Design and Implementation of SOA-based Technical Service System for Road Transport Vehicles

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Abstract. To promote the unified declaration and review of standard-compliant vehicle models more effectively and increase the efficiency of declaration of standard-compliant vehicle models, this paper designed a SOA-based road transport vehicle technical service system and realized its related functions. In the SOA-based system, the loose coupling relation between functions of applications and the adoption of open standards makes the system easy to maintain and has considerable business flexibility. The application of road transport vehicle technical support service system effectively meets the functional requirements of carmakers, car testing agencies, reviewers and system administrators, provides a good business platform for declaration of standard-compliant vehicle models and effectively makes related activities more IT enabled.

1. Introduction
The road transport vehicle technical service system is mainly used for unified declaration and unified review of standard-compliant models of road transport vehicles. Road transport vehicles refer to vehicles engaged in or proposed to engage in road transport operation, also known as operating vehicles, including but not limited to road passenger transport vehicles, road cargo transport vehicles, international road transport vehicles and road transport self-driving vehicles. Standard-compliant models of road transport vehicles (“standard-compliant vehicle model”) refer to vehicles reviewed and confirmed by technical organizations, issued and approved by the Ministry of Transport for release and meeting the applicable standards and regulations for market access. To promote the unified declaration and review of standard-compliant vehicle models more effectively and provide a good business platform for declaration of standard-compliant vehicle models, this paper designed a SOA-based road transport vehicle technical service system and realized its related functions.

SOA is a kind of system architecture oriented towards user service and has currently been widely applied in IT system building in many industries[1-5]. In the SOA-based road transport vehicle technical service system, the functionality of applications is structured from combination of some loose-coupled components that have unified interface definition mode, starting with the specific requirements and needs of target users. Using SOA-based system construction approach, all application functions are encapsulated in some functional modules and these encapsulated functional modules are used to assemble and construct the system we require, while these functional modules represent different services in the SOA architecture. Considering the gradual perfection of the declaration and review of standard-compliant vehicle models, and the gradually increased requirements for smart application
technologies, business flexibility is crucial to the design of road transport vehicle technical service system.

2. System requirement analysis
Through surveys of the needs of all target users, this paper takes stock of the detailed business requirements for standard-compliant vehicle model declaration, detailed as follows:

1. The system design shall meet the carmakers’ requirements for addition, modification, revocation and correction of standard-compliant vehicle model declaration and shall also meet the functional requirements for extension, change, correction and transfer to historical standard-compliant vehicle models for announced standard-compliant vehicle models, among others;
2. The system design shall meet the requirements of car testing agency users for filing of testing equipment and testing ground, entry, generation, modification or revocation of vehicle model testing reports, among others;
3. The system design shall meet the functional requirements of the reviewer users for preliminary examination, reexamination, approval and information feedback of the application package for standard-compliant vehicle models, among others;
4. The system design shall meet the functional requirements of system administrator users for system user authority management, tracking of standard-compliant vehicle model declaration process, reviewer assignment and system log management, among others;
5. The system design shall meet the requirements of industry administration users for data inquiry, statistics and analysis of standard-compliant vehicle model declarations, among others;
6. The completion and filing of materials related to standard-compliant vehicle models within the system shall meet the latest policy standards related to market access for standard-compliant vehicle models.

3. System design

3.1. System architecture design
1. Technical architecture of the system
The technical architecture of the system is shown in Figure 1, structured as five layers of infrastructure and three safeguard systems.

For the five-layer structure, the infrastructure layer mainly comprises server, storage, operating system and network; the data acquisition and transmission layer mainly comprise internet to realize network transmission of various data; the data layer provides deployment and storage of various information, data and various electronic documents generated by the system; the application layer comprises the production enterprise end, testing agency end, reviewing expert end and technical support end; the user layer serves as a channel for information exchange between the application system and users. The users of this system include the operators, declarers and managers of production enterprises, operators, declarers and managers of testing agencies, preliminary examination experts and reexamination experts and personnel of the technical support organization.

The three safeguard systems lay a foundation for future system extension and nationwide system interfacing. The information security safeguard system provides security support for this system and is intended to realize protection of various aspects of the system according to the stringent security policy and technical specifications for security. The operation and maintenance management safeguard system is an important safeguard for stable and sustainable development of the results of this system and helps ensure the successful implementation of the system from construction to operation and maintenance, safeguarding the long-term and stable operation and sustainable development of the road transport vehicle technical support service system.

The technical architecture of the SOA-based system is illustrated as follows:
3.2. System function design

The road transport vehicle technical support service system platform comprises four types of users, i.e., carmakers, car testing agencies, reviewers and system administrators. The system’s functional architecture design is illustrated in Figure 2:

1. Carmaker end

The carmaker end is mainly used by production enterprises to apply for standard-compliant vehicle model designation and supports them to track the status of application, comprising such functional modules as enterprise information management, vehicle model declaration management, publicity management, announcement management and system log.

2. Car testing agency end

The car testing agency end is mainly used to generate standard-compliant vehicle model testing reports, such as deemed report, parts and components report, actual measurement sub-report and overall report, comprising such functional modules as testing agency information management, filing management, report management and system log.

3. Business review end

The business review end is mainly used for review of the application package for standard-compliant vehicle models and covers the preliminary examination phase and reexamination phase, comprising such functional modules as preliminary examination of standard-compliant vehicle model and reexamination of standard-compliant vehicle model.
(4) System management end

The system management end is mainly used for assigning experts to review application packages for standard-compliant vehicle models, approval of standard-compliant vehicle models and publicity and announcement, comprising such functional modules as user management, system management, filing management, vehicle model declaration management, publicity management, announcement management and report management.

3.3. System process design

A carmaker fills out the application for market access of a standard-compliant vehicle model and enters the basic information about the standard-compliant vehicle model into the system, while a car testing agency submits the vehicle model testing report based on the vehicle model information in the system. The system administrator assigns the standard-compliant vehicle model review task to the reviewer for review. The review consists of preliminary examination and reexamination. The preliminary design of the standard-compliant vehicle model declaration and review process is shown in the following figure:

![Figure 3. System’s business process](image)

3.4. System security design

Security design of the system was conducted based on the system function design proposal and the system technical proposal, comprising access security, transmission security and storage security.

(1) Access security

Security control is required for information access in order to prevent access of unauthorized users, including reading, browsing, modification and other operations; capable of automatic recording, access records are required in the system for unauthorized access attempts; system users are controlled according to access level; rigorous control is required for data access between system equipment; prevents any unauthorized access.

(2) Transmission security

While designing the system, encryption technology was used to ensure the data security in network transmission, prevent the information from being tampered in the transmission process, ensure the information security in the transmission process and prevent the information from being stolen in the transmission process.

(3) Storage security
Storage security prevents information from being illegally copied by internal personnel or outsiders; it prevents information from being illegally tampered and artificially destroyed; it prevents information storage medium from being stolen; multiple encryption and management ensure that information is not normally available to the stealers even if stolen. Https protocol was adopted to ensure system security.

4. System development and implementation

The road transport vehicle technical support service system platform will be developed based on B/S (Browser/Server) architecture using proven Web browser technology in conjunction with many script languages of browser and ActiveX technology and by adopting the popular flat frontend technology to provide users with good user experience, while reducing the system development cost to a certain extent.

The system development test follows the principle of security, scalability and friendliness. Considering the characteristics of deepening transport system reform, the SOA-based system design is scalable so as to be able to conduct hardware expansion and software development and upgrading in the future on the basis of the existing system’s main program.

4.1. Application of cutting-edge technologies

1. Use of Docker container technology

Docker is an open-source container engine, with Docker container as the basic unit of resource division and scheduling for encapsulating the operating environment of software, a platform used to rapidly build, publish and operate the distributed applications. It has been widely applied [6-8]. Docker container technology was used in the system implementation to conduct continuous deployment and test, which is beneficial to environment standardization and version control and has realized high resource utilization and isolation.

2. Application of workflow technology

The traditional processing flow of system business is done manually and manually transferred to the next process, which obviously can hardly meet the requirements for flexible system management. The workflow technology can be effectively integrated into various application business systems [9,10] to achieve automation of business process and increase the management efficiency remarkably. Therefore, this system employs workflow technology to realize the dynamic configuration, adjustment and optimization of workflow, thus meeting the requirements for review of adjustment and change to business process.

3. Implementation of database connection pool

A large amount of data in the system is stored and managed via database, so frequent access to database is required in the system use process. Access to database through conventional methods requires creating database connection and closing the connection after use. For Web applications, if a large number of users frequently access database, the frequent creation and closure of database connection will significantly reduce the system performance, becoming the system bottleneck. The database connection pool technology provides an effective way to resolve such problems [11,12]. This system employs database connection pool to increase the performance and efficiency of database access, while ensuring effective development of standardized data interface in support of subsequent interfacing with other systems.

4.2. Selection and configuration of development environment

1. Unified development language

The system development shall meet the requirements for high reliability, operational stability, ease of use, easy extension, low cost of maintenance and good portability, therefore development language Java 1.8 was used for system development.

2. Basic database design
The current prevalent system development languages are SQL Server, Oracle, MySQL and Postgresql. Based on the data type and user requirements of this system, PostgreSQL database was used for system development.

5. Concluding remarks
Based on SOA as a system architecture oriented towards user service, after sufficiently analyzing the users’ functional requirements, this paper designed a road transport vehicle technical service system and realized various functions of the system using Docker container technology, workflow technology, database connection pool technology and other cutting-edge technologies.

The system has been put into use and effectively promoted the unified declaration of standard-compliant vehicle models. It has provided a good business platform and increased the work efficiency of users.

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