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Automotive Regulation Database and Requirements Management

A comprehensive application that systematically manages and integrates complex global automotive regulations into the R&D workflow.

Overview

- Developed a scalable application using Java and Golang microservices to manage, fragment, and classify international automotive regulatory documents (HTML, PDF, DOCX).
- The solution automatically converts unstructured legal documents into structured requirements organized in a hierarchical framework for management and traceability.
- Implemented a custom delta comparison algorithm to detect and highlight changes between regulatory versions, ensuring compliance updates are immediate.
- Serves as a single-source of truth for global regulations, significantly easing the vehicle development process and ensuring the production of safer, more compliant products.

Client Profile

Headquartered in Germany, our client is the research and development center for the world's largest manufacturer of premium and commercial vehicles. The center focuses on research, IT engineering, and product development.

Challenges: Regulatory Complexity and Traceability

- **Global Regulatory Maze:** The need to continuously monitor and analyze a complex, ever-changing web of global and regional regulations (EU, UN, etc.) related to vehicle type approval.
- **Unstructured Data:** Regulatory documents were unstructured (PDF, DOCX, web pages), making it difficult to systematically classify and extract discrete requirements.

- **Manual Updates:** Detecting and integrating changes in regulatory requirements required labor-intensive manual delta comparisons between new and old document versions.
- **Disjointed Workflow:** Lack of a seamless mechanism to hand over legal requirements directly into the product development teams' requirements management tools.

Solution: Microservices-Based Compliance Platform

We architected and developed a robust, scalable application designed to transform unstructured regulatory documents into actionable, traceable requirements, directly integrating them into the client's R&D process. The solution utilizes a modern microservices architecture powered by Java, Golang, and PostgreSQL.

- **Document Processing Pipeline:** Documents imported via an Angular frontend are processed by Java-based microservices coordinated via RabbitMQ messages. These services sanitize and modify documents based on automated rules.
- **Requirements Fragmentation:** The application automatically splits documents into hierarchical fragments (requirements), which regulation experts then validate and enhance with metadata, implementation guidelines, and vehicle category tags.
- **Targeted Requirements Bundles:** Experts use Java and Golang microservices to tag and bundle fragments related to specific product development topics. These bundles are created via Java-based scheduled jobs and prepared for export.

Technical Highlights

- **Central Versioning:** Maintains a historical reference of all regulatory versions and provides automatic, centralized versioning of requirements at the fragment level.

- **Delta Comparison Engine:** Uses a customized dynamic-time warping (DTW) algorithm in a dedicated microservice to find matching fragments between versions and visually display changes (delta comparison).
- **Req-IF Export:** Facilitates direct and immediate transfer of finalized requirements bundles (tags) to the organization's requirements management tools via the industry-standard Req-IF file format.
- **Live Reporting:** A Golang-based backend reporting service executes highly optimized native PostgreSQL queries to generate on-demand analysis reports for tracking requirement collection and finalization.
- **Automated Quality:** Implemented extensive automated testing using Cypress for end-to-end web application testing and Testcontainers-based integration tests for the backend services.

Impact

- **Single Source of Truth:** The application serves as a central database for global regulations, ensuring all product engineers and suppliers fetch regulations from one trusted source.
- **Enhanced Compliance:** Ensures production vehicles meet current regulations globally by providing a clear and traceable lineage from legal requirement to technical specification.
- **Accelerated Updates:** Automatic versioning and fragment-level delta comparison ensure regulatory updates are identified, validated, and transferred to development teams promptly.
- **Improved Collaboration:** External suppliers and vendors can view finalized and classified regulations, fostering better collaboration (though they are restricted from accessing internal requirement bundles).
- **Historical Traceability:** The historization of both regulation documents and requirement bundles provides essential audit and reference capability for older vehicle versions.