

A Comparison of the Common Database Systems

This article is an accumulation of a number of related database articles/websites. See references below.

A database management system provides the ability for many different users to share data and process resources. But as there can be many different users, there are many different database needs. The question now is: How can a single, unified database meet the differing requirement of so many users? The answer is simply Database Management systems (DBMS). A DBMS is a complex set of software programs that controls the organization, storage, management, and retrieval of data in a database. DBMS are categorized according to their data structures or types. It is a set of prewritten programs that are used to store, update and retrieve a Database. Different DBMS have different features which mean different uses according to users need.

What is Database?



A Computer Database is a structured collection of records or data that is stored in a computer system. The structure is achieved by organizing the data according to a database model. The model in most common use today is the relational model. Other models such as the hierarchical model and the network model use a more explicit representation of relationships. A computer database relies upon software to organize the storage of data. This software is known as a database management system (DBMS). Database management systems are categorized according to the database model that they support. The model tends to determine the query languages that are available to access the database. A great deal of the internal engineering of a DBMS, however, is independent of the data model, and is concerned with managing factors such as performance, concurrency, integrity, and recovery from hardware failures. In these areas there are large differences between products.

Common used Database Management Systems

A database management system (DBMS) is a computer program (or more typically, a suite of them) designed to manage a database; a large set of structured data, and run operations on the data requested by numerous users. Typical examples of DBMS use include accounting, human resources and customer support systems. Originally found only in large companies with the computer hardware needed to support large data sets, DBMSs have more recently emerged as a fairly standard part of any company back office.

Microsoft SQL Server

Microsoft SQL Server is a relational database management system (RDBMS) produced by Microsoft. Its primary query language is Transact-SQL, an implementation of the ANSI/ISO standard Structured Query Language (SQL) used by both Microsoft and Sybase. The last version released on August 6, 2008, is entitled "SQL Server 2008".



The architecture of Microsoft SQL Server is broadly divided into three components: SQLOS which implements the basic services required by SQL Server, including thread scheduling, memory

management and I/O management; the Relational Engine, which implements the relational database components including support for databases, tables, queries and stored procedures as well as implementing the type system; and the Protocol Layer which exposes the SQL Server functionality.

Microsoft SQL Server 2008 was released under 6 editions suitable for different uses across the Windows OS only. The following list is explaining more the differences:

- **Enterprise Edition:** a comprehensive data platform that meets the high demands of enterprise online transaction processing and data warehousing applications.
- **Standard Edition:** a complete data management and business intelligence platform providing best-in-class ease of use and manageability for running departmental applications.
- **Workgroup Edition:** Run branch locations on this reliable data management and reporting platform that provides secure remote synchronization and management capabilities.
- **Web Edition:** Offer low cost, large scale highly available web applications or hosting solutions to your customers with highly available Internet facing web serving environments.
- **Developer Edition:** May be installed and used by one user to design, develop, test, and demonstrate your programs on as many systems as needed.
- **Compact Edition:** Available as a free download, build stand-alone and occasionally connected applications for mobile devices, desktops, and Web clients on all Microsoft Windows platforms.
- **Express Edition:** Available as a free download, Express is ideal for learning and building desktop and small server applications and for re-distribution by ISVs.
- **Evaluation Edition:** This edition may be installed for demonstration and evaluation purposes until an expiration period of 180 days. Free of charge.

As explained, not all editions are free to use. Microsoft will charge a significant sum from your credit card if you want to use their Server services, on Windows hosting account...

Edition	Enterprise	Standard	Specialized Editions				
			Workgroup	Developer	Web	Compact	Express
Cost	\$24,999	\$5,999	\$3,899	\$50	\$15/p/m*	Free	Free

* \$15 per proc per month

For more information about Microsoft SQL Server editions please visit:

<http://www.microsoft.com/sqlserver/2008/en/us/editions.aspx>

Microsoft Office Access Database



Microsoft Office Access, previously known as Microsoft Access, is another relational database management system that combines the relational Microsoft Jet Database Engine with a graphical user interface and software development tools. It is a member of the 2007 Microsoft Office system. Access can use data stored in Access/Jet, Microsoft SQL Server, Oracle, or any ODBC-compliant data container (including MySQL and PostgreSQL).

Skilled software developers and data architects use it to develop application software. Relatively unskilled programmers and non-programmer "power users" can use it to build simple applications. It supports some object-oriented techniques but falls short of being a fully object-oriented development tool. Access can be obtained either alone or with other Microsoft Office Applications such Word, Excel, PowerPoint, etc...

MySQL

MySQL is also a relational database management system (RDBMS) which has more than 11 million installations. The program runs as a server providing multi-user access to a number of databases. MySQL is owned and sponsored by a single for-profit firm, the Swedish company MySQL AB, now a subsidiary of Sun Microsystems, which holds the copyright to most of the codebase. The project's source code is available under terms of the GNU General Public License, as well as under a variety of proprietary agreements.



"MySQL" is officially pronounced /maɪˌɛskjuːˈɛl/ (My S Q L), not "My sequel" /maɪˈsiːkwəl/. This adheres to the official ANSI pronunciation; SEQUEL was an earlier IBM database language, a predecessor to the SQL language.

SQLite



SQLite is a mostly ACID-compliant relational database management system contained in a relatively small (~500kB) C programming library. Unlike client-server database management systems, the SQLite engine is not a standalone process with which the program communicates. Instead, the SQLite library is linked in and thus becomes an integral part of the program. The program uses SQLite's functionality through simple function calls, which reduces latency in database access as function calls are more efficient than inter-process communication. The entire database (definitions, tables, indices, and the data itself) is stored as a single cross-platform file on a host machine. This simple design is achieved by locking the entire database file at the beginning of a transaction.

SQLite was created by D. Richard Hipp, who sells training, direct technical support contracts and add-ons such as compression and encryption. The source code for SQLite is in the public domain.

Databases Applications



Databases are used in many applications, spanning virtually the entire range of computer software. Databases are the preferred method of storage for large multiuser applications, where coordination between many users is needed. Even individual users find them convenient, and many electronic mail programs and personal organizers are based on standard database technology. Software database drivers are available for most database platforms so that application software can use a common Application Programming Interface to retrieve the information stored in a database. Two commonly used database APIs are JDBC and ODBC.

Throughout recent history specialized databases have existed for scientific, geospatial, imaging, document storage, and like uses. Functionality drawn from such applications has lately begun appearing in mainstream DBMSs as well. However, the main focus there, at least when aimed at the commercial data processing market, is still on descriptive attributes on repetitive record structures.

For example suppliers database contains the data relating to suppliers such as supplier name, supplier code, supplier address ... It is often used by schools to teach students and grade them. The following is a detailed description of previously stated DBMS uses:

Microsoft SQL Server

Microsoft has tried to make her SQL server the number one SQL system in all domains by issuing different editions suitable for different uses. SQL Server has become useful in small applications like embedded cell phones or PDA's applications, but also going ahead to become the first systems for large business and enterprises projects. Oracle Database is currently the most used Database Management System in enterprises environment.

Microsoft Office Access

Access is used by small businesses, within departments of large corporations, and by hobby programmers to create ad hoc customized desktop systems for handling the creation and manipulation of data. Microsoft has strongly recommended for the past decade that Jet databases are inappropriate for basic web based applications hosted on Microsoft's Internet Information Services and utilizing Microsoft Active Server Pages ASP.

Some professional application developers use Access for rapid application development, especially for the creation of prototypes and standalone applications that serve as tools for on-the-road salespeople. Access does not scale well if data access is via a network, so applications that are used by more than a handful of people tend to rely on Client-Server based solutions. However, an Access "front end" (the forms, reports, queries and VB code) can be used against a host of database backend, including JET (file-based database engine, used in Access by default), Microsoft SQL Server, Oracle, and all other ODBC-compliant product. However, it is generally more efficient to use 'Access Data Projects' because SQL Server is the world's most popular database.

MySQL

MySQL is popular for web applications and acts as the database component of the LAMP, BAMP, MAMP, and WAMP platforms (Linux/BSD/Mac/Windows-Apache-MySQL-PHP/Perl/Python), and for open-source bug tracking tools like Bugzilla. Its popularity for use with web applications is closely tied to the popularity of PHP and Ruby on Rails, which are often combined with MySQL. PHP and MySQL are essential components for running popular content management systems such as Drupal, e107, Joomla!, WordPress and some BitTorrent trackers. Wikipedia runs on MediaWiki software, which is written in PHP and uses a MySQL database.

MySQL is released under 5 different Edition; a free Edition for Community uses and 4 Subscription Edition for Enterprise uses:

Edition*	Platinum	Gold	Silver	Basic	Community
Cost	3,999€	2,399€	1,599€	479€	FREE

* Enterprise Edition are Licensed per 1server/1year subscription. Prices are in Euro. Please visit <https://shop.mysql.com/enterprise/>

SQLite

As SQLite is the most portable version of SQL database management systems, it is the most widely deployed SQL database engine in the world. It is used in countless desktop computer applications as well as consumer electronic devices including cell phones, PDAs, and MP3 players.

SQLite is largely recommended by expert for use in simple and small domains like Application File Format, Embedded devices and applications, Websites, Replacement for ad hoc disk files, Internal or temporary databases, Command-line dataset analysis tool, Stand-in for an enterprise database during demos or testing, Database Pedagogy, Experimental SQL language extensions. SQLite is more sophisticated to be used in such domain then being used in professional environment requiring huge configuration and settings such as Client/Server Applications, High-volume Websites, Very large datasets, High Concurrency, etc... as SQLite is a Zero-Configuration DBMS. SQLite is FREE for use.

The following table resumes the applications of the previously stated DBMS:

	SQL Server	Access	MySQL	SQLite
Suitable for professional use	☑	☑	☑	☑
Suitable for basic use	☒	☑	☑	☑
Desktop Applications	☑	☑	☑	☑
Web Applications	☑	☒ ¹	☑	☑
Embedded Applications	☑ ²	☒	☒	☑
Testing Environment	☑	☑	☑	☑
Client/Server Application	☑	☒	☑	☒
Large Dataset	☑	☑	☑	☒
High-volume Website	☑	☒	☑	☒
Education Related	☑	☑	☑	☑
Windows	☑	☑	☑	☑
Linux	☒	☒	☑	☑
MacOS X	☒	☒ ³	☑	☑
UNIX	☒	☒	☑	☑

Features

A DBMS can be characterized as an "attribute management system" where attributes are small chunks of information that describe something. For example, "color" is an attribute of a car. The value of the attribute may be a color such as "red", "blue" or "silver". Alternatively, and especially in connection with the relational model of database management, the relation between attributes drawn from a specified set of domains can be seen as being primary. For instance, the database might indicate that a car that was originally "red" might fade to "pink" in time, provided it was of some particular "make" with an inferior paint job. Such higher arity relationships provide information on all of the underlying domains at the same time, with none of them being privileged above the others.



Thus, the DBMSs of today roll together frequently-needed services or features of attribute management. By externalizing such functionality to the DBMS, applications effectively share code with each other and are relieved of much internal complexity. Features commonly offered by database management systems include:

¹ Not Recommended

² Microsoft SQL Server Compact Edition

³ Microsoft Access is not included in Microsoft Office 2008 for Mac

- **Query ability**: Querying is the process of requesting attribute information from various perspectives and combinations of factors. Example: "How many 2-door cars in Texas are green?"
- **Backup and replication**: Copies of attributes need to be made regularly in case primary disks or other equipment fails. A periodic copy of attributes may also be created for a distant organization that cannot readily access the original. DBMS usually provide utilities to facilitate the process of extracting and disseminating attribute sets.
- **Rule enforcement**: Often one wants to apply rules to attributes so that the attributes are clean and reliable. For example, we may have a rule that says each car can have only one engine associated with it (identified by Engine Number). If somebody tries to associate a second engine with a given car, we want the DBMS to deny such a request and display an error message.
- **Security**: Often it is desirable to limit who can see or change which attributes or groups of attributes. This may be managed directly by individual, or by the assignment of individuals and privileges to groups, or (in the most elaborate models) through the assignment of individuals and groups to roles which are then granted entitlements.
- **Computation**: There are common computations requested on attributes such as counting, summing, averaging, sorting, grouping, cross-referencing, etc. Rather than have each computer application implement these from scratch, they can rely on the DBMS to supply such calculations.
- **Change and access logging**: Often one wants to know who accessed what attributes, what was changed, and when it was changed. Logging services allow this by keeping a record of access occurrences and changes.
- **Automated optimization**: If there are frequently occurring usage patterns or requests, some DBMS can adjust themselves to improve the speed of those interactions. In some cases the DBMS will merely provide tools to monitor performance, allowing a human expert to make the necessary adjustments after reviewing the statistics collected. This is not MySQL case.
- **Meta-data repository**: Metadata (also spelled meta-data) is data describing data. For example, a listing that describes what attributes are allowed to be in data sets is called "meta-information". The meta-data is also known as data about data.

MS SQL Server 2008

SQL Server 2008 delivers on Microsoft's Data Platform vision by helping organization managing any data, any place, and any time. It enables to store data from structured, semi-structured, and unstructured documents, such as images and music, directly within the database. SQL Server 2008 delivers a rich set of integrated services that enable to do more with data such as query, search, synchronize, report, and analyze. Data can be stored and accessed in your largest servers within the data center all the way down to desktops and mobile devices, enabling control over your data no matter where it is stored.

SQL Server 2008 enables users to consume their data within custom applications developed using Microsoft .NET and Visual Studio and within service-oriented architecture (SOA) and business process through Microsoft BizTalk Server while information workers can access data directly in the tools they use every day, such as the 2007 Microsoft Office system. SQL Server 2008 delivers a trusted, productive, and intelligent data platform for all data needs.

For a full list of SQL Server 2008 New Features, please visit the following website:
<http://www.microsoft.com/sqlserver/2008/en/us/overview.aspx>

Microsoft Office Access 2007

One of the benefits of Access from a programmer's perspective is its relative compatibility with SQL (structured query language) —queries may be viewed and edited as SQL statements, and SQL statements can be used directly in Macros and VBA Modules to manipulate Access tables. Users may mix and use both VBA and "Macros" for programming forms and logic and offers object-oriented possibilities. MSDE (Microsoft SQL Server Desktop Engine) 2000, a scaled down version of Microsoft SQL Server 2000, has been a free download for a decade and may be used with Access as an alternative to the Jet Database Engine. Unlike other RDBMS, Microsoft Access does not implement database triggers or stored procedures.

Starting in Access 2000 (Jet 4.0), there is a new syntax for creating queries with parameters, in a way that looks like creating stored procedures, but these procedures are still limited to one statement per procedure. Except in VBA, it is also made redundant by the fact that Access categorizes each object automatically and always shows the object type, by prefixing Table: or Query: before the object name when referencing a list of different database objects.

Microsoft Access can be applied to small projects (the Access 97 speed characterization was done for 32 users) but scales poorly to larger projects with more than several 10MB of data or many users because of the way indexing and locking are handled. As a Microsoft Access database can be cached locally when used on network, processing speed may be substantially better when there is only a single user. Because of the effect of packet latency on the record locking system, Access databases are effectively too slow to be used on a Virtual Private Network or a Wide Area Network. Access Data Projects work great over VPN and WAN.

Access includes an Upsizing Wizard that allows users to upsize their database to Microsoft SQL Server if they want to move to an ODBC client-server database. One recommended technique is to migrate to SQL Server and utilize Access Data Projects. This allows stored procedures, views, and constraints using standard SQL. Additionally this full client-server design significantly reduces maintenance and availability problems. Access allows no relative paths when linking, so the development environment should have the same path as the production environment (though it is possible to write a "dynamic-linker" routine in VBA). This technique also allows the developer to divide the application among different files.

MySQL

The MySQL Enterprise Server is released once per month and the sources can be obtained either from MySQL's customer-only Enterprise site or from MySQL's Bazaar repository, both under the GPL license. The MySQL Community Server is published on an unspecified schedule under the GPL and contains all bug fixes that were shipped with the last MySQL Enterprise Server release. Binaries are no longer provided by MySQL for every release of the Community Server. MySQL 5 has the following features included:

- A broad subset of ANSI SQL 99, as well as extensions
- Cross-platform support
- Stored procedures
- Triggers

- Cursors
- Updatable Views
- True VARCHAR support
- INFORMATION_SCHEMA
- Strict mode
- X/Open XA distributed transaction processing (DTP) support; two phase commit as part of this, using Oracle's InnoDB engine
- Independent storage engines (MyISAM for read speed, InnoDB for transactions and referential integrity, MySQL Archive for storing historical data in little space)
- Transactions with the InnoDB, BDB and Cluster storage engines; savepoints with InnoDB
- SSL support
- Query caching
- Sub-SELECTs (i.e. nested SELECTs)
- Replication with one master per slave, many slaves per master, no automatic support for multiple masters per slave.
- Full-text indexing and searching using MyISAM engine
- Embedded database library
- Partial Unicode support (UTF-8 sequences longer than 3 bytes are not supported; UCS-2 encoded strings are also limited to the BMP)
- ACID compliance using the InnoDB, BDB and Cluster engines
- Shared-nothing clustering through MySQL Cluster

MySQL Server has also some included features that may not be found on other RDBMS:

- **Multiple storage engines**: allowing you to choose the one which is most effective for each table in the application (in MySQL 5.0, storage engines must be compiled in; in MySQL 5.1, storage engines can be dynamically loaded at run time).
- **Native storage engines**: MyISAM, Falcon, Merge, Memory (heap), Federated, Archive, CSV, Blackhole, Cluster, Berkeley DB, EXAMPLE, and Maria.
- **Partner-developed storage engines**: InnoDB, solidDB, NitroEDB, BrightHouse
- **Community-developed storage engines**: memcached, httpd, PBXT
- **Custom storage engines**
- **Commit grouping**, gathering multiple transactions from multiple connections together to increase the number of commits per second.

SQLite

SQLite implements most of the SQL-92 standard for SQL, including database transactions that are atomic, isolated, and durable (three of the ACID requirements). SQLite supports triggers and most complex queries. SQLite silently ignores referential integrity constraints (foreign key constraints), so does not satisfy a common consistency requirement. SQLite uses an unusual type system for an SQL DBMS. Instead of assigning a type to a column as in most SQL database systems, types are assigned to individual values; in language terms it is dynamically typed. Moreover, it is weakly typed in some of the same ways that Perl is: one can insert a string into an integer column (although SQLite will try to convert the string to an integer first, if the column's preferred type is integer). This adds flexibility to columns, especially when bound to a dynamically typed scripting language. However, the technique is not portable to other SQL databases. The inability to have strictly typed columns, as in typical databases, is a common criticism. The SQLite web site describes a "strict affinity" mode, but this feature has not yet been added.

Several computer processes or threads may access the same database without problems. Several read accesses can be satisfied in parallel. A write access can only be satisfied if no other accesses are currently being serviced; otherwise the write access fails with an error code (or can automatically be retried until a configurable timeout expires). This concurrent access situation would change when dealing with temporary tables. SQLite also has bindings for a large number of programming languages, including BASIC, C, C++, Common Lisp, Java, C#, Delphi, Curl, Lua, Tcl, R, PHP, Perl, Ruby, Objective-C (on Mac OS X), Python, newLisp and Smalltalk. There is also a COM (ActiveX) wrapper making SQLite accessible on Windows to scripted languages such as JavaScript and VBScript. This adds database capabilities to HTML Applications (HTA).

Minimum Requirements

The following table resumes the minimum requirements for the previously stated RDBMS:

RDBMS	SQL Server	Access	MySQL	SQLite
Processor	Pentium III or greater 1GHz Minimum	Pentium III or greater 500MHz Minimum	Pentium III or greater	Any
Memory	2GB	256MB Minimum	256MB	32KB Minimum
Platform	Windows Only	Windows Only	Cross-platform	Cross-platform
Hard Disk Space	Up to 2GB	Up to 1.5GB	Up to 200MB	<500KB
Additional Softwares	.NET Framework 3.5 Windows Installer 4.5 Internet Explorer +6	Internet Explorer +6	None	None

RDBMS Cost

The following table compares the cost of Standard version of previously stated RDBMS:

RDBMS	SQL Server	Access	MySQL	SQLite
Cost	\$5,999	\$299	FREE	FREE

Which RDBMS is right for you?



The choice of an RDBMS is up to you but essentially is dependent on the usage and application.

For larger databases and web-based projects we would normally choose MS SQL Server because of its scalability, features and extensive support. For desktop applications we would suggest MS Access because of its ease of use when developing forms and reports. For mobile and embedded applications SQLite is the best choice. As for MySQL – it is a good all rounder.

References

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