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Database Recommendation

Oracle, SQL Server, and DB2 are powerful RDBMS options. There are a number of differences in how they work “under the hood,” and in various situations, one may be more favorable than the other. There is no easy answer, nor is there a silver-bullet for choosing one of these three (3) databases for your specific business requirements.

Oracle is a very popular choice with the Fortune 100 list of companies and for larger enterprises. Research indicates Oracle is popular with large business applications and large data warehouses. Those looking for the largest amount of features will most likely choose Oracle because it is packed with features and minimizes the need for additional third party software to enhance its capabilities.

Oracle
- Use Oracle if:
  - You require transaction control flexibility.
  - You plan to host a large database.
  - You require a high degree of scalability.
  - You want your database to be platform-independent.
  - Faster than DB2 for short running queries.

- G2’s Voice of the Users mentions the following:
  - What do you like the best about Oracle?
    - Oracle's interface is easy to use. I can navigate through multiple programs and sub-options.
    - I had been using MySQL at my previous job; this has been like stepping into a race car. It's fast and it feels like it was put together by professionals. Documentation is readily available and support is easy to find.
  - Recommendations to others considering the product

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Enterprise Architecture
Oracle, IBM DB2, and SQL RDBMS

- Easy to use and a great support system; a newbie should be able to operate it with ease.
- If your corporation is large enough, Oracle is one of the better solutions for large enterprise systems.
  - What benefits have you realized?
    - The high availability and partitioning really make this great software.

Microsoft SQL (Structured Query Language) Server (Database Engine)
- Use MS SQL Server if:
  - You’re working in a .NET development environment.
  - Your database serves a large corporate/enterprise environment.
  - You’re processing workloads rather than developing applications.
  - You require fine-tuned control over your database.

IBM DB2
- Market leader on mainframes.
- Use DB2 if:
  - You already maintain an in-house DB2 installation.
  - You wish to federate data from multiple sources.
  - You need to access data at high speed.
  - Performance optimization is extremely important to your project.
  - For long running queries, DB2 is faster than Oracle.  

For comments, questions, or concerns, please contact us at: EA@vita.virginia.gov

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Relational Database Management Systems (RDBMS)

- While there are many RDBMS’ out there of varying types for all sorts of database needs (MS-Access, Sybase, MySQL (Oracle owned), PostgreSQL, SQLite, etc.), this paper is intended to distinguish between and among what is generally considered the top three major market-leading RDBMS players.

**Oracle v12c-r2**

- Initial release in 1980.
- Considered an all-around solid market leader choice supporting multiple versions of Windows, Unix, and Linux operating systems (OS).
- For over 30 years’ Oracle Corp has produced the most prominent and effective Relational Database Management System (RDBMS) on the market.
  - Considered always consistent across platforms and OS’.
  - Just plain dominates the market.
  - Could see major changes away from Oracle in the next few years.
- In that public cloud infrastructure of tomorrow, AWS, Microsoft Azure, and Google rule. Oracle? Not so much.
- Oracle’s IaaS cloud comes in three compute flavors:
  - Physical (meaning non-virtualized)
  - Linux or Windows servers, which offer isolation of customer workloads
  - Virtual servers (where customers share infrastructure resources with other customers)
  - Bare metal servers running Docker containers

  “No one else in the public cloud offers that capability,” said Oracle President of Products, Thomas Kurian, about the company's physical servers, which he says provide 100% isolation of workloads.

  Compute offerings range from inexpensive machines ($0.10 per hour) to ones with between 32 and 44 Intel core processors, 1 TB of dRAM and 29 TBs of local storage, all the way up to 60 TB local storage that are capable of up to 1 million input and outputs per second (IOPS).

  Kurain claims these cost 20% less than AWS with 7 to 10X the performance.
- Security is at the core of the coding practices employed by the development staff that builds the Oracle database, resulting in the delivery of a secure product.

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Oracle is closed-source – the free version has very limited feature set.

Many corporate IT folks say they know that Oracle’s database outshines Amazon’s, but that alone isn't enough to win the day.

- One consultant summed up the situation perfectly. He was talking to Wall Street analyst Pat Walravens from JMP Securities at the AWS Summit in San Francisco the week of April 17, 2017. Walravens reported the conversation in a research note.
  - Note that Walravens has been a critic of Oracle over the years and currently rates Oracle’s stock a "market perform."
  - The consultant said the Oracle database "is a great product, but it can't compete on cost or ease of use... It's like a Formula-1 race car - you need a great driver and a team to look after it." 11

Oracle uses PL/SQL (Procedural Language/SQL).
Temporary tables persist across sessions, and must be removed by the user.
Oracle offers four different character/string types: CHAR, VARCHAR2, NCHAR, NVARCHAR2.
Offers both table and row locking.
Has extensive and flexible storage customization with commands like tablespace, synonym, and packages.
Widespread backup mechanisms.
Designed to manage tables and databases on a large-scale basis.

IBM DB2 for Linux, Unix, Windows (LUW)

- Initial release in 1983.
- Common in IBM host environments. 12
- IBM addresses security by delivering it outside of the database and relying on the operating system or Tivoli’s product line to secure DB2 and other IBM products. 13
  - The most obvious result is that data stored in DB2 is not inherently protected.
- DB2 is closed-source – enterprise version only available for a price.
- DB2 is Oracle’s biggest competitor on Unix and Linux OS’.
- Faster deployment with an average deployment time of 57 days LESS than an Oracle based solution. 14
- Multiple options for disaster recovery, availability, and scalability.
- Does not support XML.

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Enterprise Architecture
Oracle, IBM DB2, and SQL RDBMS

- 5.3X better compression rates for DB2 over Oracle (12.6X for DB2 versus 7.3X for Oracle).  
- Schema-based table management.
- Can only partition tables via sharding.
  - Sharding is a type of database partitioning that separates very large databases into smaller, faster, more easily managed parts called data shards.
  - Shard means a small part of a whole.
- No in-memory capabilities.
- Designed for relational integrity.
- More robust table/data management than MySQL.
- Materialized table views.
- Lacks native character/string support.

Microsoft SQL Server (Database Engine) v2017

- SQL has been generally considered the database leader on Windows OS.
- Microsoft announced in early 2016 that SQL Server 2016 is now on Linux.
- Gartner named Microsoft as leading the industry in their Magic Quadrant for:
  - 2016 – Operational Database Management Systems (ODMS) in both execution and vision.
  - 2016 – Data Warehouse and Data Management Solutions for Analytics.
  - 2017 – Business Intelligence and Analytics Platforms.
  - Leading in vision in the Magic Quadrant for Advanced Analytics Platforms.
- Uses Transact SQL (T-SQL), which is an extension of SQL originally developed by Sybase.
- Closed-source and aimed at corporate/enterprise environments.
- Offers full support for common table expressions.

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Enterprise Architecture
Oracle, IBM DB2, and SQL RDBMS

- Requires a deeper understanding of databases and database configurations than other tools.
- Can fine-tune security features such as who can run each stored procedure; who can access data, etc.
- Utilizes an engine that’s slightly slower and resource-heavy, but fully ACID compliant.
  - In computer science, ACID (Atomicity, Consistency, Isolation, Durability) is a set of properties of database transactions. In the context of databases, a sequence of database operations that satisfies the ACID properties and, thus, can be perceived as single logical operation on the data, is called a transaction. For example, a transfer of funds from one bank account to another, even involving multiple changes such as debiting one account and crediting another, is a single transaction. ²⁰
- SQL on Linux opened up a huge option for organizations looking to switch away from Oracle and their famously aggressive licensing audits.
  - The top 10 triggers (and deterrents) of an Oracle audit article provides an overview of the aggressiveness at: http://upperedge.com/oracle/the-top-10-triggers-and-deterrents-of-an-oracle-audit/
- Extremely comprehensive reporting system/storage customization.
- High degree of control over transactions and procedures.
- Schema changes do not lock tables.
- Relatively high resource footprint.

Additional Background Information

- Oracle recognized many years ago that customers are more focused on their Application Software than the RDBMS Software, meaning customers primarily purchase the application first and fit the RDBMS into that plan. Hence, Oracle’s integrated Product Suite is considered their final firewall preventing this “Perfect Storm” from totally swamping the intellectual property of Redwood Shores.

- Although Oracle and SQL use a version of Structured Query Language, or SQL:
  - MS SQL Server uses Transact SQL, or T-SQL, which is an extension of SQL originally developed by Sybase and used by Microsoft.
  - Oracle uses PL/SQL, or Procedural Language/SQL.
    - Both are different “flavors” or dialects of SQL and both languages have different syntax and capabilities.
  - Main difference between the two languages is how they handle variables, stored procedures, and built-in functions.
    - PL/SQL in Oracle can group procedures together into packages, which can’t be done in MS SQL Server.
    - PL/SQL is generally considered more complex and potentially more powerful, while T-SQL is much more simple and easier to use.

- Why would one use Oracle DB now?
  A comment was made concerning Oracle: “It seems like if you were to pick a database and start from scratch, there would be no reason Oracle would be on the top of the list.”
  - The answer is simple, and one that has been answered here 100 times. Oracle has a significant number of more features than just about all of its competitors. There are many things I can do in Oracle that I cannot do in Postgres, MySQL, SQL Server, etc.
  - If you understand how to leverage things like bitmap indexes, sub-partitions, hybrid columnar compression, parallel queries (all things most other databases can’t do), and a plethora of other features, you can maximize the living heck out of your hardware and actually end up saving money in the long run.
  - It all depends on use case. Many databases just don’t have the right features for some use cases.²¹

### Database Comparisons:

<table>
<thead>
<tr>
<th></th>
<th>IBM DB2 x</th>
<th>Microsoft SQL Server x</th>
<th>Oracle x</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
<td>Common in IBM host environments, two (2) different versions for host and Windows/Linux.</td>
<td>Microsoft's relational DBMS.</td>
<td>Widely used RDBMS</td>
</tr>
<tr>
<td><strong>Database Model</strong></td>
<td>Relational DBMS</td>
<td>Relational DBMS</td>
<td>Relational DBMS</td>
</tr>
<tr>
<td><strong>Implementation Language</strong></td>
<td>C</td>
<td>C++</td>
<td>C</td>
</tr>
<tr>
<td><strong>SQL - Support of almost the entire SQL standard (DML, DDL, and DCL statements)</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

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### API's and other access methods

<table>
<thead>
<tr>
<th>ODBC</th>
<th>JDBC</th>
<th>ADO.NET</th>
<th>Xquery</th>
<th>JSON-style queries (MongoDB compatible)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ODBC</td>
<td>JDBC</td>
<td>ADO.NET</td>
<td></td>
<td>Tabular Data Stream (TDS)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>OLE DB</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Oracle Call Interface (OCI)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ODP.NET</td>
</tr>
</tbody>
</table>

### Supported programming languages

| C, C#, C++, Cobol, Delphi, Fortran, Java, Perl, PHP, Python, Ruby, Visual Basic |
| C++, Delphi, Go, Java, JavaScript (Node.js), PHP, Python, R, Ruby, Visual Basic |
| C, C#, C++, Clojure, Cobol, Delphi, Eiffel, Erlang, Fortran, Groovy, Haskell, Java, JavaScript, Lisp, Objective C, OCaml, Perl, PHP, Python, R, Ruby, Scala, Tcl, Visual Basic |

### Max Table Size

| 2 ZB (Zettabytes) | 524,272 TB | 4 GB block size |

- **Byte (8 bits)**
- **Kilobyte (1,000 Bytes)**
- **Megabyte (1,000,000 Bytes)**
- **Gigabyte (1,000,000,000 Bytes)**
- **Terabyte (1,000,000,000,000 Bytes)**
- **Petabyte (1,000,000,000,000,000,000 Bytes)**
- **Exabyte (1,000,000,000,000,000,000,000 Bytes)**
- **Zettabyte (1,000,000,000,000,000,000,000,000 Bytes)**

When an object instance exists in memory, there is no fixed limit on the number of attributes in the object. But the maximum total amount of memory consumed by an object instance is 4 GB. When an object instance is inserted into a table, the attributes are exploded into separate columns in the table, and the Oracle 1000-column limit applies.\(^4\)

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## Deadlocks

A deadlock is created when two applications lock data that is needed by the other, resulting in a situation in which neither application can continue executing.

Deadlocks are a serious problem under load.  
"...in the absence of current statistics... the optimizer has to lock, read in, and compare all the rows in the main table with the value supplied in the predicate. Table scans always read (and lock) all the rows in the table."

## Costs

DB2 10.5 provides a lower total operating cost of ownership than Oracle – 28% to 34% lower 3-year TCO for transactional processing 54% to 63% lower 3-year TCO for high performance analytics.

Considered more stable than MS-SQL as there are minimal to no deadlocks under load. The Oracle documentation is clear: for a SELECT statement in Oracle, no locks are created. (SELECT...FOR UPDATE is another matter.)

<table>
<thead>
<tr>
<th>Database</th>
<th>SQL Server 2016</th>
<th>Oracle</th>
<th>2017 Cost SAVINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$1,428,800</td>
<td>$3,745,000</td>
<td>61%</td>
</tr>
</tbody>
</table>

---


<table>
<thead>
<tr>
<th>License Model</th>
<th>Processor Value Unit (PVU)</th>
<th>Authorized User Single Install License (AUSI or AU)</th>
<th>Processor Named User Plus (NUP)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Terabyte Pricing (TB)</td>
<td>Pay per whole TB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Limited Use Socket (LUS)</td>
<td>Licensing by sockets</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fixed Term Licence (FTL)</td>
<td>License for one year</td>
<td></td>
</tr>
</tbody>
</table>

---

### COMPARISON OF CONFIGURATIONS: SINGLE INSTANCE, SE2

<table>
<thead>
<tr>
<th><strong>DB2 Workgroup Edition</strong></th>
<th><strong>Oracle SE2</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 AU = 428,20 $</td>
<td>1 NUP = 350 $ + 77 $ = 427 $</td>
</tr>
<tr>
<td>5 Users Minimum</td>
<td>10 Users Minimum</td>
</tr>
<tr>
<td>1 CPU = 21,410 $</td>
<td>1 CPU = 21,350 $</td>
</tr>
<tr>
<td>Max. 4 sockets /16 cores</td>
<td>Max. 2 sockets</td>
</tr>
<tr>
<td>128 GB RAM</td>
<td></td>
</tr>
<tr>
<td>50 Users ~ 1 CPU</td>
<td>50 Users ~ 1 CPU</td>
</tr>
</tbody>
</table>

- **2 CPU / 100 User**
  - **DB2**: 42,820 $
  - **Oracle**: 42,700 $

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## COMPARISON OF CONFIGURATIONS: 4-NODE CLUSTER (4*4 CPUs)

<table>
<thead>
<tr>
<th>DB2 Enterprise Advanced</th>
<th>Oracle EE + Partitioning + AC</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB Enterprise Advanced</td>
<td>Enterprise Edition</td>
</tr>
<tr>
<td></td>
<td>4*4 $57.950 = 927.200$</td>
</tr>
<tr>
<td>PureScale</td>
<td>Real Application Clusters</td>
</tr>
<tr>
<td>included</td>
<td>4*4 $5.060 = 80.960$</td>
</tr>
<tr>
<td>Partitioning</td>
<td>Partitioning</td>
</tr>
<tr>
<td>included</td>
<td>4*4 $14.030 = 224.480$</td>
</tr>
<tr>
<td>Adaptive Compression</td>
<td>Advanced Compression</td>
</tr>
<tr>
<td>included</td>
<td>4*4 $14.030 = 224.480$</td>
</tr>
<tr>
<td>Total:</td>
<td>Total:</td>
</tr>
<tr>
<td>+ 2 CF Server</td>
<td>1.376.160 $</td>
</tr>
</tbody>
</table>

Oracle vs DB2 Shootout

4 * 4 CPU / 256 GB RAM

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