INF 2112: Database Application I (MS SQL Server)

LECTURE 1

Database and Instance

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Introduction

- In today’s market, where huge amount of data get exchanged everyday, it is very important to understand how to handle data.

What is Database?

- A collection of information organized in such a way that a computer program can quickly select the desired piece of information.
- Database is used to store data at the **backend.**
- **Front-end** is presented to the user using any server side scripting language.

Database Management System (DBMS)

- DBMS is a computer software providing the interface between users and a database (or databases).
- The system is designed to allow the definition, creation, querying, update and administration of databases.

What is MS SQL Server?

- SQL Server supports ANSI SQL, which is the standard SQL (Structured Query Language) language. However, SQL Server comes with its own implementation of the SQL language, T-SQL (Transact-SQL).
- T-SQL is a Microsoft proprietary Language known as Transact-SQL. It provides further capabilities of declaring variable, exception handling, stored procedure, etc.
- It has an integrated environment to handle SQL databases, which is the SQL Server Management Studio.

Usage of SQL Server

- To create databases.
- To maintain databases.
- To analyze the data through SQL Server Analysis Services (SSAS).
- To generate reports through SQL Server Reporting Services (SSRS).

Versions of SQL Server

SQL Server Components

- SQL Server works in client-server architecture, hence it supports two types of components − (a) Workstation and (b) Server.
- **Workstation components** are installed in every device/SQL Server operator's machine. These are just interfaces to interact with Server components. Example: SSMS, SSCM, Profiler, BIDS, SQLEM etc.
- **Server components** are installed in centralized server. These are services. Example: SQL Server, SQL Server Agent, SSIS, SSAS, SSRS, SQL browser, SQL Server full text search etc.

Instance of SQL Server

- An instance is an installation of SQL Server.
- An instance is an exact copy of the same software.
- If we install 'n' times, then 'n' instances will be created.
- There are two types of instances in SQL Server
  - a) Default b) Named.
- Only one default instance will be supported in one Server.
- Multiple named instances will be supported in one Server.
- Default instance will take the server name as Instance name.
- Default instance service name is MSSQLSERVER.
- 50 instances will supported in 2005 and later versions.
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SQL Server Instances

- There are two ways through which we may access the default (primary) instance. First, we can use the server name. Secondly, we can use its IP address.
- Named instances are accessed by appending a backslash and instance name.
- For example, to connect to an instance named xyx on the local server, you should use 127.0.0.1\xyz.

Advantages of Instances

- To install different versions in one machine.
- To reduce cost.
- License issues
- To maintain production, development, and test environments separately.
- To reduce temporary database problems.
- To separate security privileges.
- To maintain standby server.

SQL Server Editions

- **Enterprise** − This is the top-end edition with a full feature set.
- **Standard** − This has less features than Enterprise, when there is no requirement of advanced features.
- **Workgroup** − This is suitable for remote offices of a larger company.
- **Web** − This is designed for web applications.
- **Developer** − This is similar to Enterprise, but licensed to only one user for development, testing and demo. It can be easily upgraded to Enterprise without reinstallation.
- **Express** − This is free entry level database. It can utilize only 1 CPU and 1 GB memory, the maximum size of the database is 10 GB.
- **Compact** − This is free embedded database for mobile application development. The maximum size of the database is 4 GB.

Key Components and Services of SQL Server

- **Database Engine:** This component handle storage, Rapid transaction Processing, and Securing Data.
- **SQL Server:** This service starts, stops, pauses, and continues an instance of Microsoft SQL Server. Executable name is sqlservr.exe**.**
- **SQL Server Agent:** It performs the role of Task Scheduler. It can be triggered by any event or as per demand. Executable name is sqlagent.exe.
- **SQL Server Browser:** This listens to the incoming request and connects to the desired SQL server instance. Executable name is sqlbrowser.exe.
- **SQL Server Full-Text Search:** This lets user running full-text queries against Character data in SQL Tables. Executable name is fdlauncher.exe

Key Components and Services of SQL Server (Cont...)

- **SQL Server VSS Writer:** This allows backup and restoration of data files when the SQL server is not running. Executable name is sqlwriter.exe.
- **SQL Server Analysis Services (SSAS):** Provide Data analysis, Data mining and Machine Learning capabilities. SQL server is integrated with R and Python language for advanced analytics. Executable name is msmdsrv.exe.
- **SQL Server Reporting Services (SSRS):** Provides reporting features and decision-making capabilities. It includes integration with Hadoop. Executable name is ReportingServicesService.exe
- **SQL Server Integration Services (SSIS):** Provided Extract-Transform and Load capabilities of the different type of data from one source to another. It can be view as converting raw information into useful information. Executable name is MsDtsSrvr.exe

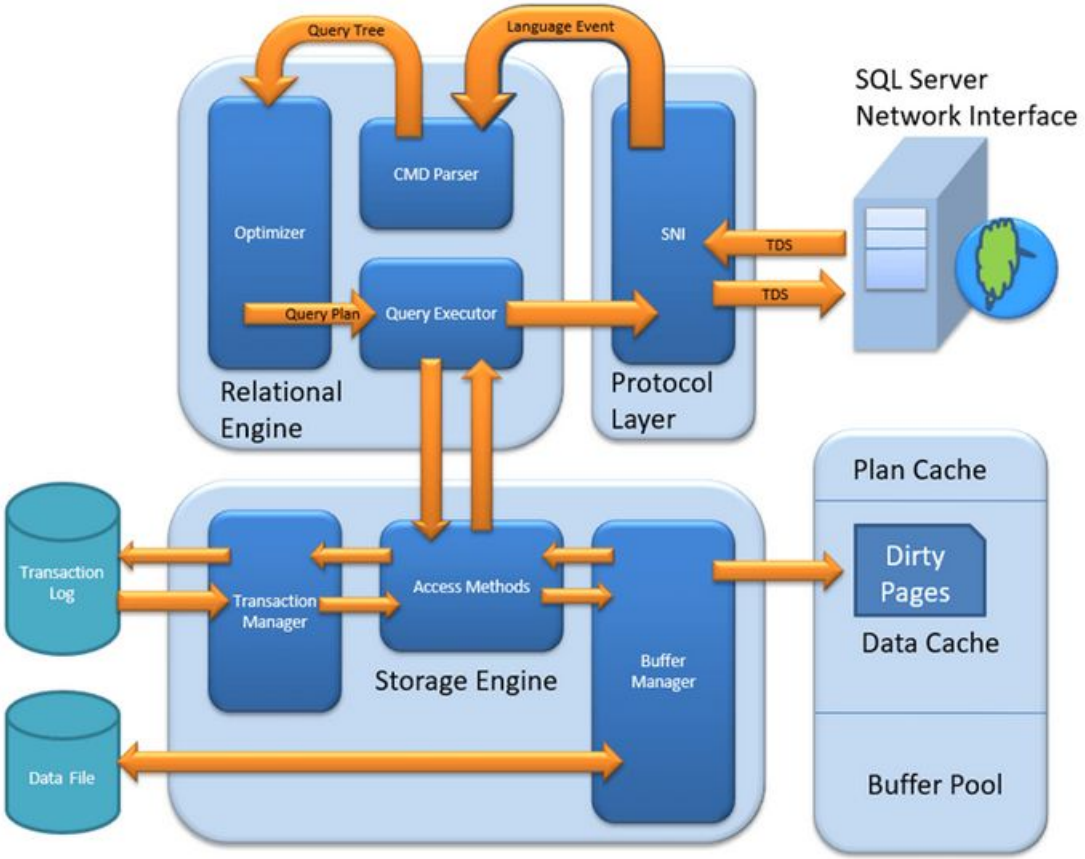
Features of SQL Server

- **User Experience**
  - Can be used on various OS, easy to use tools and connectors.
- **Availability**
  - High availability and disaster recovery
- **Performance**
- **Analytics**
  - Provides built-in analytics within the database
- **Security**
- **Business Intelligent**
  - Built-in

Introduction to T-SQL

- Stands for Transact-SQL

SQL Server Architecture

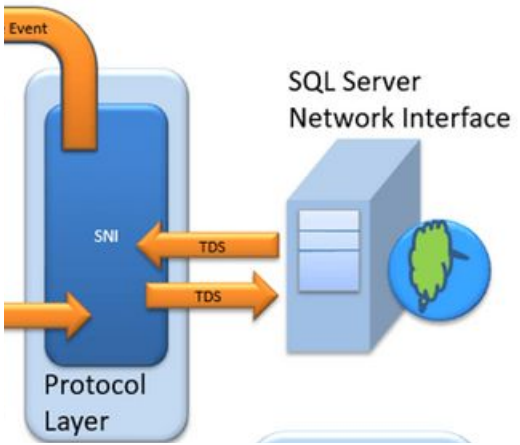


SQL Server Architecture Explained

- MS SQL Server is a client-server architecture. MS SQL Server process starts with the client application sending a request.
- The SQL Server accepts, processes and replies to the request with processed data.
- As the Diagram in the previous slide depicts there are three major components in SQL Server Architecture:
  - Protocol Layer
  - Relational Engine
  - Storage Engine

Protocol Layer - SNI

- It supports 3 Type of Client Server Architecture:
- **a. Shared Memory:** Here MS SQL server provides SHARED MEMORY PROTOCOL. CLIENT and MS SQL server run on the same machine. Both can communicate via Shared Memory protocol.
  - For Connection to Local DB – In SQL Management Studio, "Server Name" Option could be:
    - "."
    - "localhost"
    - "127.0.0.1"
    - "Machine\Instance"



Protocol Layer - SNI

- **b. TCP/IP:** MS SQL SERVER provides the capability to interact via TCP/IP protocol, where CLIENT and MS SQL Server are remote to each other and installed on a separate machine.
  - In SQL Management Studio - For Connection via TCP\IP, "Server Name" Option has to be "Machine\Instance of the server."
  - SQL server uses port 1433 in TCP/IP.

Protocol Layer - SNI

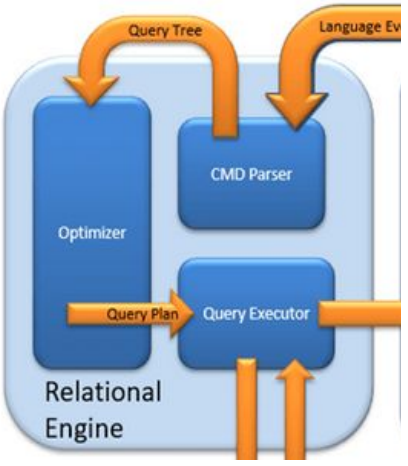
- c. **Named Pipes:** MS SQL SERVER provides the capability to interact via the Named Pipe protocol. Here the CLIENT and MS SQL SERVER are in connection via LAN.
  - For Connection via Named Pipe. This option is disabled by default and needs to be enabled by the SQL Configuration Manager.

Tabular Data Streams (TDS)

- All 3 protocols use TDS packets. TDS is encapsulated in Network packets. This enables data transfer from the client machine to the server machine.
- TDS was first developed by Sybase and is now Owned by Microsoft

Relational Engine

- The Relational Engine is also known as the Query Processor.
- It has the SQL Server components that determine what exactly a query needs to do and how it can be done best.
- It is responsible for the execution of user queries by requesting data from the storage engine and processing the results that are returned.



CMD Parser

- **CMD Parser:** Checks the syntax of the query and converts it to the machine language.
- **Syntactic check:**
  - Like every other Programming language, MS SQL also has the predefined set of Keywords. Also, SQL Server has its own grammar which SQL server understands.
  - SELECT, INSERT, UPDATE, and many others belong to MS SQL predefined Keyword lists.
  - CMD Parser does syntactic check. If users' input does not follow these language syntax or grammar rules, it **returns an error.**

Optimizer

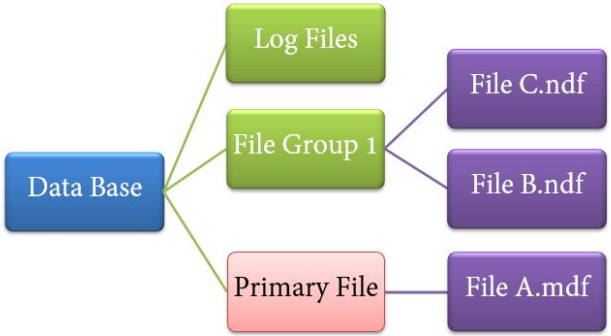
- The optimizer creates an execution plan for the user's query.
- Note that not all queries are optimized.
  - Optimization is done for DML (Data Modification Language) commands like SELECT, INSERT, DELETE, and UPDATE. Such queries are first marked then send to the optimizer.
  - DDL commands like CREATE and ALTER are not optimized, but they are instead compiled into an internal form. The query cost is calculated based on factors like CPU usage, Memory usage, and Input/ Output needs.
- Optimizer's role is to find the **cheapest, not the best, cost-effective execution plan.**

Query Executor

- Query executer calls **Access Method**. It provides an execution plan for data fetching logic required for execution. Once data is received from Storage Engine, the result gets published to the Protocol layer. Finally, data is sent to the end user.

Storage Engine

- The work of the Storage Engine is to store data in a storage system like Disk or SAN and retrieve the data when needed.
  - **Primary File (.mdf)**
    - Every database contains one Primary file.
    - This store all important data related to tables, views, Triggers, etc.
  - **Secondary (.ndf)**
    - Database may or may not contains multiple Secondary files.
    - This is optional and contain user-specific data.
  - **Log file (.ldf)**
    - This is used to recover from any unwanted instances. Perform important task of Rollback to uncommitted transactions.



Access Method

- It acts as an interface between query executor and Buffer Manager/Transaction Logs.

SQL Server Architecture

- **Server:** This is where the SQL services are installed and the database resides.
- **Relational Engine:** Execution occurs here.
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- **Optimizer:** Prepares the execution plan and determines how the user query will be executed.
- **Query Executor:** Where the query gets executed step by step.
- **Storage Engine:** Responsible for storage and retrieval of data.
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Download and Install SQL Server

- The link has all the necessary information for the task.
  - https://www.guru99.com/download-install-sql-server.html
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MS SQL Server - Management Studio

- **SQL Server Management Studio** is a workstation component\client tool that will be installed if we select workstation component in installation steps. This allows you to connect to and manage your SQL Server from a graphical interface instead of having to use the command line.
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- In order to connect to a remote instance of an SQL Server, you will need this or similar software. It is used by Administrators, Developers, Testers, etc.
- ***Open your SSMS and observe the available options.***

Thank You!