**How Metadata Is Used?**

**1. Database Layer**

* **Metadata storage**: Tables like Products, Categories, Attributes, Inventory, Pricing, etc., hold metadata such as size, color, brand, material, etc.
* **Normalization**: Metadata is split into related tables to avoid redundancy and support flexibility.

**2. Search System**

* Metadata (e.g., color, size, brand) is indexed by search engines like **Elasticsearch** for fast filtering.
* Enables **faceted search** like:  
  Users -> Search -> Filter by: Size: M, Color: Red, Brand: Adidas

**3. Recommendation System**

* Uses metadata (e.g., "casual cotton shirt") to suggest similar or complementary items using collaborative or content-based filtering.

**4. Caching Layer**

* Frequently accessed metadata (like popular items or filters) is cached using **Redis** or **Memcached** to reduce DB load.

**5. Frontend (UI/UX)**

* Metadata is used to dynamically render dropdowns, filters, product details.
* Enables A/B testing using metadata tags like isFeatured, seasonal.

**6. Analytics & Reporting**

* Metadata helps generate reports like:
  + Most sold size
  + Popular colors per region
  + Inventory by material/brand

**7. Logging & Observability**

* Logs can include metadata (e.g., SKU, item ID, category) to trace failures or monitor metrics like product search frequency.

**8. Microservices Communication**

* Services like Inventory, Pricing, Search, and Recommendations exchange metadata via APIs (REST/GraphQL) or message queues (Kafka, RabbitMQ).

**9. Scalability**

* Product metadata is horizontally partitioned (sharded) by category or region.