A REVIEW OF MODERN DATABASE APPLICATIONS

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Abstract

This research focuses on the review of modern database applications. Database applications are software programs designed to collect, manage and disseminate information efficiently. However, there are various database applications, some of which are advanced with programming methods that can be used to build custom business solutions in networked environment. Consequently, most database applications are customized with database programming languages to automate specific types of work, hence many home and small business owners create simple databases such as customer contact and mailing lists with easy-to-use software such as Microsoft "Access" and "FileMaker Pro. The research seeks to analyze the various categories of database applications, their examples, releases and versions and make comparison between some of them based on certain measurable parameters.

1.0 INTRODUCTION

A database at its simplest definition is a gathering of information called data, stored on a server. The data is properly organized in a manner that can easily be retrieved, managed and edited in significant ways by the end user (Hammer, 2017). The data could be something complex or simple such as personal information about clients or customers. It could also be inventory, sales, calls or anything anyone needs to combine as a whole as well as the associated format it will take. Database applications are software programs designed to collect, manage and disseminate information efficiently. Many home and small business owners create simple databases such as customer contact and mailing lists with simple software such as Microsoft "Access" and "FileMaker Pro." "Oracle," "SQL Server," and "FoxPro" are examples of advanced database applications with programming techniques that can be used to ignite custom business solutions in networked environment. Their primary purpose is to facilitate entry and retrieval of information from a computerized database. Database applications are mainly used to search, sort, calculate, report and share information. Databases may also contain code to perform mathematical and statistical calculations on the data to give support to queries submitted by users. Database applications offer security by placing limitation to data based upon user names and passwords. Most database applications are customized with a database programming language to automate specific types of work (Harrison, 2019).

A glaring feature of modern database applications is that they facilitate simultaneous updates and queries from multiple users. Systems in the 1970s might have accomplished this by having each user in front of a terminal to a mainframe computer. By the mid-1980s, it became very common to give each user a personal computer with a program running on it and which is connected to a database server. Information would be gotten from the database, transmitted over a network, and then arranged, graphed, or otherwise formatted by the program running on the said PC. In the mid-1990s it became more common to build database applications with a Web interface. Instead of developing custom software to run on a user's PC, the user would use the same web browser program

for all applications. A database application with a Web interface had the advantage that it could be used on devices of different sizes, with different hardware, and operating systems. Examples of early database applications with web interfaces include amazon.com, which was derived from the Oracle relational database management system, the photo.net online community, whose implementation on top of Oracle was clearly stated in the book Database-Backed Web Sites (Ziff-Davis Press; May 1997), and eBay, also running Oracle platform.

2.0 REVIEW OF RELATED LITERATURE

Electronic medical records are referred to on emrexperts.com, in December 2010, as "a software database application". A 2005 O'Reilly book uses the term in its title: Database Applications and the Web. Some of the most complex database applications remain accounting systems, such as SAP, which may contain thousands of tables in only a single module. Many of today's most widely used computer systems are database applications, for example, Facebook, which was built on top of MySQL (Harrison,2019). The etymology of the phrase "database application" comes from the practice of dividing computer software into systems programs, such as the operating system, compilers, the file system, and tools such as the database management system, and application programs, such as a payroll check processor. On a standard PC running Microsoft Windows, for example, the Windows operating system contains all of the systems programs while games, word processors, spreadsheet programs, photo editing programs, etc. would be application programs. As "application" is short for "application program", so is "database application" is short for "database application program (Wikibooks, 2020). It is not every program that makes use of a database would typically be considered a "database application". For example, many physics experiments, e.g., the Large Hadron Collider, generate massive data sets that programs subsequently analyze. The data sets constitute a "database", though they are not typically managed with a standard relational

database management system (Letton, 2020). The computer programs that analyze the data are mainly developed to answer hypotheses, not to return information into the database and therefore the overall program would not be regarded as a "database application".

Web Applications

Several contemporary web sites are built using several database applications simultaneously as core components. Most retail store Web sites including "Bestbuy.com," and "Amazon.com" use database systems to store, update and present data about products for sale. These Web sites also combine an accounting database system to record sales transactions and a CRM database application to incorporate feedback and drive a positive customer experience. The well acknowledged Web-based "Facebook" application is essentially a database built upon the "MySQL" database system and is an indication of the increasing usage of database applications as foundations for Web-based applications(www.aws.amazon.com)

Accounting Applications

An accounting system is a special purpose or custom database application used to manage financial data. Assets, liabilities, inventory and the transactions between customers and suppliers are recorded by custom forms. The income statements, balance sheets, purchase orders and invoices generated are custom reports based upon information inherent in the database. Accounting applications can run on a single computer suitable for a small business or in a networked shared environment to accommodate the needs of multiple departments and locations in larger organizations. "Microsoft Money," "Quicken," "QuickBooks" and "Peachtree" are accounting systems built upon database applications.

CRM Applications

A customer relationship management system (CRM) is another example of a database application that has been customized to facilitate the marketing, sales, and support relationships between a business and its customers. The overall objective is to maximize sales, minimize costs and foster strategic customer relationships. Simple contact management programs such as "ACT," or the task manager in Microsoft's "Outlook" can be customized to suit the needs of individuals and small businesses. "SAP," "Salesforce.com," and Oracle's "Siebel" are robust CRM database applications suitable for larger enterprises. A customer relationship management (CRM) application is one that different kinds of businesses use to keep track of customer contact information, addresses, orders and shipping information. A CRM can be pre-packaged or specifically created by a software development company. The complexity of the software depends on the business rules and size of the company. Although CRM applications have their advantages, they also exist some disadvantages. Some CRM applications use remote Internet connections to keep track of customer records. Salesforce is a well-known CRM application provided through an Internet connection on the company's domain. The disadvantage of this type of CRM is that the company does not have control of the data, and if the remote CRM system has an outage, the company is unable to retrieve records. If the company chooses a small CRM application that is unstable, it can mean several thousands of dollars in lost revenue. When using a remote CRM application hosted by another company, use local backups to avoid record loss.

AIM AND OBJECTIVES

The aim of this research is to state and describe the various modern database applications. The objectives are;

1) To highlight the various database applications
2) State the features of each of the highlighted database application
3) Make comparison between some of them.

DISCUSSION

Database applications can be categorized majorly as

1) Relational database application
2) Non-Relational database application
3) Mobile database application
4) Web database application

Relational database applications

Oracle Database: Oracle Database (Often mentioned as **Oracle RDBMS** or simply as **Oracle**) is a multi-model database management system anchored by Oracle Corporation. It is a database often used for running online transaction processing (OLTP), data warehousing (DW) and mixed (OLTP & DW) database workloads. The latest generation, Oracle Database 19c, is available on-prem, on-cloud, or in a hybrid-Cloud environment. 19c also can be deployed on Oracle Engineered Systems (e.g., Exadata) on-prem, on Oracle (public) Cloud or (private) cloud (Wikibooks, 2020)

Oracle is the first organization to provide a highly optimized database and compute platforms by combining the newest in hardware and software technologies (Oracle Exadata, Exalogic). It also delivered to the forefront the notion of balanced configurations. A well-developed configuration approach ensures that when computing resources are required, they can be made to be in addition in a modular fashion to existing infrastructure. In other words, system features such as CPU resources, network and I/O bandwidth, and storage capacity are all added proportionately so that all resources are configured evenly.

Oracle features a history of bringing important technologies to the realm of mainstream workloads, like of utilization of encryption, compression by regular OLTP, and data warehouse applications. Typically, using these features involves a significant

performance overhead. With Oracle Exadata, compression is often enabled even for high-performance OLTP applications additionally to data warehousing applications. Oracle has had a history of providing enterprise software that facilitates consolidation, scalability, and capacity on demand (e.g., Oracle database Real Application Clusters or RAC) since the commencement of Oracle Database 10g and Oracle Application Server 10g in early 2000. Oracle offers out-of-the-box integration of various features and functionalities in its software offerings. Examples include Oracle Business Intelligence Enterprise Edition (OBIEE), which operates in combination of an application server, common metadata models, E-T-L (Extract-Transform-Load) tools, technologies and dashboards, and reporting tools; and Oracle Database, which offers full support for database-wide encryption and compression out of the box.

Oracle software products offer unique features, such as:

- Oracle Database row-level locking, which avoids locking rows of data in tables when reading them. For all other relational databases, this is often a nightmare, as they need to enable row locking even for a quick period, or enable “dirty reads” to avoid locking, which has its own side effects, like reading uncommitted data.
- Oracle Database Real Application clusters, which permit active-active clustering of multiple instances accessing one single Oracle database. Recently, other database vendors have begun to supply this sort of solution as well.
- Organizations use an array of tools and technologies to manage and monitor different layers of IT systems. Oracle's consolidated management software, Oracle Enterprise Manager (OEM) Grid Control, can monitor and manage all components in a data center. OEM also offers an easy web-based user interface that can be accessed from any device, like PDA, laptop/desktop, or mobile phone.

Table 1. Oracle database Comparison with other databases

	Oracle Database	DB2	SQL Server	Sybase	Informix
Row-level locking	Yes	Yes (with isolation levels)	No	Yes	No
Active-active clustering	Yes	Yes (DB2 PureScale)	No	Yes (via Cluster edition)	No
Integration with in-memory cache database and flash cache	Yes	No	No	No	No
Compression	Yes (OLTP/DW/Archive)	Partial	No	No	No
Transparent database encryption	Yes	Partial	No	No	No
Unified management capability	Yes	No	No	No	No (command-line utilities)

Releases and Versions

Oracle products use a custom release-numbering and -naming convention. The "c" within the current release, Oracle Database 21c, stands for "Cloud". Previous releases (e.g., Oracle Database 10g and Oracle9i Database) have used suffixes of "g" and "i" which represent "Grid" and "Internet" respectively. Prior to the release of Oracle8i Database, no suffixes featured in Oracle Database naming conventions. However, it should be noted that there was no v1 of Oracle Database, as co-founder Larry Ellison "knew no one would want to shop for version 1". Oracle's RDBMS release numbering has used the codes as stated below:

Table 2. Oracle database naming conventions, versions and features.

acle Database Version	Initial Release Version	Initial Release Date	Terminal Patchset Version	Terminal Patchset Date	Marquee Features
Oracle v2	2.3	1979			First commercially available SQL-based RDBMS implementing some basic SQL queries and simple joins
Oracle v3	3.1.3	1983			Concurrency control, data distribution, and scalability
Oracle v4	4.1.4.0	1984	4.1.4.4		Multiversion read consistency. First version available for MS-DOS.
Oracle v5	5.0.22 (5.1.17)	1985	5.1.22		Support for client/server computing and distributed database systems. First version available for OS/2.
Oracle v6	6.0.17	1988	6.0.37		Row-level locking, scalability, online backup and recovery, PL/SQL. First version available for Novell Netware 386.
Oracle 6.2	6.2.0				Oracle Parallel Server

Oracle7	7.0.12	June 1992			PL/SQL stored procedures, Triggers, Distributed 2-phase commit, Shared Cursors, Cost Based Optimizer
Oracle 7.1	7.1.0	May 1994			Parallel SQL Execution. First version available for Windows NT.
Oracle 7.2	7.2.0	May 1995			Shared Server, XA Transactions, Transparent Application Failover
Oracle 7.3	7.3.0	February 1996	7.3.4		Object-relational database
Oracle8 Database	8.0.3	June 1997	8.0.6		Recovery Manager, Partitioning. First version available for Linux.
Oracle8*i* Database	8.1.5.0	1998	8.1.7.4	August 2000	Native internet protocols and Java, Virtual Private Database
Oracle9*i* Database	9.0.1.0	2001	9.0.1.5	December 2003	Oracle Real Application Clusters (RAC), Oracle XML DB
Oracle9*i* Database Release 2	9.2.0.1	2002	9.2.0.8	April 2007	Advanced Queuing, Data Mining, Streams, Logical Standby
Oracle Database 10*g* Release 1	10.1.0.2	2003	10.1.0.5	February 2006	Automated Database Management, Automatic Database Diagnostic Monitor, Grid infrastructure, Oracle ASM, Flashback Database

Oracle Database 10*g* Release 2	10.2.0.1	July 2005	10.2.0.5	April 2010	Real Application Testing, Database Vault, Online Indexing, Advanced Compression, Data Guard Fast-Start Failover, Transparent Data Encryption
Oracle Database 11*g* Release 1	11.1.0.6	September 2007	11.1.0.7	September 2008	Active Data Guard, Secure Files, Exadata
Oracle Database 11*g* Release 2	11.2.0.1	September 2009	11.2.0.4	August 2013	Edition Based Redefinition, Data Redaction, Hybrid Columnar Compression, Cluster File System, Golden Gate Replication, Database Appliance
Oracle Database 12*c* Release 1	12.1.0.1	July 2013	12.1.0.2	July 2014	Multitenant architecture, In-Memory Column Store, Native JSON, SQL Pattern Matching, Database Cloud Service
Oracle Database 12*c* Release 2	12.2.0.1	September 2016 (cloud) March 2017 (on-prem)			Native Sharding, Zero Data Loss Recovery Appliance, Exadata Cloud Service, Cloud at Customer
Oracle Database 18c	18.1.0 // 12.2.0.2	February 2018 (cloud, Exadata) July 2018 (other)			Polymorphic Table Functions, Active Directory Integration, Transparent Application Continuity, Approximate Top-N Query Processing, PDB Snapshot Carousel, Online Merging of Partitions and Sub-partitions
Oracle Database 19c	19.1.0 // 12.2.0.3	February 2019			Active Data Guard DML Redirection, Automatic Index

		(Exadata) April 2019 (Linux) June 2019 (cloud)			Creation, Real-Time Statistics Maintenance, SQL Queries on Object Stores, In-Memory for IoT Data Streams, Hybrid Partitioned Tables, Automatic SQL Plan Management, SQL Quarantine, Zero-Downtime Grid Infrastructure Patching, Finer-Granularity Supplemental Logging, Automated PDB Relocation
Oracle Database 21c	21.1	December 2020 (cloud)			Blockchain Tables, Multilingual Engine - JavaScript Execution in the Database, Binary JSON Data Type, Per-PDB Data Guard Physical Standby (aka Multitenant Data Guard), Per-PDB GoldenGate Change Capture, Self-Managing In-Memory, In-Memory Hybrid Columnar Scan, In-Memory Vector Joins with SIMD, Sharding Advisor Tool, Property Graph Visualization Studio, Automatic Materialized Views, Automatic Zone Maps, SQL Macros, Gradual Password Rollover

Note: Oracle database naming convention, retrieved from en.wikipedia.org/wiki/oracle database.

Microsoft SQL Server: On June 12th 1988, Microsoft joined AshtonTate and Sybase to make a variant of Sybase SQL Server for IBM OS/2 (then developed jointly with Microsoft), which was released the subsequent year. This was the primary version of Microsoft SQL Server, and served as Microsoft's entry to the enterprise-level database

market, competing against Oracle, IBM, Informix, Ingres and later, Sybase. SQL Server was shipped in 1992, bundled with OS/2 version 1.3, followed by version 4.21 for Windows NT, released alongside Windows NT 3.1. The history of Microsoft SQL Server begins with the primary Microsoft SQL Server product - SQL Server 1.0, a 16-bit server for the OS/2 and there had been series of versions since its inception of which the newest version is SQL Server 2019.

Microsoft launched SQL Server 2019 on November 4th 2019. SQL Server 2019 (15.x) introduces Big Data Clusters for SQL Server. It also provides additional capability and enhancements for the SQL Server database engine, SQL Server Analysis Services, SQL Server Machine Learning Services, SQL Server on Linux, and SQL Server Master Data Services. The table below shows the various versions of SQL Server.

Table 3. MS SQL Server versions, year, release and code name

Version	Year	Release	Code name	Internal database version
1.0 (OS/2)	1989	SQL Server 1.0 (16-bit)	Filipi	–
1.1 (OS/2)	1990	SQL Server 1.1 (16-bit)	Pietro	–
4.2A (OS/2)	1992	SQL Server 4.2A	–	–

Version	Year	Release	Code name	Internal database version
4.2B (OS/2)	1993	SQL Server 4.2B (16-bit)	–	–
4.21a (WIN NT)	1993	SQL Server 4.21a	SQLNT	–
6.0	1995	SQL Server 6.0	SQL95	406
6.5	1996	SQL Server 6.5	Hydra	408
7.0	1998	SQL Server 7.0	Sphinx	515
-	1999	SQL Server 7.0 OLAP Tools	Plato	–
8.0	2000	SQL Server 2000	Shiloh	539
8.0	2003	SQL Server 2000 64-bit Edition	Liberty	539

Version	Year	Release	Code name	Internal database version
9.0	2005	SQL Server 2005	Yukon	611/612
10.0	2008	SQL Server 2008	Katmai	655
10.25	2010	Azure SQL database (initial release)	Cloud database or CloudDB	–
10.50	2010	SQL Server 2008 R2	Kilimanjaro (aka KJ)	661
11.0	2012	SQL Server 2012	Denali	706
12.0	2014	Azure SQL database	–	–
12.0	2014	SQL Server 2014	SQL14	782
13.0	2016	SQL Server 2016	SQL16	852
14.0	2017	SQL Server 2017	Helsinki	869

Version	Year	Release	Code name	Internal database version
15.0	2019	SQL Server 2019	Seattle	895

Note: History of Microsoft SQL Server, retrieved from en.wikipedia.org/wiki/ history of Microsoft- SQL -Server.

IBM DB2 Family

IBM Db2 Database is a relational database that facilitates advanced data management and analytics capabilities for your transactional workloads. IBM Db2 encompasses data management products, including the Db2 relational database. The products feature AI-powered capabilities which help to modernize the management of both structured and unstructured data across on premises and multicloud environments.

History has it that IBM in contrast to other database vendors, produced a platform-based Db2 product for each of its major operating systems. However, in the 1990s IBM deviated and produced a Db2 common product, designed with a mostly common code base for L-U-W (Linux-Unix-Windows); DB2 for System z and DB2 for System i are different. As a result, they utilize different drivers.

DB2 traces its roots back to the beginning of the 1970s when Edgar F. Codd, a researcher working for IBM, described the theory of relational databases, and in June 1970 published the model for data manipulation. In 1974, the IBM San Jose Research center developed a relational DBMS, System R, to implement Codd's concepts which led to the development of Structured Query Language (SQL). In 1976, IBM released Query by Example for the VM platform where the table-oriented front-end produced a linear-syntax language that drove transactions to its relational database IBM later bought

Metaphor Computer Systems to utilize their GUI interface and encapsulating SQL platform that had already been in use since the mid 80's. In parallel with the development of SQL, IBM also developed Q (QBE), the first graphical query language. IBM's first commercial relational-database product, SQL/DS was released for the DOS/VSE and VM/CMS operating systems in 1981. The name DB2 (IBM Database 2), was first given to the Database Management System or DBMS in 1983 when IBM released DB2 on its MVS mainframe platform. Later, IBM brought DB2 to other platforms, including OS/2, UNIX, and MS Windows servers, and then Linux (including Linux on IBM Z) and PDAs; this process took place in 1990s. The inspiration for the mainframe version of DB2's architecture came in part from IBM IMS, a hierarchical database, and its dedicated database-manipulation language, IBM DL/i. DB2 is also embedded in the i5/OS operating system for IBM S (iSeries, formerly the AS/400), and versions are available for z/VSE and z/VM. An earlier version of the code that would become DB2 LUW (Linux, Unix, Windows) was part of an Extended Edition component of OS/2 called Database Manager. IBM extended the functionality of Database Manager a number of times, and eventually, IBM took the decision to completely rewrite the software. The new version of Database Manager was called DB2/2 and DB2/6000 respectively.

In the mid-1990s, IBM released a clustered DB2 implementation called DB2 Parallel Edition, which initially ran on AIX. This edition allowed scalability by providing a shared-nothing architecture, in which a single large database is partitioned across multiple DB2 servers that communicate over a high-speed interconnect.

In 2001, IBM bought Informix Software, and in the following years incorporated Informix technology into the DB2 product suite. DB2 can technically be considered to be an object SQL DBMS. In mid-2006, IBM announced "Viper," which is the codename for DB2 9 on both distributed platforms and z/OS. DB2 9 for z/OS was announced in early 2007. IBM claimed that the new DB2 was the first relational database to store XML "natively.

In October 2007, IBM announced "Viper 2," which is the codename for DB2 9.5 on the distributed platforms. There were three key themes for the release, Simplified Management, Business Critical Reliability and Agile XML development.

In June 2009, IBM announced "Cobra" (the codename for DB2 9.7 for LUW. DB2 9.7 added data compression for database indexes, temporary tables, and large objects. DB2 9.7 also supported native XML data in hash partitioning (database partitioning), range partitioning (table partitioning), and multi-dimensional clustering.

In October 2009, IBM introduced its second major release of the year when it announced DB2 pureScale. DB2 pureScale is a database cluster solution for non-mainframe platforms, suitable for Online transaction processing (OLTP) workloads. It provides a fault-tolerant architecture and shared-disk storage. A DB2 pureScale system can grow to 128 database servers, and provides continuous availability and automatic load balancing (Chang, et.al, 2010). In early 2012, IBM announced the next version of DB2, DB2 10.1 (code name Galileo) for Linux, UNIX, and Windows. DB2 10.1 contained a number of new data management capabilities including row and column access control. In June 2013, IBM released DB2 10.5 (code name "Kepler"). On 12 April 2016, IBM announced DB2 LUW 11.1, and in June 2016, it was released. In mid-2017, IBM re-branded its DB2 and dashDB product offerings and amended their names to "Db2".

On June 27, 2019, IBM released Db2 11.5, the AI Database. It added AI functionality to improve query performance as well as capabilities to facilitate AI application development. (Letton, 2020).

Sybase

SAPASE (Adaptive Server Enterprise). It is a relational model database server developed by Sybase Corporation, which later became part of SAP AG. ASE is basically used on the Unix platform, but is also available for Microsoft windows. It was formerly known as **Sybase SQL Server**, and also often called **Sybase DB** or **Sybase**

ASE. Sybase corporation's primary relational database management system product came into the market under the name Sybase SQL Server. In 1988, SQL Server for OS/2 was co-developed for the PC by Sybase, Microsoft, and Ashton-Tate. Ashton-Tate got rid of its interest and Microsoft became the lead partner after porting SQL Server to Windows NT. Microsoft and Sybase marketed the product through version 4.2.1. However, there has been several versions since its inception.

In April 2014, SAP released ASE 16. It included support for partition locking, Relaxed Query Limits, Query Plan Optimization with Star Joins, Dynamic Thread Assignment, Sort and Hash Join Operator improvements, Full-Text Auditing, Auditing for Authorization Checks Inside Stored Procedures, create or replace functionality, Query Plan and Execution Statistics in HTML, Index Compression, Full Database Encryption, Locking, Run-time locking, Metadata and Latch enhancements, Multiple Trigger support, Residual Data Removal, Configuration History Tracking, CRC checks for dump database and the ability to calculate the transaction log growth rate for a specified time period among others.

Informix

IBM Informix is a brand name within IBM's Information Management division that revolves around several relational database management system (RDBMS) offerings. The Informix products since its inception were developed by Informix Corporation, whose Informix Software subsidiary was acquired by IBM in 2001. In April 2017, IBM and HCL technologies (Products & Platforms Division) came to common understanding with fifteen-year partnership to promote the product.

IBM has consistently been active in the development and marketing of the key Informix products, the current version of which (14.10) forms the basis of several product editions with variation in capacity and functionality. The Informix database has been used in many high transaction rate OLTP applications in the retail, finance, energy and utilities,

manufacturing and transportation sectors. More recently the server has been enhanced to improve its support for data warehouse workloads.

The Informix server facilitates the object-relational model, which has permitted IBM to proffer extensions that support data types that are not a part of the SQL standard. The most widely used of these are the JSON, BSON, time series and spatial extensions, which provide both data type support and language extensions that permit high performance domain specific queries as well as efficient storage for data sets based on semi-structured, time series, and spatial data.

PostgreSQL

PostgreSQL is an advanced, enterprise class open-source relational database supporting both SQL (relational) and JSON (non-relational) querying. It is a highly stable database management system, with more than twenty years of community development which is rated for its high levels of resilience, integrity, and correctness. PostgreSQL is used as the main data store or data warehouse for many web, mobile, geospatial, and analytics applications. PostgreSQL has a good historical antecedent for both support of advanced data types, and a level of performance optimization that is common across its commercial database counterparts, like Oracle and SQL Server. AWS supports PostgreSQL through a fully managed database service with Amazon relational database service. Amazon Aurora with PostgreSQL compatibility is also built using PostgreSQL.

PostgreSQL possesses robust feature sets which are not limited to multi-version concurrency control (MVCC), point in time recovery, granular access controls, table spaces, asynchronous replication, nested transactions, online/hot backups, a refined query planner/optimizer and write ahead logging. It supports international character sets, multi byte case sensitivity and formatting. It offers high degree of scalability both in the quantity of data and the number of current users that can be accommodated. It is ACID complaint with full support for foreign keys, joins, views, triggers, and stored procedures

in different languages. The latest version is PostgreSQL is 12.3 with more advanced features as compared to older versions.

MYSQL

MYSQL is an open-source relational database management system (RDBMS). Its name is coined out of "My", the name of co-founder Micheal Widenius's daughter, and "SQL", the abbreviation for Structured Query Language. A relational database organizes data into one or more data tables in which data types may be related to each other; these relations help structure the data. SQL is used to create, modify and extract data from the relational database, as well as control user access to the database. In addition to relational databases and SQL, an RDBMS like MySQL works with an operating system to implement a relational database in a computer's storage system, manages users, allows for network access and facilitates testing database integrity and creation of backups. (Spector, 2018).

MySQL is free and open-source software under the terms of the GNU (General public license), and is also available under a variety of proprietary licenses. MySQL was owned and sponsored by the Swedish company MYSQL AB, which was bought by Sun Microsystems (now Oracle Corporations). In 2010, when Oracle acquired Sun, Widenius forked the open-source MySQL project to create MariaDB.

MySQL has stand-alone clients that permit users to interact directly with a MySQL database using SQL, but more often MySQL is used with other programs to implement applications that need relational database capability. MySQL is an integral part of LAMB web application software stack (and others), which is an acronym for *Linux, Apache, MySQL, Perl/PHP/Python*. MySQL is used by many database-driven web applications, including Drupal, Joomla, phpBB, and Wordpress. MySQL is also used by many popular websites, Twitter, Facebook, etc.

MySQL Server 8.0 was announced in April 2018, including NoSQL Document Store, atomic and crash safe DDL sentences and JSON Extended syntax, new functions, such as

JSON table functions, improved sorting, and partial updates. Previous MySQL Server 8.0.0-dmr (Milestone Release) was announced 12 September 2016.

MySQL was declared DBMS of the year 2019 from the DB-engines ranking.

Non-Relational Database Application

Mongo DB

10gen software company started the development of MongoDB in 2007 as a component of a planned platform as a service product. In 2009, the company migrated to an open-source development model, with the company offering commercial support and other services. In 2013, 10gen rebranded its name to MongoDB Inc. On October 20, 2017, MongoDB was named a publicly traded company, listed on NASDAQ as MDB with an IPO price of $24 per share. On October 30, 2019, MongoDB collaborated with Alibaba (NYSE: BABA) Cloud, who would offer its customers a MongoDB-as-a-service solution. Customers can make use of the managed offering from BABA's global data centers. The features of Mongo DB include Ad-hoc queries, indexing, replication, load balancing, file storage, aggregation, server-side JavaScript execution, capped collections as well support for multi document ACID transactions amongst others.

Mongo DB Edition includes MongoDB community server, MongoDB enterprise server, MongoDB Atlas.

HBase

HBase is an open-source non-relational distributed database with a model taken after Google's Bigtable and written in Java. It is developed as part of Apache Software foundation's Apache Hadoop project and runs on top of HDFs (Hadoop distributed file system) or Alluxio, providing Bigtable-like capabilities for Hadoop. That is, it provides a fault tolerant way of storing large quantities of sparse data (small amounts of information caught within a large collection of empty or unimportant data, such as

finding the 50 largest items in a group of 2 billion records, or finding the non-zero items representing less than 0.1% of a huge collection).

HBase features compression, in-memory operation, and Bloom filters on a per-column basis as outlined in the original Bigtable paper. Tables in HBase can serve as the input and output for MapReduce jobs run in Hadoop, and may be accessed through the Java API but also through REST, Avro or Thrift gateway APIs. HBase is a column-oriented key-value data store and has been widely adopted because of its lineage with Hadoop and HDFS. HBase runs on top of HDFS and is well-suited for faster read and write operations on large datasets with high throughput and low input/output latency.

HBase is presently serving several data-driven websites but Facebook's Messaging Platform recently migrated from HBase to My Rocks. Unlike relational and traditional databases, HBase does not support SQL scripting; instead, the equivalent is written in Java, employing similarity with a MapReduce application.

Orient DB

Orient DB is an open-source NoSQL database management system written in Java. It is a Multi model database, supporting graph, document, key/value, and object models, but the relationships are managed as in graph databases with direct connections between records. It supports schema-less, schema-full and schema-mixed modes. It has a strong security profiling system based on users and roles and supports querying with Gremlin along with SQL extended for graph traversal. Orient DB uses several indexing mechanisms based on B-tree and Extendible hashing, the last one is known as "hash index", there are plans to implement LSM-tree and Fractal tree index-based indexes. Each record has Surrogate Key which indicates position of record inside of Array list, links between records are stored either as single value of record's position stored inside of referrer or as B-tree of record positions (so-called record IDs or RIDs) which allows fast traversal (with O (1) complexity) of one-to-many relationships and fast

addition/removal of new links. Orient DB is the third most popular graph database according to the DB-engines graph database ranking, as of September 2017.

The development of Orient DB still relies on an open-source community led by Orient DB LTD company created by its original author Luca Garulli. The project uses GitHub to manage the sources, contributors and versioning, Google Group and Stack Overflow to provide free support to the worldwide users. Orient DB also offers a free Udemy course for those hoping to learn the basics and get started with Orient DB.

Mobile Database Applications

Mobile computing devices (e.g., smartphones and PDAs) store and share data over a mobile network, or a database which is actually stored by the mobile device. This could be a list of contacts, price information, distance travelled, or any other information.

Several applications require the ability to download information from an information repository and operate on this information even when out of range or disconnected. An example of this is your contacts and calendar on the phone. In this scenario, a user would require access to update information from files in the home directories on a server or customer records from a database. This type of access and work load generated by such users is different from the traditional workloads seen in client-server systems of today.

Mobile databases are not used solely for the revision of company contacts and calendars, but used in a number of industries.

- Mobile users should be able to work without a network connection due to poor or zero level connectivity. A cache could be maintained to hold recently accessed data and transactions so that they are not lost due to failed connectivity. Users might not require access to truly live data, only recently modified data, and uploading of changing might be deferred until reconnected.
- Bandwidth must be conserved (a common requirement on wireless network that charge per megabyte or data transferred).

- Mobile computing devices tend to have slower CPUs and limited battery life.
- Users with multiple devices (e.g., smartphone and tablet) need to synchronize their devices to a more centralized data store. This may require application-specific automation features.

This is in database theory known as "replication", and good mobile database system should provide tools for automatic replication that takes into account that others may have modified the same data as you while you were away, and not just the last update is kept, but also supports "merge" of variants.

- Users may change location geographically and on the network. Usually dealing with this is left to the operating system, which is responsible for maintaining the wireless network connection.

Table 4: Commercially available mobile databases include those shown on this comparison chart. Peer to Peer (P2P) or Device to Device

Name	Developer	Type	Sync Central	Sync P2P	Description	License
Couchbase Lite	Couchbase	JSON document	Yes	Yes	Embedded/portable database, can synchronize with multiple stationary databases and/or mobile devices.	Apache 2.0 License
InterBase	Embarcadero Technologies	Relational	Dependent	Dependent	IoT Award-winning embedded/portable database, can synchronize with multiple stationary	Proprietary

Name	Developer	Type	Sync Central	Sync P2P	Description	License
					databases and/or mobile devices using patent pending Change Views	
ObjectBox	ObjectBox Ltd.	Object Database	Dependent	No	Embedded database with a small footprint designed for performance on Mobile and IoT devices (Android, iOS, Linux, Windows, ...)	Language Bindings are Apache 2.0
Realm	Realm Inc.	Object Database	Dependent	No	Portable local database, has a synchronized mode that synchronizes (real-time) with stationary database	Core Apache 2.0 License, Sync Proprietary
Sybase	Sybase i Anywhere	Relational	Dependent	No	Embedded/portable database, can synchronize with stationary database	Proprietary
DB2 Everyplace	IBM	Relational	Dependent	No	Portable, can synchronize with stationary database	Proprietary EULA

Name	Developer	Type	Sync Central	Sync P2P	Description	License
SQL Server Compact	Microsoft	Relational	No	No	Small-footprint embedded/portable database for Microsoft Windows mobile devices and desktops, supports synchronization with Microsoft SQL Server	Proprietary
SQL Server Express	Microsoft	Relational	No	No	Embedded database, free download	Proprietary
Oracle database Lite	Oracle corporation	Relational	No	No	Portable, can synchronize with stationary database	Proprietary
SQL Lite	D.Richard Hipp	Relational	No	No	C programming library	Public domain
SQLBase	Gupta Technologies LLC of Redwood Shores, California		No	No		Proprietary

Name	Developer	Type	Sync Central	Sync P2P	Description	License
Sparksee we (graph database)	Sparcity Technologies	Graph Database	No	No	Fast, Memory Efficient, Embedded and Portable out-of-core Graph Database. Written in C++98.	Proprietary

Note: Mobile database, retrieved from www.wikiwandi.com/en/mobile database

Web Database Applications

A Web database refers to a database application designed to be managed and accessed through the Internet. Website operators can properly engage in the management of this collection of data and present analytical results based on the data in the Web database application. Databases first appearance came in the 1990s, and have been an asset for businesses, allowing the collection of seemingly infinite amounts of data from infinite amounts of customers. Web databases enable collected data to be organized and cataloged thoroughly within many parameters. The online database does not require advanced computer skills, and lots of database software programs provide a simple easy "click-and-create" style with no complicated coding.

Web database software programs are found within desktop publishing programs, like Microsoft Office Access and OpenOffice Base. Other programs consist of the Webex WebOffice database and FormLogix Web database. The foremost advanced software applications can set up data collection forms, polls, feedback forms and present data analysis in real time.

Often within the world of Web databases, MySQL (structured query language) is going to be mentioned. This is a relational database management system that manages different Web databases. It operates as a server, and is an open-source project. MySQL is often included with Web hosting for managing either personal or business website databases. It is a programming language, so is it may be a bit harder to work with than a straight Web database software program.

Amazon Aurora

Amazon Aurora is a MySQL and PostgreSQL-compatible relational database designed for the cloud, with a combination of the performance and availability of traditional enterprise databases in addition to the simplicity and cost-effectiveness of open-source databases.

Amazon Aurora is about five times faster than standard MYSQL databases and about three times faster than standard PostgreSQL databases. It provides the security, availability, and reliability of commercial databases at 1/10th the cost. Amazon Aurora is wholly managed by Amazon relational database service (RDS), which facilitates the automation of time-consuming administration tasks like hardware provisioning, database setup, patching, and backups.

Amazon Aurora features a distributed, fault-tolerant, self-healing storage system that auto-scales up to 64TB per database instance. It delivers high performance and availability with up to fifteen low-latency read replicas, point-in-time recovery, continuous backup to Amazon S3, and replication across three Availability Zones (AZs).

5.0 CONCLUSION

In a nutshell, it can be summarized the above-mentioned database management systems have their advantages and disadvantages, some might be useful whereas others might not be that suitable. Today's time is that of data where an enormous amount of data has to be

stored, updated, and created daily. The demand for Database Management Tools is growing exponentially and the competition is also high. With each tool trying to be better in terms of features compared to the others, uses can select an application as per requirement from the above list.

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