23-05-2023

**3-Tier Architectural Design for an Ecommerce Website**

A three-tier software architectural design for an e-commerce website typically consist of three distinct layers:

1. **Presentation Layer (UI Tier):**

Just as it sounds, the presentation layer is the part that is presented to the customer. It is the user interface and communication layer of the architecture, where the customer interacts with the website on the frontend, and the application collects data and processes requests from the backend. The presentation layer is often developed using HTML, CSS or JavaScript, but, depending on the ecommerce platform, desktop applications may be written in multiple different languages.

1. **Business Layer (Application layer):**

The business layer, also known as the application or service layer, is at the centre of the application. It uses business logic, a specific set of business rules, to gather and process information, and it can also add, delete or change information in the data layer.

This layer consists of application’s core functionalities and performs tasks such as order processing, inventory management, payment processing, user authentication, and authorization. It acts as an intermediary between the presentation layer and the data storage layer.

1. **Data Storage Layer (Data Tier):**

The data tier, also known as the database layer, is the final layer used to store data and process requests. This information may be stored using a relational database management system such as LINQ or SQL. It can also include caching items, and file systems. It manages product information, user profiles, order details, and other relevant data. The data storage layer is accessed by the business logic layer to fetch or update data based on user requests or system operations.

**Interactions between the layers:**

* The presentation layer communicates user inputs to the business logic layer thus triggering actions and requesting data.
* The business logic layer processes the requests from the presentation layer, performs necessary computations or operations, and interacts with the data storage layer to retrieve or store data.
* The data storage layer stores and retrieves data as requested by the business logic layer, ensuring data consistence and integrity.

**In-depth understanding of every individual layer separately:**

1. Presentation Layer:

The presentation layer in an e-commerce website focuses on delivering an engaging and user-friendly interface to customers. It consists of interface (UI) components, user experience (UX) design, and frontend development technologies.

1. User Interface (UI) Design:

It is responsible for creating visually appealing and intuitive interfaces that enhance the user experience. Key aspects of UI design in an e-commerce website includes:

* Layout and Navigation: Designing a well-structured layout that enables easy navigation through product categories, sub-categories, search functions, cart, checkout, and wish list features.
* Responsiveness: Ensures that the website is properly responsive and optimized for different devices and operating systems, different screen sizes, thus ensuring a seamless experience.
* Visual elements: Selecting appropriate themes, colour schemes, font styles, images, display elements that align with the brand’s theme and idea thus engaging a greater audience by providing a visual impact.
* Consistency: This is the feature of maintaining a consistent design across all the pages, creating a cohesive familiar experience for the users.

1. User Experience (UX) Design:

UX design focuses primarily on the users. They study interfaces between user and the products, finding ways to ensure that the product answers to the user’s key needs.

* User flows: Creating a proper and channelised user flows for browsing products, viewing product details, subsequent wish listing or adding to the cart, proper checkout flow and tracking of product in consistent sequence.
* Search Functionality along with Personalisation: Implementing an efficient and accurate search feature that allows users to find the products based on keywords, search filters or categories. This also includes a good recommendation system inbuilt. Targeted promotions, and user-specific features can be incorporated to enhance shopping experience.
* Product Presentation: Proper display of all the relevant products according to the user’s search result. This must include clear picture and descriptions along with related products and their prices neatly mentioned.
* Cart and Checkout: Optimizing the cart and checkout process to be seamless, easy to understand, streamlined, secure.

1. Frontend Development Technologies:

The presentation layer is implemented using various frontend development technologies, frameworks and languages. These various technologies are:

* Hypertext Markup Language and CSS: These are the most fundamental technologies used for creating a website and subsequently defining their visual styles.
* JavaScript and Frameworks: JS gives the website their functionality and makes them interactive and dynamic. Popular JS frameworks are ReactJS, NodeJS, Angular.
* Responsive Design: Using CSS frameworks like Bootstrap to create responsive layouts and ensure optimal user experience across different devices.
* API Integration: Communicating with backend systems via RESTful APIs to retrieve product data, process orders, and update user information.

1. Business Logic Layer:

It has a crucial role in managing the core functionalities and business rules of the system. It handles the processing, validation or various operations.

1. Order processing:

The business logic layer manages the entire order processing workflow including:

* Validating and processing customer orders, ensuring that all the required information is provided and is accurate.
* Calculating order totals, including the gst, taxes, discounts, delivery costs.
* It also manages the inventory system, checking product stock availability and updating the stock list.
* It also coordinates with the payment gateways and processes payment transactions securely.
* Generates order confirmation and notifies the customer regularly regarding the order status.

1. User Authentication and Authorization:

User authentication and authorization are crucial aspects of an e-commerce website. The business logic layer handles tasks like:

* User registration, login, and password management.
* Implementing security measures like hashing and salting passwords to ensure data protection.
* Managing user roles and permissions, allowing access to specific features or content based on user privileges.

1. Product Catalogue and Inventory Management:

The business logic layer handles the management of products and inventory, including:

* Storing and organizing product information such as titles, descriptions, prices, categories, and images.
* Enabling product search and filtering functionality based on various attributes.
* Implementing product recommendation algorithms to suggest relevant products to customers.
* Updating and tracking inventory levels, ensuring accurate stock management.
* Managing product attributes, variations, and options (e.g., size, colour).

1. Pricing and Promotions:

The business logic layer manages pricing strategies and promotional offers, including:

* Applying discounts, coupon codes, or promotional campaigns based on specific criteria.
* Calculating and displaying accurate prices, considering currency conversions, taxes, shipping costs, and any applicable fees.
* Implementing pricing rules and algorithms to dynamically adjust prices based on factors such as demand, availability, or customer segments.

1. Shopping Cart and Checkout:

The business logic layer handles the shopping cart and checkout process, including:

* Managing the user's cart, adding and removing products, and updating quantities.
* Calculating the subtotal, taxes, shipping costs, and total order amount.
* Handling the checkout flow, allowing guest checkout or account creation, and capturing necessary customer information.
* Integrating with payment gateways to process secure and reliable transactions.

1. Integration with Third-Party Services:

The business logic layer interacts with various third-party services and APIs, including:

* Payment gateways: Integrating with payment providers to securely process payment transactions.
* Shipping carriers: Interfacing with shipping APIs to obtain shipping rates, generate labels, and track shipments.

1. Security and Data Integrity:

The business logic layer enforces security measures and ensures data integrity, such as:

* Implementing input validation and sanitization to prevent security vulnerabilities like SQL injection.
* Enforcing business rules and validating data integrity when interacting with the data storage layer.
* Implementing access controls and authorization checks to protect sensitive information and restrict unauthorized operations.

1. Customer Management:

* Storing and managing customer information, including profiles, addresses, and contact details.
* Enabling account management functionalities such as updating personal information, managing saved addresses, and viewing order history.
* Implementing customer communication features, such as email notifications or messaging systems, to keep customers informed about their orders, account updates, or promotional offers.
* Implementing customer service-related features, including support ticket management or live chat integration.

1. This layer also handles Reviews and ratings, analytics and reporting, system integration and extensibility, error handlining and logging. It is common to use design patterns and architectural principles, such as MVC or MVVM, to structure and organise the business logic layer effectively.
2. Data Storage Layer:

This layer is responsible for managing and persisting data required by the system. It involves all the functionalities related to storing of related information.

1. Relational Databases:

Relational databases, such as MySQL, PostgreSQL, or Oracle, are commonly used to store structured data in a tabular format. In the e-commerce context, relational databases are typically used for:

* Product Catalogue: Storing product information, including product names, descriptions, pricing, categories, attributes, and relationships.
* User Profiles: Storing user data such as names, email addresses, contact information, and authentication credentials.
* Orders and Transactions: Recording order details, including customer information, product details, quantities, prices, payment information, and order statuses.
* Inventory Management: Tracking product stock levels, availability, and handling stock updates when orders are placed or fulfilled.

1. NoSQL Databases:

NoSQL (Not only SQL) databases, like MongoDB are used when there is a need for flexible and scalable data storage. NoSQL databases are suitable for managing various types of data, including:

* User Preferences and Personalization: Storing user preferences, wish lists, or personalized recommendations.
* User Activity Logs: Capturing user interactions, browsing history, search queries, or clickstream data for analytics and personalization purposes.
* Content Management: Storing content assets like blog posts, articles, or media files.

1. Caching Systems:

Caching systems are employed to improve performance by temporarily storing frequently accessed data in memory. In an e-commerce context, caching can be applied to:

* Product Catalogue: Caching frequently accessed product data to reduce database queries and improve response times.
* Recently Viewed Products: Caching recently viewed products for quick retrieval and display on the website.

1. Search Engines:

Search engines are often used to enable fast and efficient search functionalities in e-commerce websites. Search engines offer advanced features such as:

* Full-Text Search: Allowing users to search for products based on keywords, product names, descriptions, or attributes.
* Faceted Search: Supporting filtering and refinement of search results based on various attributes, categories, or price ranges.
* Search Relevance and Ranking: Utilizing algorithms and scoring techniques to provide accurate and relevant search results to users.

1. File Storage:

File storage systems are used to store and manage various media files associated with products, such as product images, videos, or user-generated content. Common approaches include:

* Local File System: Storing files on the local server or associated network storage.
* Content Delivery Networks (CDNs): Utilizing CDNs to cache and deliver static files, reducing server load and improving file retrieval times.

1. Integration with External Systems:

The data storage layer may also involve integration with external systems or services, including:

* Payment Gateways: Interfacing with payment gateways to securely handle payment transactions and storing relevant transaction details.
* Shipping Providers: Integrating with shipping providers to fetch shipping rates, generate shipping labels, and track shipments.

1. Data Security and Privacy:

Implementing proper security measures to protect sensitive data, including encryption of confidential information, enforcing access controls, and adhering to data privacy regulations like GDPR (General Data Protection Regulation).

1. Data Backup and Recovery:

When there is data loses, there are majorly three major repercussions:

* Lost Revenue, Customers, and Credibility
* The high cost of Recovery
* Losing Months or years of work

Rewind uses an Application Programming Interface (API) to connect their software and your store or firm’s data. It scans, collects, and saves all the changes to your database and store once a day. The backup file stays secure and encrypted in Rewind’s vault. Should you ever need it, you have a restore point that’s no older than 24 hours.

1. Scalability and Performance:

In the world of eCommerce, the words "performance" as well as "scalability" are often used interchangeably, but they mean different things. Performance refers to the speed and responsiveness of an eCommerce website. It is how quickly a website can load and respond to user actions. Scalability, on the other hand, means that a website can handle more visitors and more demand.

1. Data Migration and Maintenance:

eCommerce data migration is a process that involves transferring your online store data that includes -product information, customer data, SEO data, workflows from one eCommerce platform to another. Types of data migration are:

* Storage Migration.
* Database Migration
* Application Migration
* Cloud Migration
* Business Process Migration
* Data Centre Migration.

1. Database Management Systems (DBMS):

* In an e-commerce application, the main purpose of a database is to store information for retrieving the product details, customer information, track transactions, and further, maintain the inventory.
* One of the biggest benefits of using a database for e-commerce is structuring vast amounts of shop data.
* When the data is organized in a proper format, it can be accessed more efficiently by e-commerce applications.
* Database plays a very critical and important role in the e-commerce industry, in today’s scenario the reason behind the success of an e-commerce firm is how much it has optimized its database.
* Because today’s consumers rely heavily on technology, e-commerce firms must use it to their advantage.

1. Data Access Layer:

The Data-Access Layer (DAL) is a component of a software architecture that is responsible for managing the data storage and retrieval of an application. It sits between the business-logic layer and the data storage system and provides an abstraction layer that allows the business-logic layer to interact with the data storage system without being aware of its specific implementation. The DAL is responsible for performing tasks such as:

* Connecting to the data storage system and managing the connection.
* Generating and executing SQL queries or other data access commands to retrieve and store data.
* Mapping the data from the data storage system to the application’s data objects and vice versa.
* Handling errors and exceptions related to data access.
* Providing support for transactions and other data access features.

1. Data Integrity and Validation:

Every piece of information undergoes multiple checks in process of validation. Here is a list of all the common data validation types:

* Data type check. The first is the field type check, which ensures that, for example, letters are not inserted in a field for numbers only. Another constituent of this check is input validation — making sure that the input is error-free and does not have logical mistakes.
* Code check. This includes checks for required fields (ensuring that all the mandatory fields are filled) and attributes validation (verifying information against a list of attributes and seeing if the required attributes match).
* Range check. Also known as an attributes range check, this ensures that attributes stay within a certain range of values.
* Format check. This type of check ensures that inputted records precisely fit the predefined format. For example, an international phone number has a fixed format: + country code – (area code) – 3-digit prefix – 4-digit subscriber number. Any deviations, like the absence of a country code, are considered errors.
* Consistency check. This involves verifying data against a list of values that contain formatting rules and seeing if specified properties match. This check confirms that the input is logically consistent.
* Uniqueness check. This includes checking the uniqueness of specific attributes, such as brands, serial numbers, or MPN (Manufacturer Part Number), and making sure they are not entered into a database more than once.

1. Database Indexing:

A search index is a regularly, and automatically, updated database of all your products and related information in a simple form. It’s something that enables users on a site to perform fast and accurate searches. It makes it possible for the search engine to perform any search in microseconds, because it doesn’t have to crawl hundreds or thousands of pages every time, it only has to search in the index.

1. Database Replication and High Availability:

Database replication is the frequent electronic copying of data from a database in one computer or server to a database in another -- so that all users share the same level of information. The result is a distributed database in which users can quickly access data relevant to their tasks without interfering with the work of others. Numerous elements contribute to the overall process of creating and managing database replication.

A High Availability (HA) Database is a database system designed to operate continuously with no interruptions in service. So, database errors and failures must be handled by automatically failing over to redundant nodes when problems occur.

1. Compliance and Data governance:

Data compliance pertains to the privacy of personal information and how businesses and organizations store, retrieve, and secure this sensitive data. Organizations and businesses, especially those that work with personal information, are responsible for safeguarding this personal data.

Data governance looks at creating an environment where data can be effectively used for useful insights that enhance business processes. Data governance is considered a must for any organization seeking to use its data to draw insights after analysis. Without data governance, data fails to meet regulations and the quality standards needed to extract usable insights.