.1.1.1, 10.1.1.2, 10.1.1.3
```

```
sales=
   (DESCRIPTION=
      (ADDRESS_LIST=
         (LOAD_BALANCE=on)
         (ADDRESS=
            (PROTOCOL=tcp)
            (HOST=10.1.1.1)
            (PORT=10240))
        (ADDRESS=
            (PROTOCOL=tcp)
            (HOST=10.1.1.2)
            (PORT=10240))
        (ADDRESS=
            (PROTOCOL=tcp)
            (HOST=10.1.1.3)
            (PORT=10240)))
     (CONNECT_DATA=
        (SERVICE_NAME=sales)))
```

Client-side Failover using Address and Description Lists
RAC + Data Guard Example



Connect Descriptor

```
(DESCRIPTION_LIST =
      (LOAD_BALANCE=off)(FAILOVER=on)
      (DESCRIPTION =
          (LOAD_BALANCE=on)
          (ADDRESS=(PROTOCOL=tcp)(HOST=sales-scan)(PORT=1521))
          (CONNECT_DATA=(SERVICE_NAME=sales.example.com)))
      (DESCRIPTION =
          (LOAD_BALANCE=on)
          (ADDRESS=(PROTOCOL=tcp)(HOST=backup-scan)(PORT=1521))
          (CONNECT_DATA=(SERVICE_NAME=sales.example.com))))
```

The Connect Descriptor internally expands to

```
(DESCRIPTION_LIST =
     (LOAD_BALANCE=off)(FAILOVER=on)
     (DESCRIPTION =
         (ADDRESS_LIST=
             (LOAD_BALANCE=on)
             (ADDRESS=(PROTOCOL=tcp)(HOST=sales-1)(PORT=1521))
             (ADDRESS=(PROTOCOL=tcp)(HOST=sales-2)(PORT=1521)))
         (CONNECT_DATA=(SERVICE_NAME=sales.example.com)))
     (DESCRIPTION =
         (ADDRESS_LIST=
             (LOAD_BALANCE=on)
             (ADDRESS=(PROTOCOL=tcp)(HOST=backup-1)(PORT=1521))
             (ADDRESS=(PROTOCOL=tcp)(HOST=backup-2)(PORT=1521)))
         (CONNECT_DATA=(SERVICE_NAME=sales.example.com))))
```

Fail-over for Connected Sessions

- Established client connections could hang when
  - Database host crashes
  - Remote Networks fail
- Detection of such failures could take a while
  - TCP behavior - timeouts in minutes
  - Depends on what the client does
- To catch such failures
  - Set a Receive Timeout
    - If your application is active and does not use long-running queries
  - Use Fast Application Notification (FAN)

CON6711: Best Practices for Application High Availability
Wed. 10/04/2017 at 3:30pm Moscone West - Room 3012

Configuration Example – JDBC App

- Connect Timeout set through property

  `oracle.net.CONNECT_TIMEOUT`
- Read Timeout set through

  `oracle.jdbc.ReadTimeout`
  - Note: Do not use as a query-timeout.
- For Query Timeout, use

  `Statement.cancel` or

  `Statement.setQueryTimeout`
- How to set properties?

  `specify in code`

```
Code Example:
Properties prop = new Properties();
prop.setProperty("user","scott");
prop.setProperty("password","tiger");
prop.setProperty("oracle.net.CONNECT_TIMEOUT","3000");
prop.setProperty("oracle.jdbc.ReadTimeout","3000");
Conn=(new oracle.jdbc.OracleDriver()).connect(url,prop);
```

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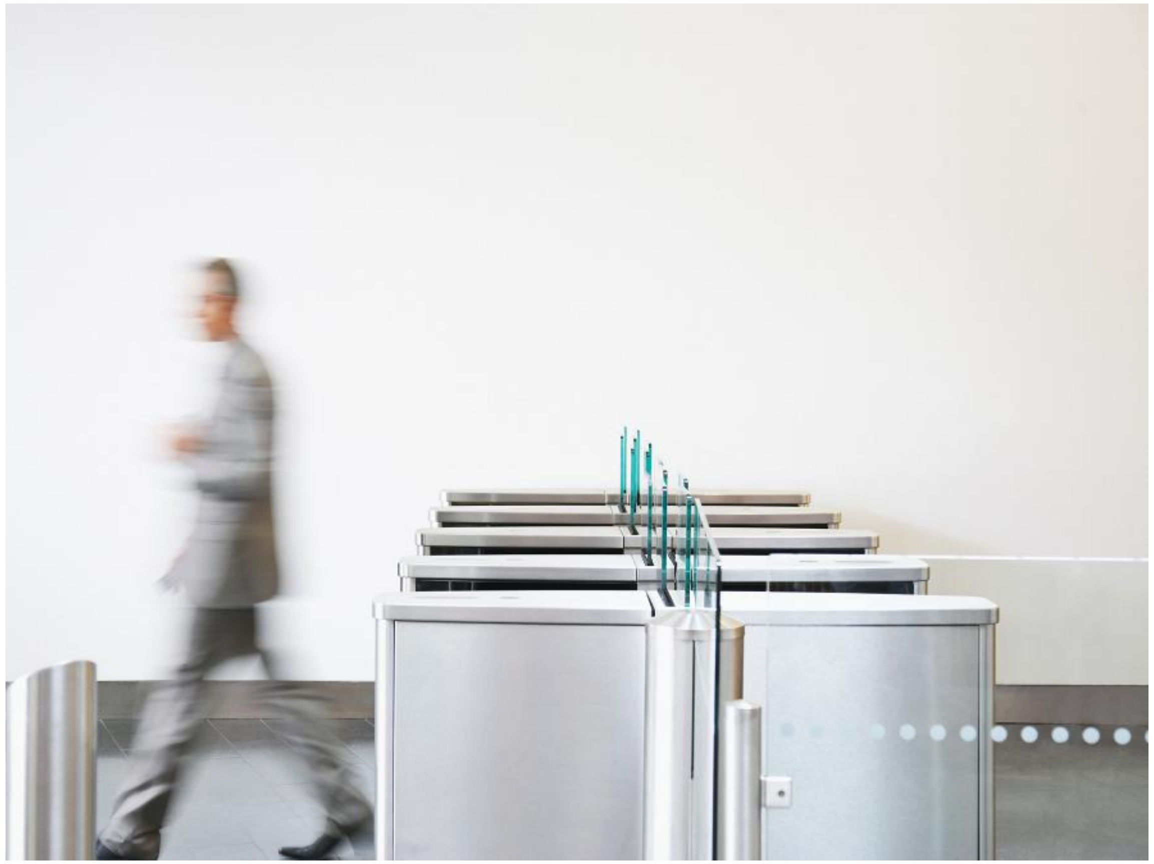


Database Service Availability and Load Balancing

What is the Net Listener?

- First process that clients talk to
- Brokers client requests, handing them off to service handlers
  - Dispatchers
  - Dedicated servers
  - Connection Broker – DRCP
- Receives load updates from the database
- Does server side load-balancing across instances in RAC
- Does server side failover across nodes in RAC
- Can listen on multiple end-points or protocol addresses
- Also supports other presentations – HTTP, FTP

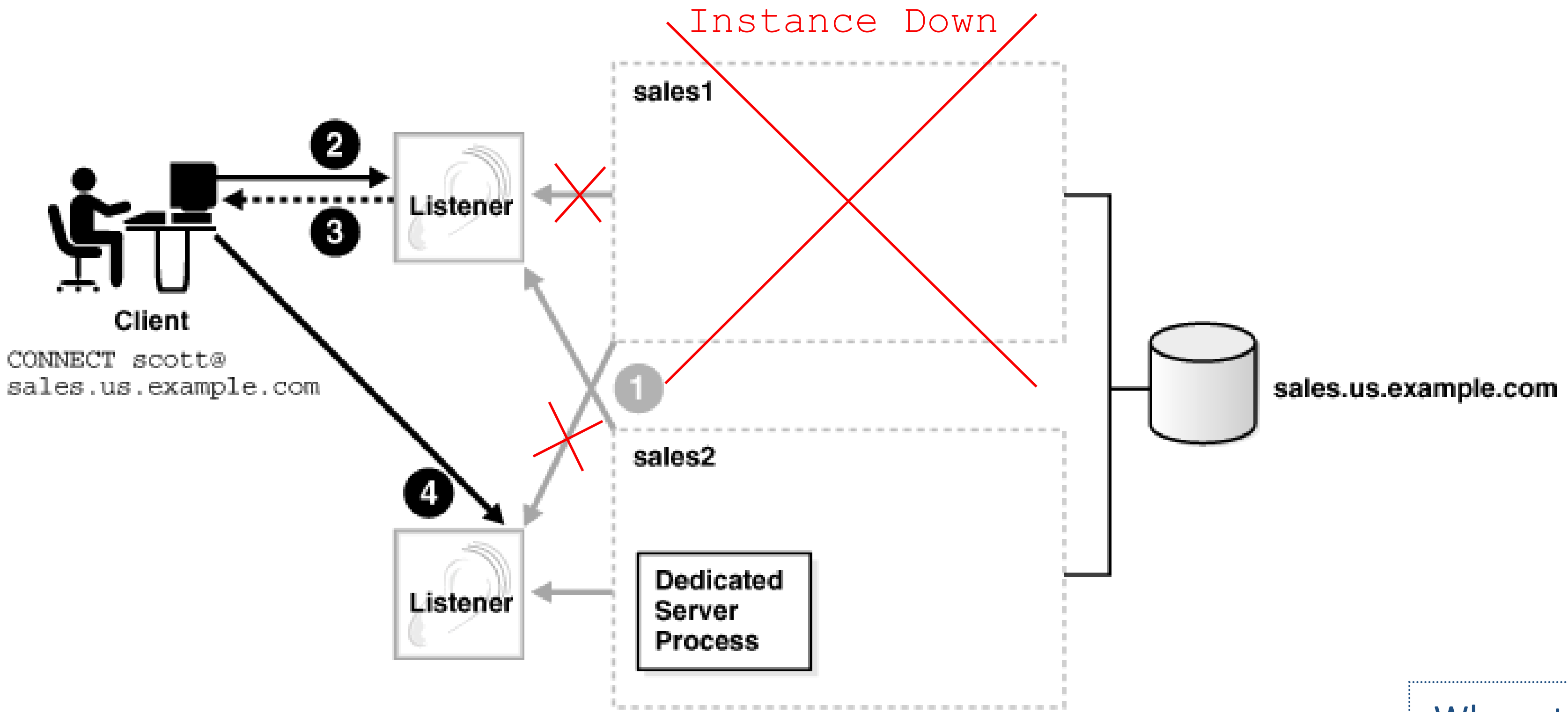
Database Service Availability and Load Balancing
Database Registration with Listener

- Use Dynamic Registration
  - LREG (or PMON in pre-12c) updates the listener about
    - Offered services and available service handlers
    - Load statistics – frequently updated
  - To configure, set in init.ora
    - LOCAL_LISTENER: Address of listeners on local host
    - REMOTE_LISTENER: Address of listeners on remote hosts
  - By default
    - LREG connects to listener on port 1521
    - Automatically setup with RAC
- Remove static SID_LIST configuration in listener.ora
  - Keep only if you want to remotely start the database

Where to configure?

Database parameter file

Database Service Availability and Load Balancing (Example)



- Change behavior by setting Connection Load Balancing Goal
  - Long – for applications with long-lived connections (default)
  - Short – for applications with short-lived connections

Where to configure?

On server, using srvctl utility, or DBMS_SERVICE package

Listener Logon Storm Handler

- Logon storm
  - Sudden spike in incoming connection rate
    - Normal – middle-tier reboot
    - Abnormal – DoS attack
  - Storms cause CPU starvation for existing sessions
- Enable the Connection Rate Limiter feature
  - Provides end-point level control of throttling

```
LISTENER=(ADDRESS_LIST=
    (ADDRESS=(PROTOCOL=tcp)(HOST=sales)(PORT=1521)(RATE_LIMIT=3))
    (ADDRESS=(PROTOCOL=tcp)(HOST=lmgmt)(PORT=1522)(RATE_LIMIT=no)))
```

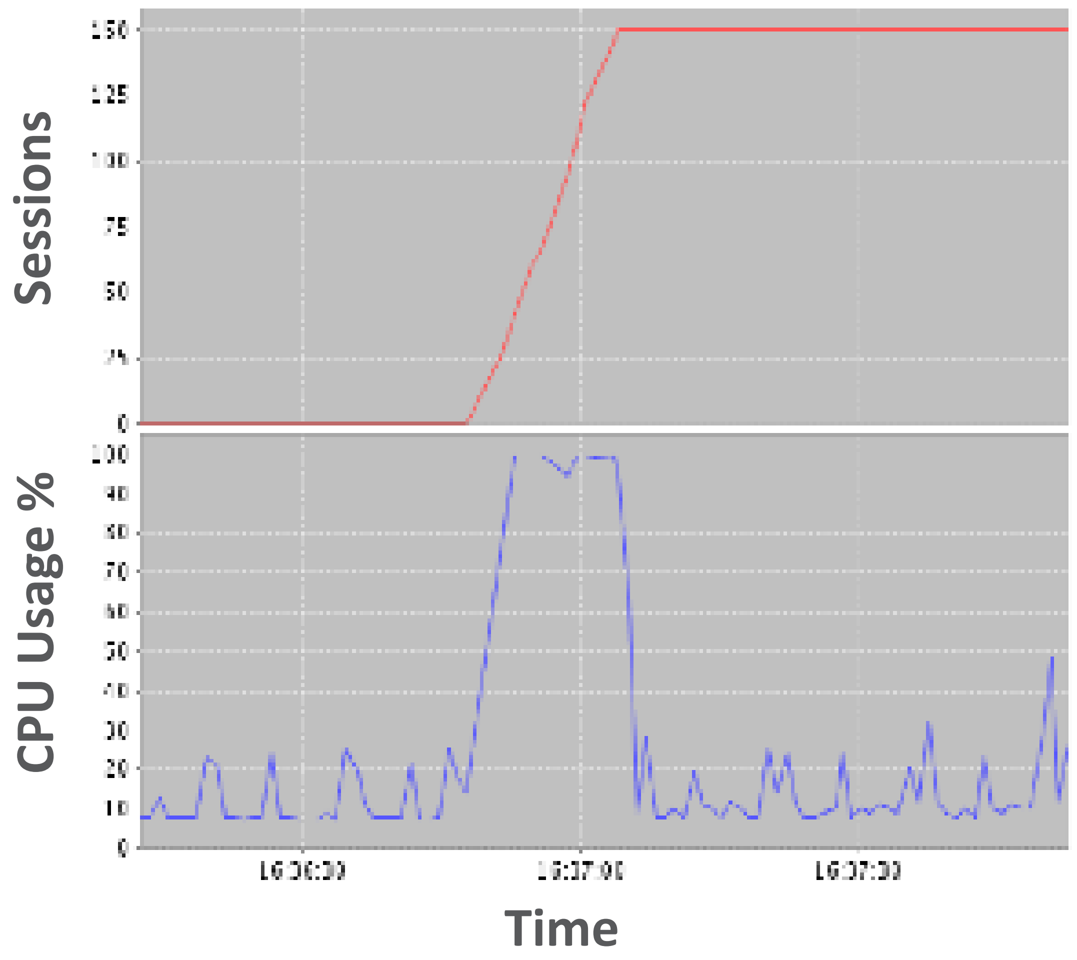
  - Can also be set globally at the listener level
  - Set the Rate Limit to a value that matches your machine capabilities

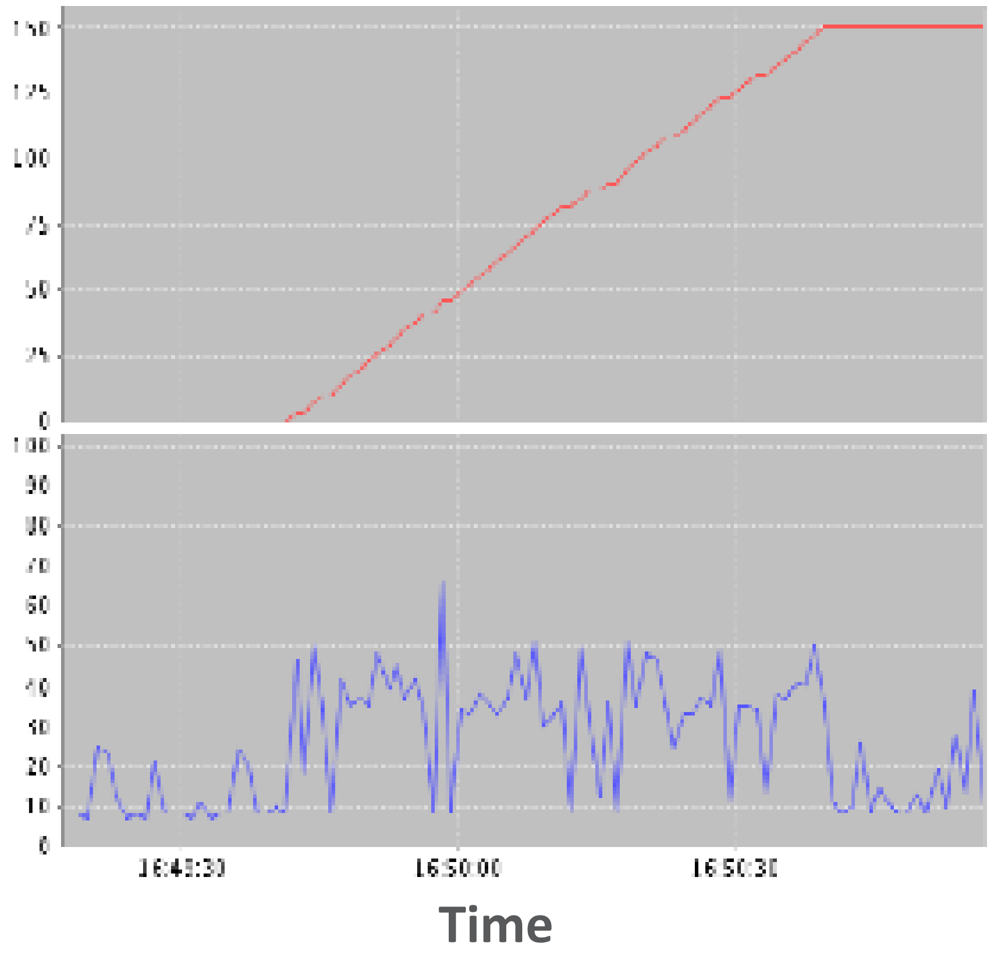
Where to configure?

Server: listener.ora

Logon Storm Comparison

150 concurrent connections





Other Best Practices

- Increase the maximum concurrent requests per listener end-point
  - QUEUESIZE parameter in listener.ora
  - Max `listen()` backlog for TCP (operating system parameter)
  - Set to your expected Connection Request rate

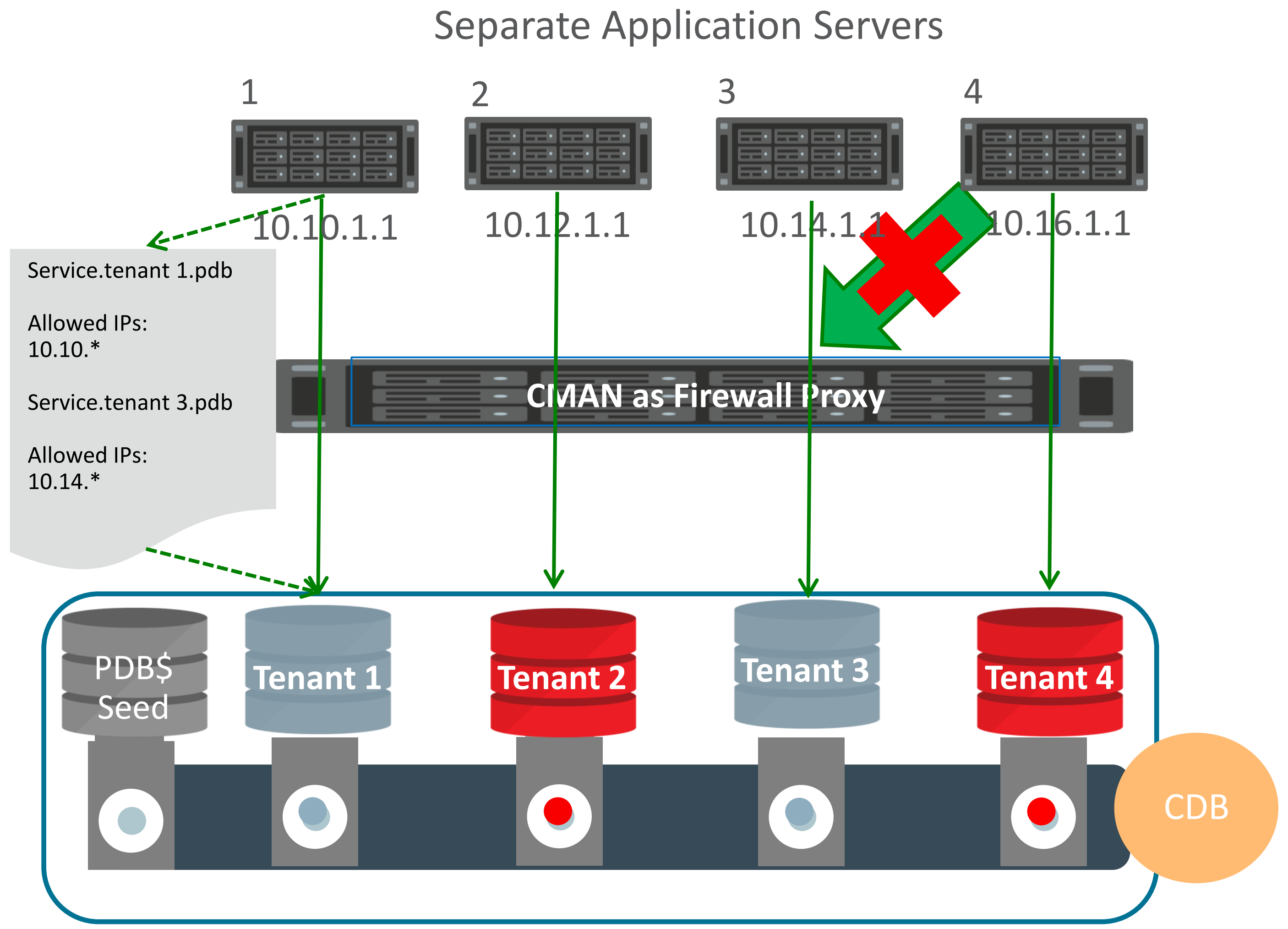
- Optimize Environment variables for the oracle account
  - Longer the PATH, longer it takes to fork off the Oracle process
    - Ensure that PATH is small
    - Does not include any network shares
  - Cut down the number of environment variables

Oracle Connection Manager (CMAN)

- Firewall Proxy aware of Oracle database services
  - Fully Transparent: no application changes required
  - Can be used to hide database subnet, including RAC re-directs, from clients
  - Provides network isolation for multi-tenant environments
- Supports all SQL*Net protocols as well as protocol conversion
  - Can be used as a bridge between IPv4 and IPv6 networks
- Provides access control to services based on configurable rule lists
- Auto-updates when new databases and services are added

Oracle Connection Manager

Access Control



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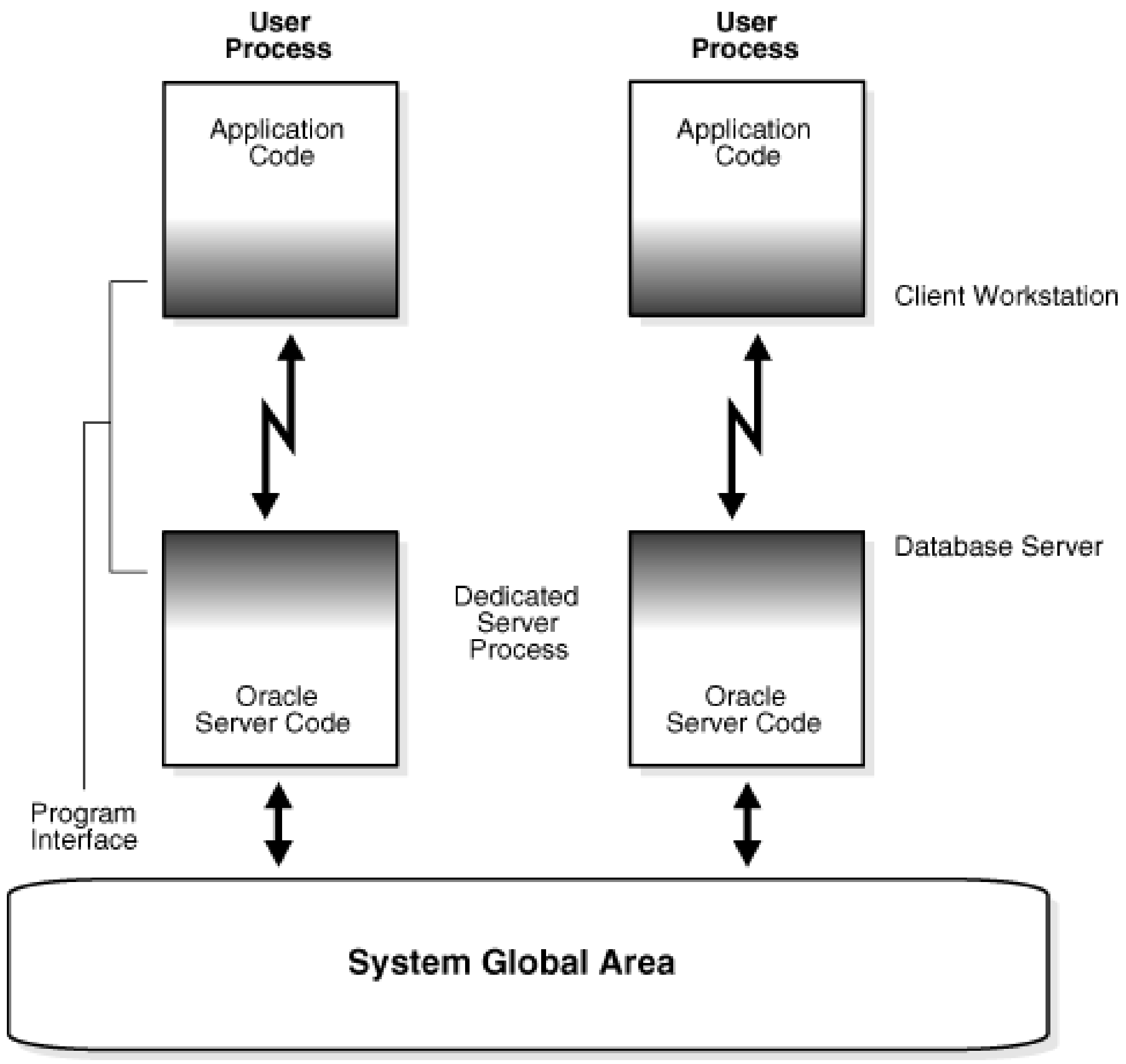
Oracle Server Architecture Overview

- Choosing the right server architecture is critical to meeting scalability requirements

- Oracle Database Server supports three architectures
  - Dedicated Server (default)
  - Shared Server aka MTS
  - Database Resident Connection Pool

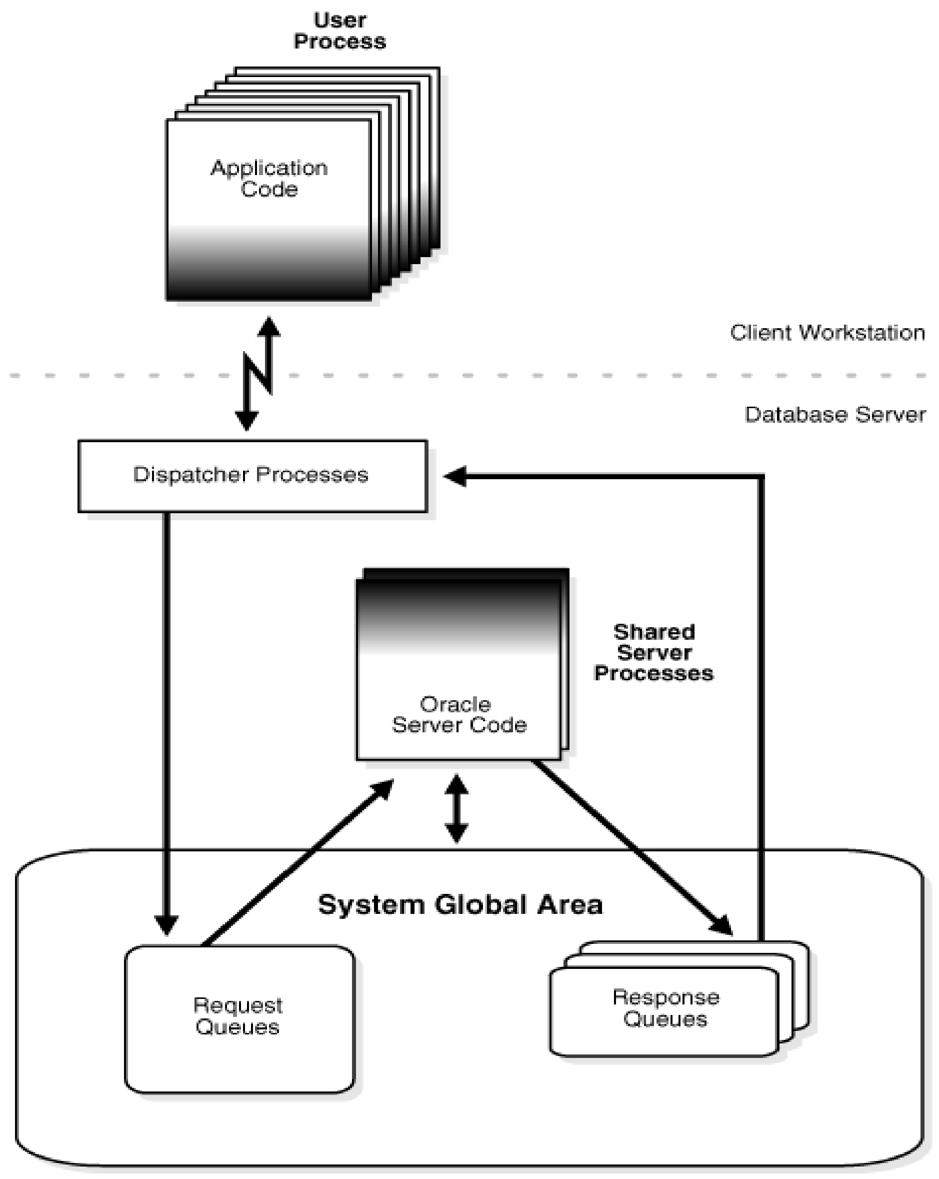
Dedicated Servers

- Each client connection has its own process (thread on Windows)
- Dedicated process ensures lower latencies
- Have to start a new process on connect
- Have to tear down a process on disconnect
- Scalability limits
  - Memory
  - Number of Processes



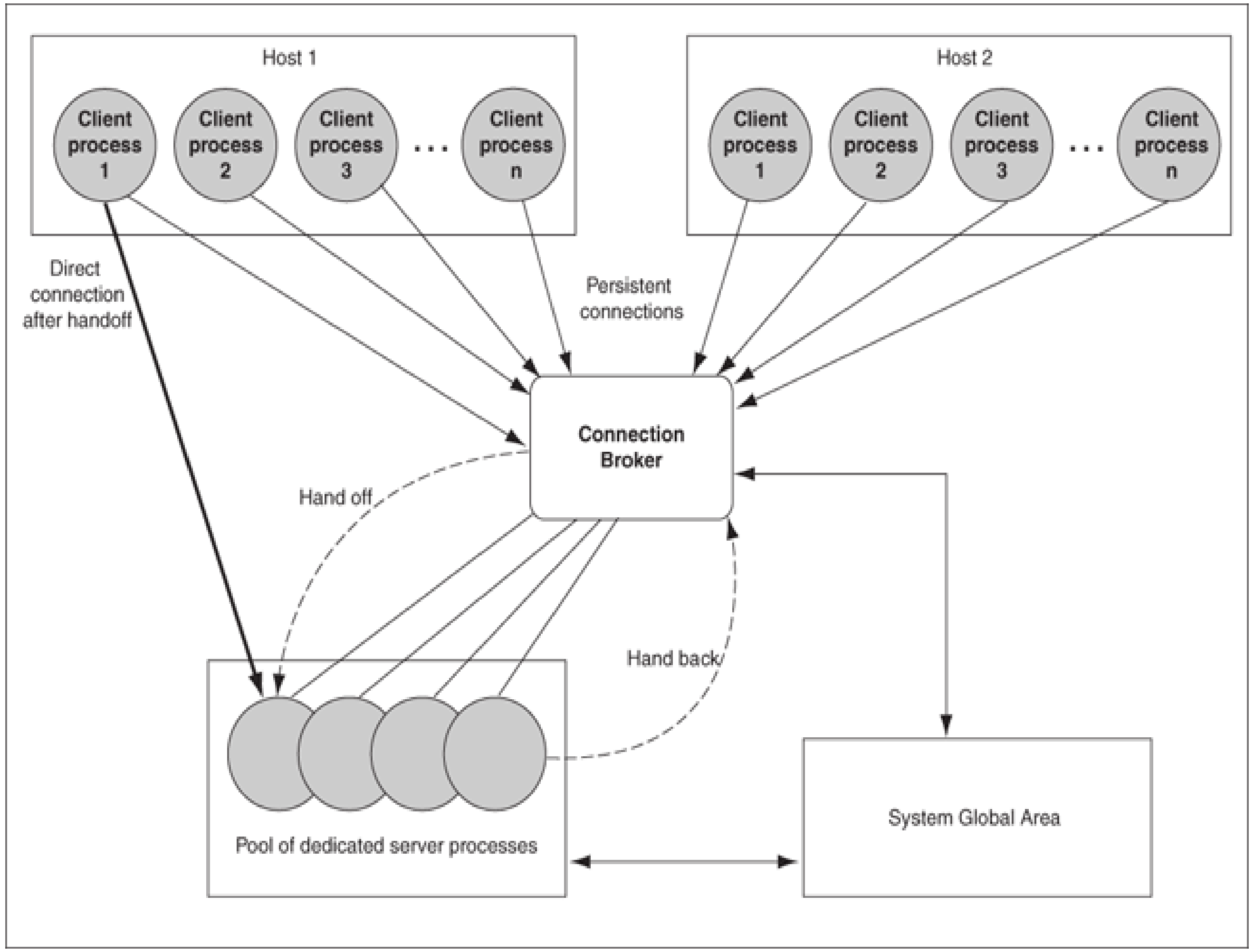
Shared Servers (aka MTS)

- Each server handles multiple clients
- Dispatchers relay requests and responses between clients and servers
- Idle connections will not consume much memory
- Good for large number of connections with many idle
- Latency increase due to man- in-the-middle



Database Resident Connection Pool

- Pooled dedicated servers shared across client systems and processes
- Low connect/disconnect costs
  - Server "locked" on connect
  - Server "released" on disconnect
- Low-latency performance of dedicated servers
- Extreme scalability with a DRCP-capable client driver



Dedicated vs. Shared vs. DRCP

- Use dedicated for:
  - High-performance connections
  - Active, long-running, data transfer intensive operations
- Use shared for:
  - Sessions that may be idle for some time
  - Clients that frequently connect and disconnect
- Use DRCP:
  - When you have thousands of clients which need access to a database server session for a short period of time
  - Applications mostly use same database credentials, and have identical session settings
  - OCI, OCCI, JDBC, PHP (OCI8 extension), Python (cx_Oracle), Perl (DBI)

Using Shared Servers

- Enable shared servers with init.ora parameters
  - Becomes new default
- To force server type, specify server type during connect
  - Dedicated:
    - `sales-server/sales.us.example.com:`**`dedicated`**
  - Shared:
    - `sales-server/sales.us.example.com:`**`shared`**
- Rough guidelines:
  - 20 Shared Servers per 500 sessions, then tune from there
  - 1 dispatcher for every 250 sessions

Using DRCP

- Pooling is enabled by the DBA using

```
EXECUTE DBMS_CONNECTION_POOL.START_POOL
        ('SYS_DEFAULT_CONNECTION_POOL');
```

- Change connect string on client in tnsnames.ora:

```
(DESCRIPTION=
     (ADDRESS=(PROTOCOL=tcp)(HOST=sales-server)(PORT=1521))
     (CONNECT_DATA=(SERVICE_NAME=sales)(SERVER=pooled)))
```

- Can use Easy Connect syntax too

```
sqlplus joeuser@sales-server:1521/sales:pooled
```

- In test environment, we were able to support more than 20,000 connections to a 2 GB Database Server (11g)

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Database Server Security
Inbound Connection Timeouts

- Limits the time taken for a client to connect and authenticate
- SQLNET.INBOUND_CONNECT_TIMEOUT
  - Controls timeout for Database server processes
- INBOUND_CONNECT_TIMEOUT_*listener_name*
  - Controls timeout for the listener
- Enabled by default to 60 seconds
- Independent of client-side timeouts

Where to configure?

Server: sqlnet.ora
listener.ora

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Dead Connection Detection

- Used by server to detect outage of client nodes
  - Enabled using `sqlnet.expire_time`
- Legacy DCD feature uses Oracle Net probe packets
  - Relies on TCP send failures
  - Slower and has more overhead
- New DCD (12c)
  - Relies on TCP keep-alive
  - Efficient detection of dead clients
  - Avoids probe buffering or out-of-buffer issues
  - Maintains backwards compatibility with older clients

Where to configure?

Server: sqlnet.ora

Database Server Security
TCP Valid Node Checks

- Use TCP Invited Nodes
  - List of IPs or hostnames that are permitted to connect
- Use TCP Excluded Nodes
  - List of IPs or hostnames that are NOT permitted to connect
- Use CIDR notation and wildcard format for ease of configuration whenever possible
- Invited nodes takes precedence over excluded
- To enable, set

```
TCP.VALIDNODE_CHECKING = YES
TCP.INVITED_NODES  = (hostname1, hostname2)
TCP.EXCLUDED_NODES = (hostname3, hostname4)
```

Where to configure?

Server: sqlnet.ora

For More Information

search.oracle.com

Oracle Net Services Product Overview

or

oracle.com/technetwork/database/enterprise-edition/index-098579.html

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