



# SAP

# HANA

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## About the Tutorial

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SAP HANA is an in-memory data platform that is deployable as an on-premise appliance, or in the cloud. It is a revolutionary platform, which is best suited for performing real-time analytics, and developing and deploying real-time applications. At the core of this real-time data platform is the SAP HANA database, which is fundamentally different from any other database engine in the market today.

This tutorial will teach you the basics of SAP HANA. The tutorial is divided into sections such as SAP HANA Basics, SAP HANA-Modeling, Reporting, and SAP HANA-SQL. Each of these sections contain related topics with screenshots explaining the SAP HANA database installations.

## Audience

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This tutorial has been prepared for anyone who has a basic knowledge of SQL. After completing this tutorial, you will find yourself at a moderate level of expertise in administration and operations or implantation and modeling using SAP HANA.

## Prerequisites

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Before you start proceeding with this tutorial, we assume that you are well-versed with basic database concepts. You should have a good exposure to SQL, as SAP HANA is like a relational database. If you are not aware of these concepts, then we recommend that you first go through our short tutorials on SQL.

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# **PART 1: SAP HANA – INTRODUCTION**

# 1. SAP HANA – OVERVIEW

SAP HANA is a combination of HANA Database, Data Modeling, HANA Administration and Data Provisioning in one single suite. In SAP HANA, HANA stands for High-Performance Analytic Appliance.

According to former SAP executive, Dr. Vishal Sikka, HANA stands for Hasso's New Architecture. HANA developed interest by mid-2011 and various fortune 500 companies started considering it as an option to maintain Business Warehouse needs after that.

## Features of SAP HANA

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The main features of SAP HANA are given below:

- SAP HANA is a combination of software and hardware innovation to process huge amount of real time data.
- Based on multi core architecture in distributed system environment.
- Based on row and column type of data-storage in database.
- Used extensively in Memory Computing Engine (IMCE) to process and analyze massive amount of real time data.
- It reduces cost of ownership, increases application performance, enables new applications to run on real time environment that were not possible before.
- It is written in C++, supports and runs on only one Operating System Suse Linux Enterprise Server 11 SP1/2.

## Need for SAP HANA

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Today, most successful companies respond quickly to market changes and new opportunities. A key to this is the effective and efficient use of data and information by analyst and managers.

HANA overcomes the limitations mentioned below:

- Due to increase in "Data Volume", it is a challenge for the companies to provide access to real time data for analysis and business use.
- It involves high maintenance cost for IT companies to store and maintain large data volumes.
- Due to unavailability of real time data, analysis and processing results are delayed.

## SAP HANA Vendors

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SAP has partnered with leading IT hardware vendors like IBM, Dell, Cisco etc. and combined it with SAP licensed services and technology to sell SAP HANA platform.

There are, total, 11 vendors that manufacture HANA Appliances and provide onsite support for installation and configuration of HANA system.

**Top few Vendors include:**

- IBM
- Dell
- HP
- Cisco
- Fujitsu
- Lenovo (China)
- NEC
- Huawei

According to statistics provided by SAP, IBM is one of major vendor of SAP HANA hardware appliances and has a market share of 50-52% but according to another market survey conducted by HANA clients, IBM has a market hold up to 70%.

## **SAP HANA Installation**

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HANA Hardware vendors provide preconfigured appliances for hardware, Operating System and SAP software product.

Vendor finalizes the installation by an onsite setup and configuration of HANA components. This onsite visit includes deployment of HANA system in Data Center, Connectivity to Organization Network, SAP system ID adaption, updates from Solution Manager, SAP Router Connectivity, SSL Enablement and other system configuration.

Customer/Client starts with connectivity of Data Source system and BI clients. HANA Studio Installation is completed on local system and HANA system is added to perform Data modeling and administration.

## 2. SAP HANA – IN-MEMORY COMPUTING ENGINE

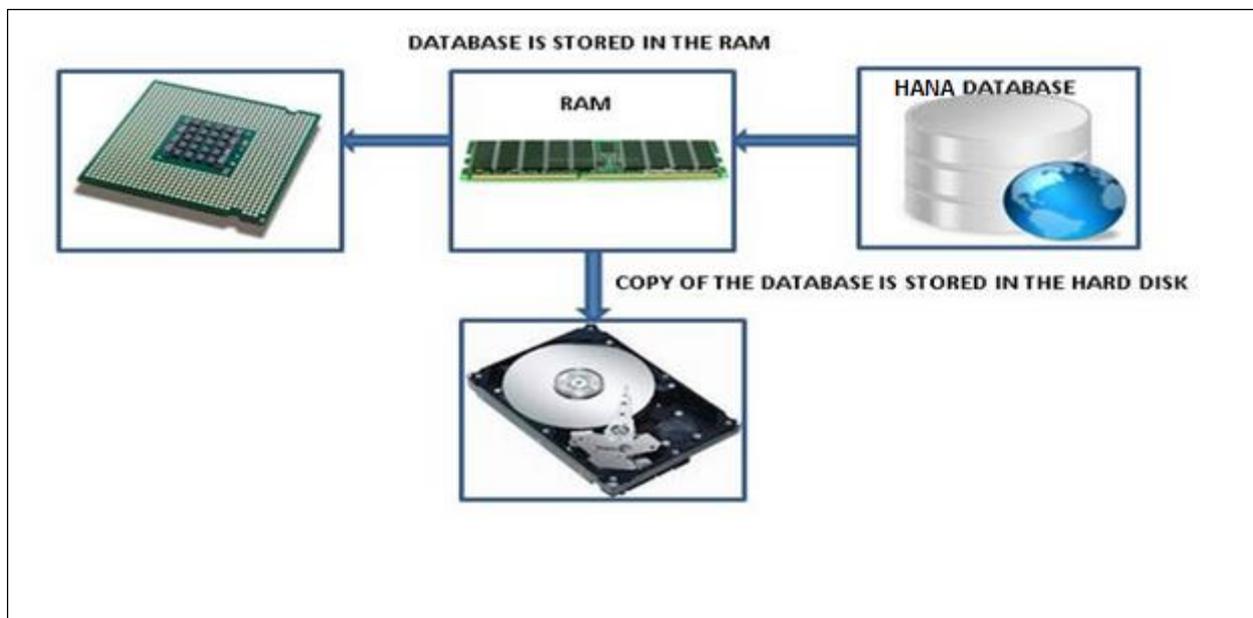
An In-Memory database means all the data from source system is stored in a RAM memory. In a conventional Database system, all data is stored in hard disk. SAP HANA In-Memory Database wastes no time in loading the data from hard disk to RAM. It provides faster access of data to multicore CPUs for information processing and analysis.

### Features of In-Memory Database

The main features of SAP HANA in-memory database are:

- SAP HANA is Hybrid In-memory database.
- It combines row based, column based and Object Oriented base technology.
- It uses parallel processing with multicore CPU Architecture.
- Conventional Database reads memory data in 5 milliseconds. SAP HANA In-Memory database reads data in 5 nanoseconds.

It means, memory reads in HANA database are 1 million times faster than a conventional database hard disk memory reads.



**Figure: SAP HANA In-Memory Database**

Analysts want to see current data immediately in real time and do not want to wait for data until it is loaded to SAP BW system. SAP HANA In-Memory processing allows loading of real time data with use of various data provisioning techniques.



## Advantages of In-Memory Database

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- HANA database takes advantage of in-memory processing to deliver the fastest data-retrieval speeds, which is enticing to companies struggling with high-scale online transactions or timely forecasting and planning.
- Disk-based storage is still the enterprise standard and price of RAM has been declining steadily, so memory-intensive architectures will eventually replace slow, mechanical spinning disks and will lower the cost of data storage.
- In-Memory Column-based storage provides data compression up to 11 times, thus, reducing the storage space of huge data.
- This speed advantages offered by RAM storage system are further enhanced by the use of multi-core CPUs, multiple CPUs per node and multiple nodes per server in a distributed environment.

# 3. SAP HANA – STUDIO

SAP HANA studio is an Eclipse-based tool. SAP HANA studio is both, the central development environment and the main administration tool for HANA system. Additional features are:

- It is a client tool, which can be used to access local or remote HANA system.
- It provides an environment for HANA Administration, HANA Information Modeling and Data Provisioning in HANA database.

SAP HANA Studio can be used on following platforms:

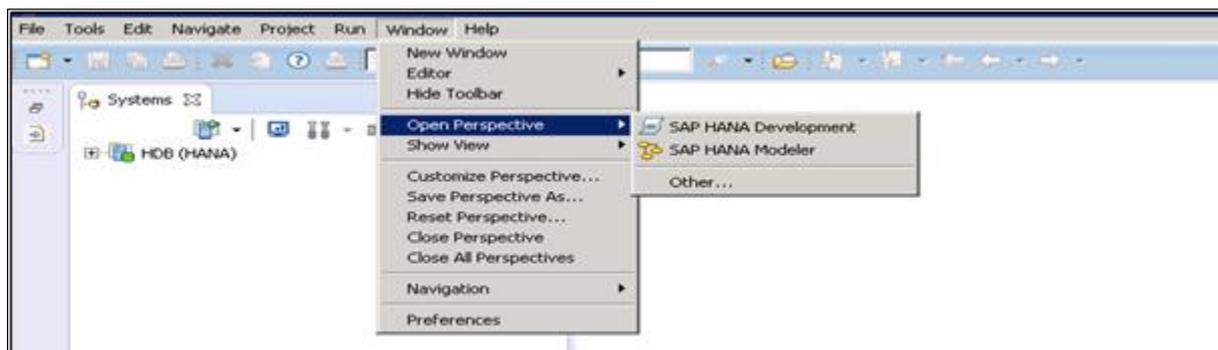
- Microsoft Windows 32 and 64 bit versions of: Windows XP, Windows Vista, Windows 7
- SUSE Linux Enterprise Server SLES11: x86 64 bit
- Mac OS, HANA studio client is not available

Depending on HANA Studio installation, not all features may be available. At the time of Studio installation, specify the features you want to install as per the role. To work on most recent version of HANA studio, Software Life Cycle Manager can be used for client update.

## SAP HANA Studio Perspectives / Features

SAP HANA Studio provides perspectives to work on the following HANA features. You can choose Perspective in HANA Studio from the following option:

**HANA Studio-> Window-> Open Perspective->Other**



**Figure: SAP HANA Studio: Open Perspectives**

## Sap Hana Studio Administration

Toolset for various administration tasks, excluding transportable design-time repository objects. General troubleshooting tools like tracing, the catalog browser and SQL Console are also included.

## **SAP HANA Studio Database Development**

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It provides Toolset for content development. It addresses, in particular, the DataMarts and ABAP on SAP HANA scenarios, which do not include SAP HANA native application development (XS).

## **SAP HANA Studio Application Development**

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SAP HANA system contains a small Web server, which can be used to host small applications. It provides Toolset for developing SAP HANA native applications like application code written in Java and HTML.

By default, all features are installed.

# 4. SAP HANA STUDIO –ADMINISTRATION VIEW

To Perform HANA Database Administration and monitoring features, SAP HANA Administration Console Perspective can be used.

Administrator Editor can be accessed in several ways:

- From System View Toolbar: Choose Open Administration default button
- In System View: Double Click on HANA System or Open Perspective



## HANA Studio: Administrator Editor

In Administration View: HANA studio provides multiple tabs to check configuration and health of the HANA system. Overview Tab tells General Information like, Operational Status, start time of first and last started service, version, build date and time, Platform, hardware manufacturer, etc.

## Adding a HANA System to Studio

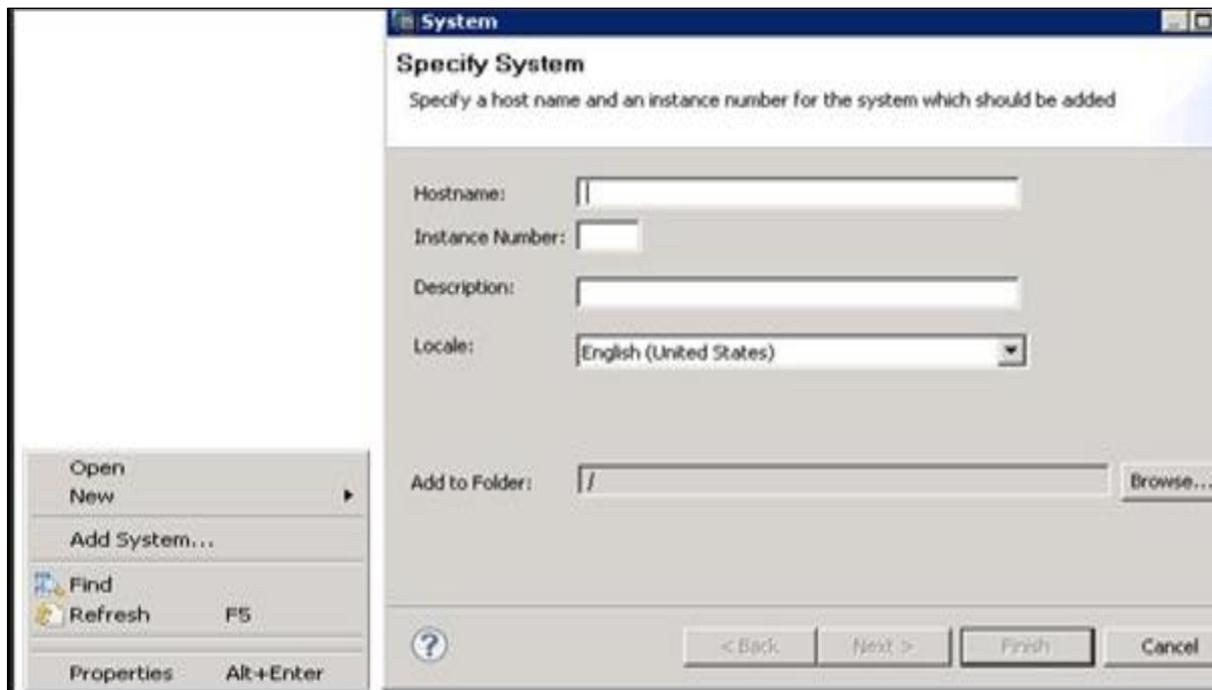
Single or multiple systems can be added to HANA studio for administration and information modeling purpose. To add new HANA system, host name, instance number and database user name and password is required.

1. Port 3615 should be open to connect to Database
2. Port 31015 Instance No 10
3. Port 30015 Instance No 00
4. SSh port should also be opened

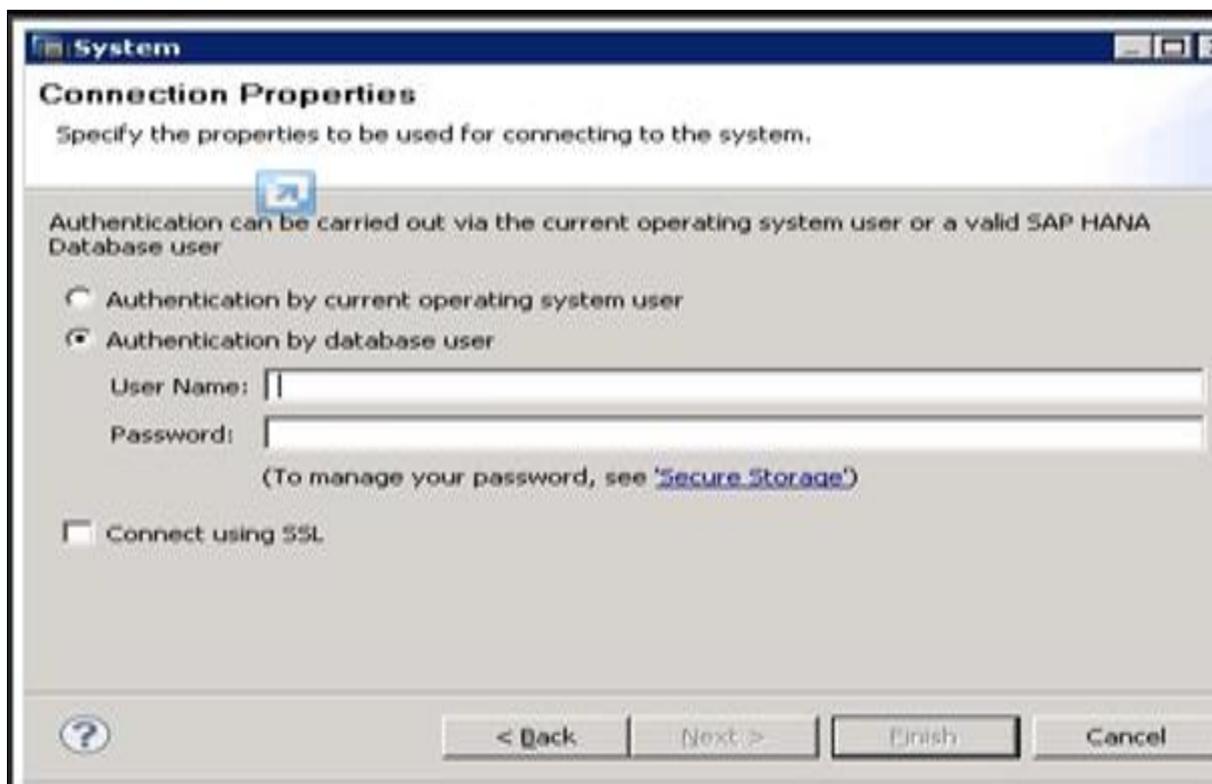
## Adding a System to Hana Studio

To add a system to HANA studio, follow the given steps.

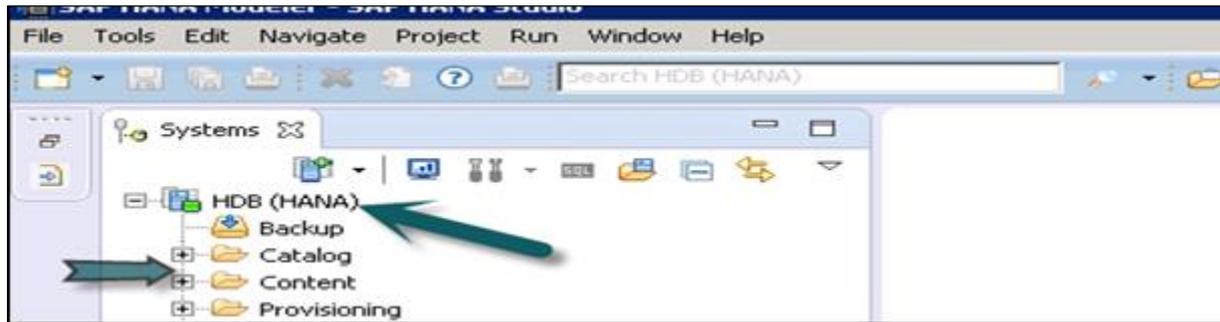
Right Click in Navigator space and click on Add System. Enter HANA system details, i.e. Host name & Instance number and click next.



Enter Database user name and password to connect to SAP HANA database. Click on Next and then Finish.



Once you click on Finish, HANA system will be added to System View for administration and modeling purpose. Each HANA system has two main sub-nodes, Catalog and Content.



## Catalog and Content

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### Catalog

It contains all available Schemas i.e. all data structures, tables and data, Column views, Procedures that can be used in Content tab.

### Content

The Content tab contains design time repository, which holds all information of data models created with the HANA Modeler. These models are organized in Packages. The content node provides different views on same physical data.

# 5. SAP HANA – SYSTEM MONITOR

System Monitor in HANA studio provides an overview of all your HANA system at a glance. From System Monitor, you can drill down into details of an individual system in Administration Editor. It tells about Data Disk, Log disk, Trace Disk, Alerts on resource usage with priority.

The following Information is available in System Monitor:

Column	Description
System ID	ID assigned to system when added
Operational State	Overall system status
Alerts	The system issues alerts when resource usage and statistical thresholds are violated. These alerts are categorized as low, medium, or high priority. There are also information alerts. The number of alerts and their status is shown here.
Data Disk (GB)	Size of the data volume on disk
Log Disk (GB)	Size of the log volume on disk
Trace Disk (GB)	Size of trace files on disk
Database Resident Memory (GB)	Size of resident memory at operating system level owing to SAP HANA database processes
System Resident Memory (GB)	Total size of resident memory in the operating system
Used Memory (GB)	Amount of physical memory used by the SAP HANA database
CPU (%)	Percentage of CPU used by the SAP HANA database
Hostname	Name of the server hosting the SAP HANA database
Instance Number	Instance number is the administrative unit that comprises the server software components
System Data Disk (GB)	Total disk space occupied on disk(s) containing data
System Log Disk (GB)	Total disk space occupied on disk(s) containing log files
Column	Description
System Trace Disk (GB)	Total disk space occupied on disk(s) containing trace files
System Physical Memory (GB)	Total amount of physical memory used
System CPU (%)	Overall CPU usage
Distributed	Indicates whether the system is running on a single host or it is a distributed system running on more than one host
Start Time First	Time that the first service started  This value is updated when system is restarted for any reason.
Start Time Latest	Time that the last service was started, if, for example, one of the services was restarted individually
Version	Software version number of the SAP HANA studio
Platform	Operating system on which the SAP HANA studio is running
Number of Crash Dump Files	The number of crash dump files in the trace directory of the system

# 6. SAP HANA – INFORMATION MODELER

SAP HANA Information Modeler; also known as HANA Data Modeler is heart of HANA System. It enables to create modeling views at the top of database tables and implement business logic to create a meaningful report for analysis.

## Features of Information Modeler

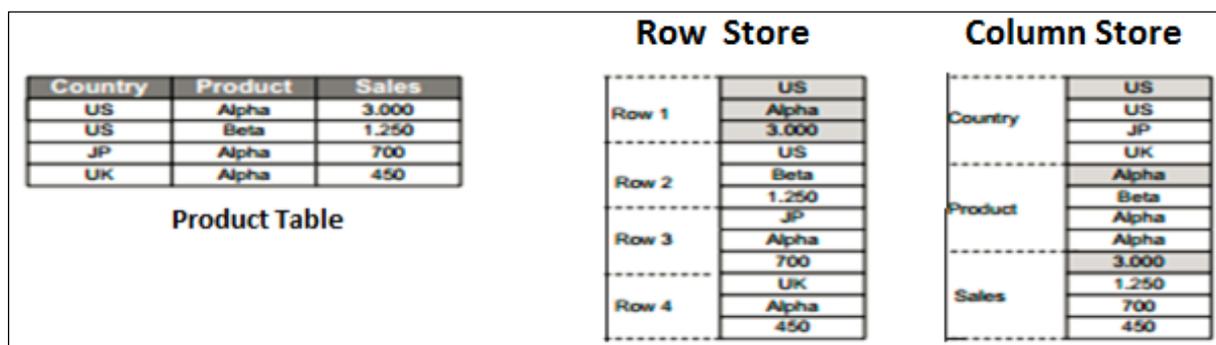
- Provides multiple views of transactional data stored in physical tables of HANA database for analysis and business logic purpose.
- Informational modeler only works for column based storage tables.
- Information Modeling Views are consumed by Java or HTML based applications or SAP tools like SAP Lumira or Analysis Office for reporting purpose.
- Also possible to use third party tools like MS Excel to connect to HANA and create reports.
- SAP HANA Modeling Views exploit real power of SAP HANA.

There are three types of Information Views, defined as:

- Attribute View
- Analytic View
- Calculation View

## Row vs Column Store

SAP HANA Modeler Views can only be created on the top of Column based tables. Storing data in Column tables is not a new thing. Earlier it was assumed that storing data in Columnar based structure takes more memory size and not performance Optimized.



With evolution of SAP HANA, HANA used column based data storage in Information views and presented the real benefits of columnar tables over Row based tables.



## Column Store

In a Column store table, Data is stored vertically. So, similar data types come together as shown in the example above. It provides faster memory read and write operations with help of In-Memory Computing Engine.

In a conventional database, data is stored in Row based structure i.e. horizontally. SAP HANA stores data in both row and Column based structure. This provides Performance optimization, flexibility and data compression in HANA database.

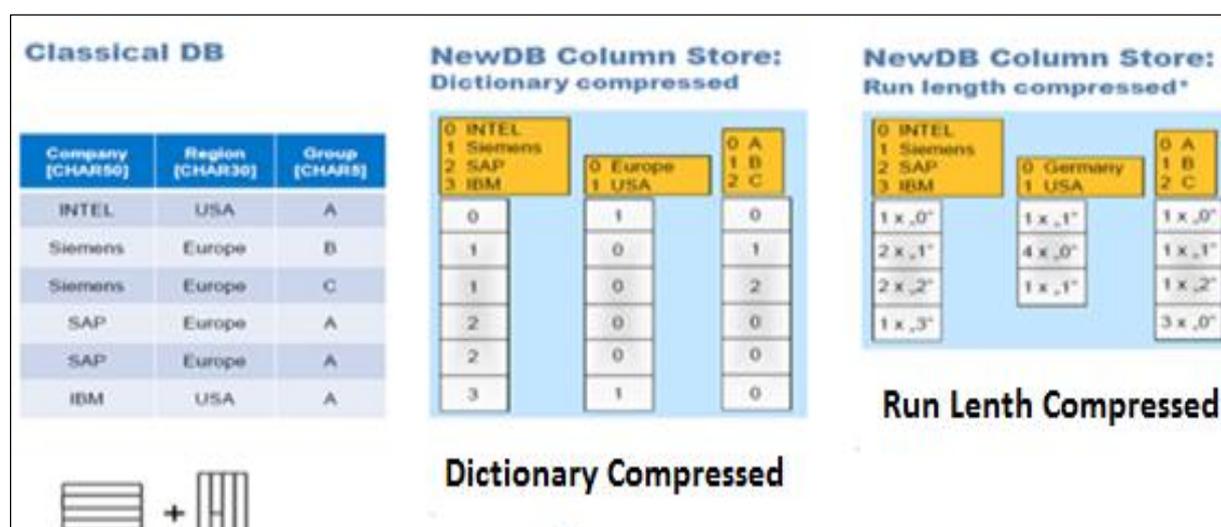
Storing Data in Columnar based table has following benefits:

- Data Compression
- Faster read and write access to tables as compared to conventional Row based storage
- Flexibility & parallel processing
- Perform Aggregations and Calculations at higher speed

There are various methods and algorithms how data can be stored in Column based structure- Dictionary Compressed, Run Length Compressed and many more.

In Dictionary Compressed, cells are stored in form of numbers in tables and numeral cells are always performance optimized as compared to characters.

In Run length compressed, it saves the multiplier with cell value in numerical format and multiplier shows repetitive value in table.

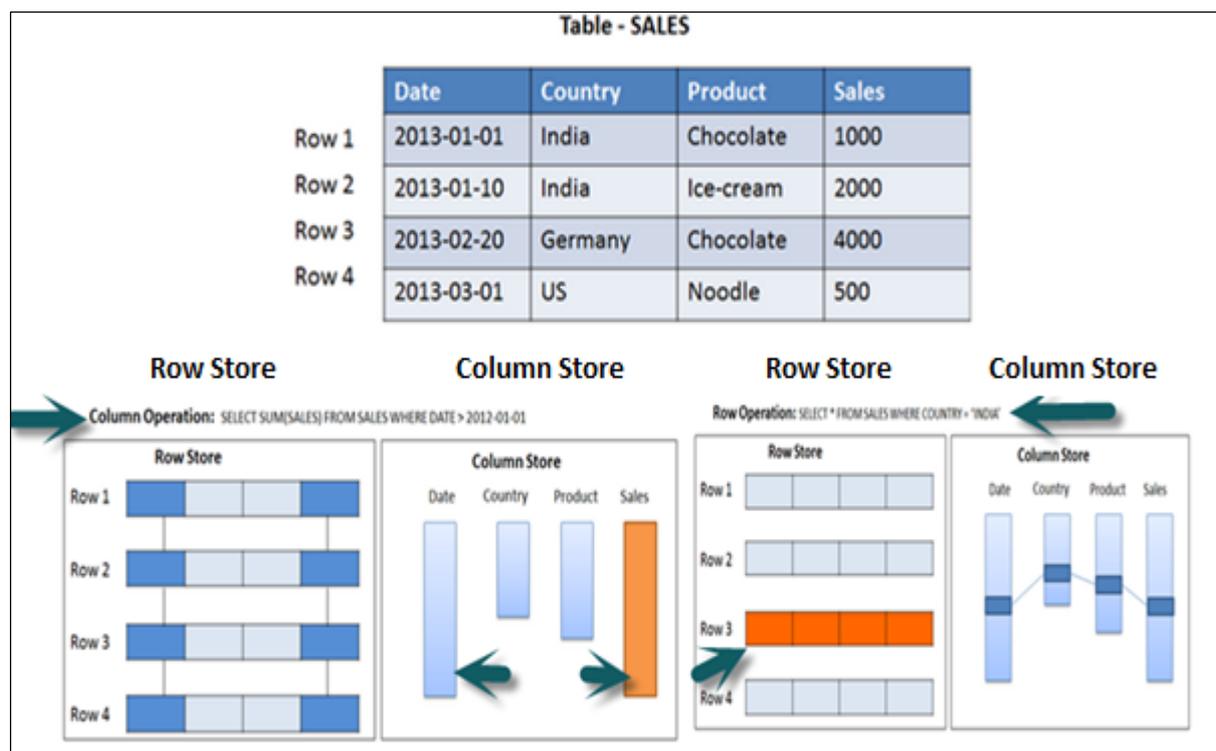


**Column Store: Types of Column based storage**

## Functional Difference: Row vs Column Store

It is always advisable to use Column based storage, if SQL statement has to perform aggregate functions and calculations. Column based tables always perform better when running aggregate functions like Sum, Count, Max, Min.

Row based storage is preferred when output has to return complete row. The example given below makes it easy to understand.



In the above example, while running an Aggregate function (Sum) in sales column with Where clause, it will only use Date and Sales column while running SQL query so if it is column based storage table then it will be performance optimized, faster as data is required only from two columns

While running a simple Select query, full row has to be printed in output so it is advisable to store table as Row based in this scenario.

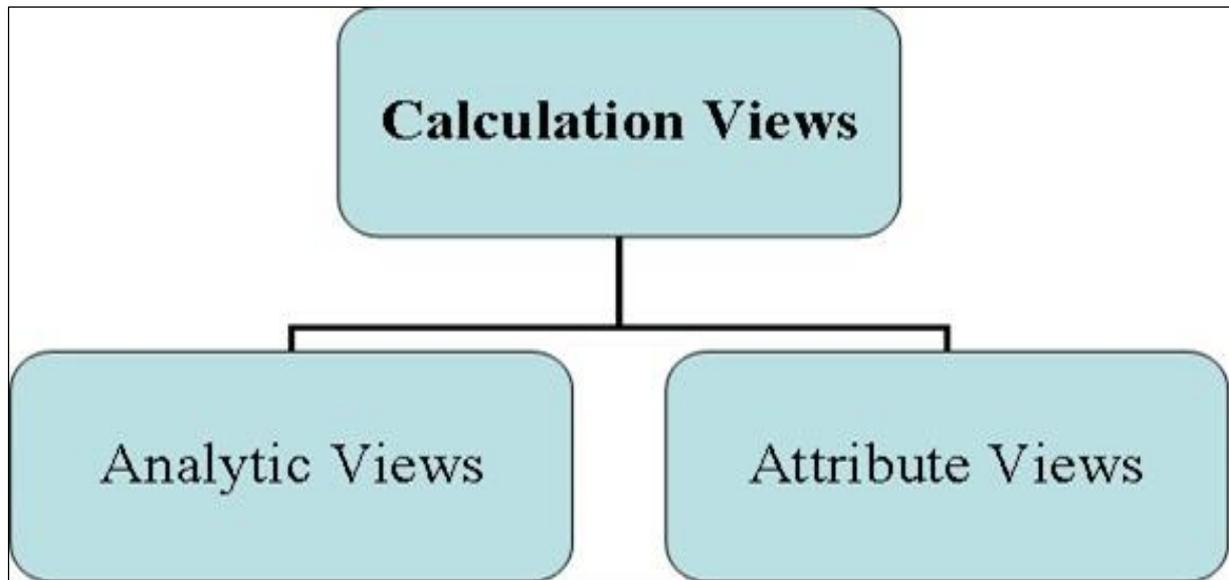
## Information Modeling Views

### Attribute View

Attributes are non-measurable elements in a database table. They represent master data and similar to characteristics of BW. Attribute Views are dimensions in a database or are used to join dimensions or other attribute views in modeling.

Important features are:

- Attribute views are used in Analytic and Calculation views.
- Attribute view represent master data.
- Used to filter size of dimension tables in Analytic and Calculation View.



### Analytic View

Analytic Views use power of SAP HANA to perform calculations and aggregation functions on the tables in database. It has at least one fact table that has measures and primary keys of dimension tables and surrounded by dimension tables contain master data.

Important features are:

- Analytic views are designed to perform Star schema queries.
- Analytic views contain at least one fact table and multiple dimension tables with master data and perform calculations and aggregations
- They are similar to Info Cubes and Info objects in SAP BW.
- Analytic views can be created on top of Attribute views and Fact tables and performs calculations like number of unit sold, total price, etc.

### Calculation Views

Calculation Views are used on top of Analytic and Attribute views to perform complex calculations, which are not possible with Analytic Views. Calculation view is a combination of base column tables, Attribute views and Analytic views to provide business logic.

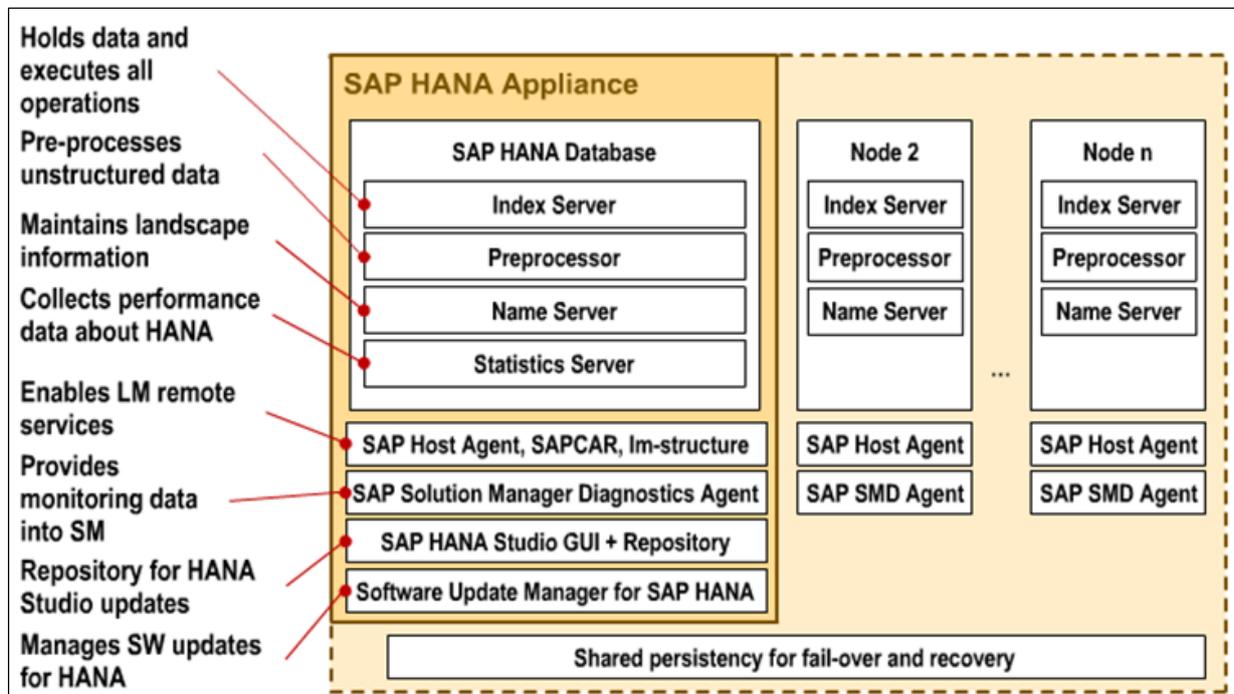
Important features are:

- Calculation Views are defined either graphical using HANA Modeling feature or scripted in the SQL.
- It is created to perform complex calculations, which are not possible with other views- Attribute and Analytic views of SAP HANA modeler.
- One or more Attribute views and Analytic views are consumed with help of inbuilt functions like Projects, Union, Join, Rank in a Calculation View.

# 7. SAP HANA – CORE ARCHITECTURE

SAP HANA was initially, developed in Java and C++ and designed to run only Operating System Suse Linux Enterprise Server 11. SAP HANA system consists of multiple components that are responsible to emphasize computing power of HANA system.

- Most important component of SAP HANA system is Index Server, which contains SQL/MDX processor to handle query statements for database.
- HANA system contains Name Server, Preprocessor Server, Statistics Server and XS engine, which is used to communicate and host small web applications and various other components.



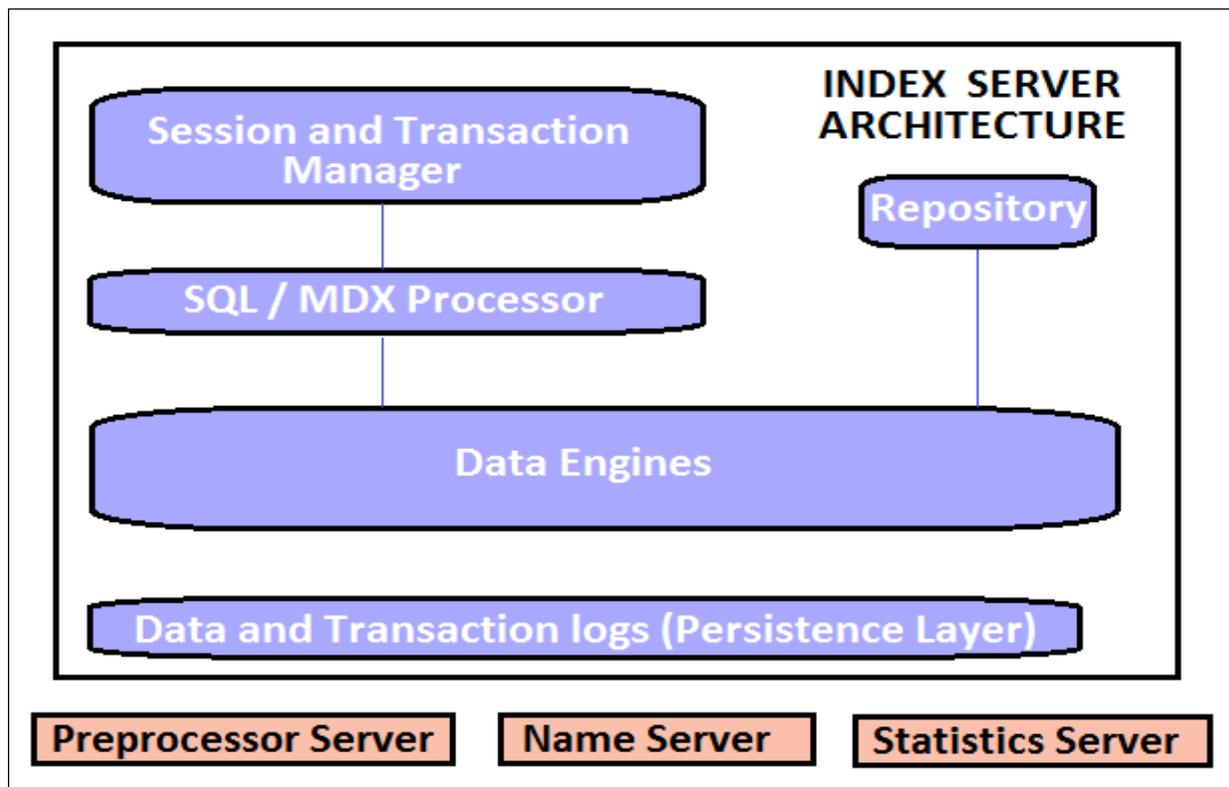
## SAP HANA: Core Architecture

### Index Server

Index Server is heart of SAP HANA database system. It contains actual data and engines for processing that data. When SQL or MDX is fired for SAP HANA system, an Index Server takes care of all these requests and processes them. All HANA processing takes place in Index Server.

Index Server contains Data engines to handle all SQL/MDX statements that come to HANA database system. It also has Persistence Layer that is responsible for durability of HANA system and ensures HANA system is restored to most recent state when there is restart of system failure.

Index Server also has Session and Transaction Manager, which manage transactions and keep track of all running and closed transactions.



## Index Server: Architecture

### SQL/MDX Processor

It is responsible for processing SQL/MDX transactions with data engines responsible to run queries. It segments all query requests and direct them to correct engine for the performance Optimization.

It also ensures that all SQL/MDX requests are authorized and also provide error handling for efficient processing of these statements. It contains several engines and processors for query execution:

- MDX (Multi Dimension Expression) is query language for OLAP systems like SQL is used for Relational database. MDX Engine is responsible to handle queries and manipulates multidimensional data stored in OLAP cubes.
- Planning Engine is responsible to run planning operations within SAP HANA database.
- Calculation Engine converts data into Calculation models to create logical execution plan to support parallel processing of statements.

- Stored Procedure processor executes procedure calls for optimized processing; it converts OLAP cubes to HANA optimized cubes.

## Transaction and Session Management

It is responsible to coordinate all database transactions and keep track of all running and closed transactions.

When a transaction is executed or failed, Transaction manager notifies relevant data engine to take necessary actions.

Session management component is responsible to initialize and manage sessions and connections for SAP HANA system using predefined session parameters.

## Persistence Layer

It is responsible for durability and atomicity of transactions in HANA system. Persistence layer provides built in disaster recovery system for HANA database.

It ensures database is restored to most recent state and ensures that all the transactions are completed or undone in case of a system failure or restart.

It is also responsible to manage data and transaction logs and also contain data backup, log backup and configuration back of HANA system. Backups are stored as save points in the Data Volumes via a Save Point coordinator, which is normally set to take back every 5-10 minutes.

## Preprocessor Server

Preprocessor Server in SAP HANA system is used for text data analysis.

Index Server uses preprocessor server for analyzing text data and extracting the information from text data when text search capabilities are used.

## Name Server

NAME server contains System Landscape information of HANA system. In distributed environment, there are multiple nodes with each node has multiple CPU's, Name server holds topology of HANA system and has information about all the running components and information is spread on all the components.

- Topology of SAP HANA system is recorded here.
- It decreases the time in re-indexing as it holds which data is on which server in distributed environment.

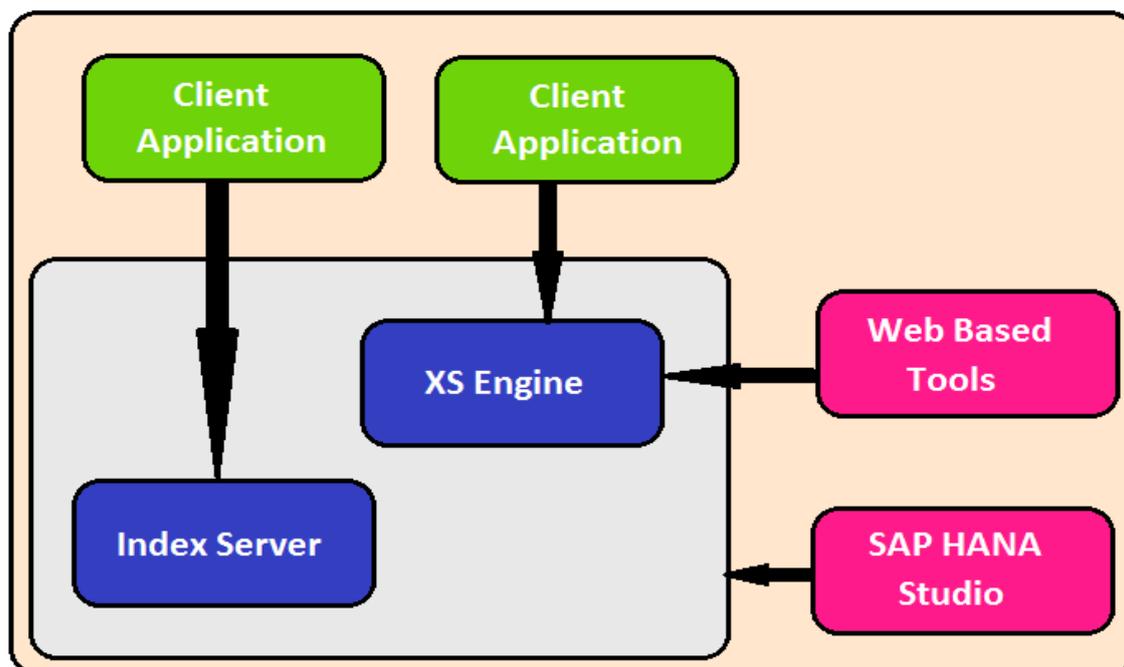
## Statistical Server

This server checks and analyzes the health of all components in HANA system. Statistical Server is responsible for collecting the data related to system resources, their allocation and consumption of the resources and overall performance of HANA system.

It also provides historical data related to system performance for analyses purpose, to check and fix performance related issues in HANA system.

## XS Engine

XS engine helps external Java and HTML based applications to access HANA system with help of XS client. As SAP HANA system contains a web server which can be used to host small JAVA/HTML based applications.



**SAP HANA: XS Engine**

XS Engine transforms the persistence model stored in database into consumption model for clients exposed via HTTP/HTTPS.

### SAP Host Agent

SAP Host agent should be installed on all the machines that are part of SAP HANA system Landscape. SAP Host agent is used by Software Update Manager SUM for installing automatic updates to all components of HANA system in distributed environment.

### LM Structure

LM structure of SAP HANA system contains information about current installation details. This information is used by Software Update Manager to install automatic updates on HANA system components.

### SAP Solution Manager (SAP SOLMAN) diagnostic Agent

This diagnostic agent provides all data to SAP Solution Manager to monitor SAP HANA system. This agent provides all the information about HANA database, which include database current state and general information.

It provides configuration details of HANA system when SAP SOLMAN is integrated with SAP HANA system.

### SAP HANA Studio Repository

SAP HANA studio repository helps HANA developers to update current version of HANA studio to latest versions. Studio Repository holds the code which does this update.

### **Software Update Manager for SAP HANA**

SAP Market Place is used to install updates for SAP systems. Software Update Manager for HANA system helps is update of HANA system from SAP Market place.

It is used for software downloads, customer messages, SAP Notes and requesting license keys for HANA system. It is also used to distribute HANA studio to end user's systems.



## **PART 2: SAP HANA – MODELING**

# 8. SAP HANA – MODELING

## SAP HANA Modeling

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SAP HANA Modeler option is used to create Information views on the top of schemas-> tables in HANA database. These views are consumed by JAVA/HTML based applications or SAP Applications like SAP Lumira, Office Analysis or third party software like MS Excel for reporting purpose to meet business logic and to perform analysis and extract information.

HANA Modeling is done on the top of tables available in Catalog tab under Schema in HANA studio and all views are saved under Content table under Package.

You can create new Package under Content tab in HANA studio using right click on Content and New.

All Modeling Views created inside one package comes under the same package in HANA studio and categorized according to View Type.

Each View has different structure for Dimension and Fact tables. Dim tables are defined with master data and Fact table has Primary Key for dimension tables and measures like Number of Unit sold, Average delay time, Total Price, etc.

## Fact and Dimension Table

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Fact Table contains Primary Keys for Dimension table and measures. They are joined with Dimension tables in HANA Views to meet business logic.

**Example of Measures:** Number of unit sold, Total Price, Average Delay time, etc.

Dimension Table contains master data and is joined with one or more fact tables to make some business logic. Dimension tables are used to create schemas with fact tables and can be normalized.

**Example of Dimension Table:** Customer, Product, etc.

Suppose a company sells products to customers. Every sale is a fact that happens within the company and the fact table is used to record these facts.

TimeID	ProductID	CustomerID	Unit Sold
4	17	2	1
8	21	3	2
8	4	1	1

CustomerID	Name	Gender	Income	Education	Region
1	Brian Edge	M	2	3	4
2	Fred Smith	M	3	5	1
3	Sally Jones	F	1	7	3

**Figure: Fact and Dimension Table**

For example, row 3 in the fact table records the fact that customer 1 (Brian) bought one item on day 4. And, in a complete example, we would also have a product table and a time table so that we know what she bought and exactly when.

The fact table lists events that happen in our company (or at least the events that we want to analyze- No of Unit Sold, Margin, and Sales Revenue). The Dimension tables list the factors (Customer, Time, and Product) by which we want to analyze the data.

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