**Problem statement**

**1. Context & Overview**

The U.S. tariff system has gone through **three distinct policy phases**:

* **President 1**: Imposed **item-level tariffs** on 10 countries.
* **President 2**: Expanded the tariff policy to **4 additional countries** at the item level.
* **President 3**: Introduced **component-level tariffs**, meaning duties now apply to materials (e.g., steel, aluminum) within products.

**Challenge**: This evolution demands a flexible system capable of understanding and applying different layers of rules, including historical tariffs, item structure (BoM), and changing political directives.

**2. Requirements**

**Functional Requirements**

* **Tariff Rule Definition**: Define rules by country, item, or component.
* **Calculation Engine**: Dynamically calculate total tariff based on the applicable rules.
* **Component Mapping**: Link finished goods to raw materials using a Bill of Materials (BoM).
* **Versioning**: Support rule changes over time (e.g., per presidency).
* **Integration**: Connect with external import/export or logistics systems.
* **Auditing & Reporting**: Track policy changes and report on impact.

**Non-Functional Requirements**

* **Extensibility**: Add new rule types, components, or countries easily.
* **Performance**: Complete tariff calculation in under 200ms.
* **Security**: Enforce role-based access for rule editing vs. viewing.
* **Scalability**: Handle a growing number of rules and item-component combinations.
* **Data Integrity**: Validate country codes, rates, and hierarchies.

**3. High-Level Design (HLD)**

**System Components**

1. **Tariff Rule Service** – CRUD API for tariff definitions.
2. **Tariff Engine** – Resolves which rules apply and computes final duties.
3. **BoM Resolver** – Translates an item into its component parts.
4. **Policy Manager** – Associates rules with versions, such as presidential terms.
5. **Analytics Service** – Tracks historical decisions, trends, and tariff impacts.
6. **Admin Console** – Interface for policy makers to test, draft, and deploy rules.

**4. Low-Level Design (LLD)**

**Key Data Models**

**TariffRule**

{

"level": "item" | "component",

"entity\_id": "ITEM123" | "COMPONENT456",

"country": "CHN",

"tariff\_rate": 0.15,

"start\_date": "2025-01-01",

"source": "President 3 Policy"

}

**Item**

{

"item\_id": "ITEM123",

"description": "Refrigerator",

"components": ["STEEL\_A", "ALUMINUM\_B"]

}

**Calculation Logic**

def compute\_tariff(item\_id, country):

components = resolve\_bom(item\_id)

item\_tariffs = get\_item\_tariff(item\_id, country)

component\_tariffs = sum([

get\_component\_tariff(c, country) for c in components

])

return combine\_tariff(item\_tariffs, component\_tariffs)

**How It Works:**

1. **Resolve Components:**  
   resolve\_bom(item\_id) returns the components that make up the item (e.g., steel, aluminum).
2. **Fetch Item-Level Tariff:**  
   get\_item\_tariff(item\_id, country) gets the tariff directly applied to the full item.
3. **Fetch Component Tariffs:**  
   Loops through each component and sums the tariffs from get\_component\_tariff(component, country).
4. **Combine Tariffs:**  
   combine\_tariff(item\_tariffs, component\_tariffs) merges both tariffs based on policy rules (e.g., additive, maximum, override).

**5. Forward-Thinking Enhancements**

1. **Simulation Engine** – Preview impact of new policies before they go live.
2. **AI Suggestions** – Use trade data to recommend tariffs.
3. **Conflict Resolution Engine** – Decide what to do if both item and component tariffs apply.
4. **Staging & Approval Workflow** – Ensure rules go through review before activation.
5. **Multilateral Agreements** – Handle treaties like NAFTA or USMCA for rule sharing among countries.

**6. Conclusion**

The proposed system is:

* Modular and scalable
* Able to handle political and economic shifts
* Designed for transparency, flexibility, and future integrations

This design prepares your organization for a dynamic trade environment while maintaining control, visibility, and compliance across all tariff rules.

Design a complete system by covering - HLD, LLD, Database design and APIs with complete implementation and diagrams.