Research of Service Granularity Base on SOA in Railway Information Sharing Platform

Xie Zhengyu, Dong Baotian, and Wang Li
School of Traffic and Transportation, Beijing Jiaotong University, Beijing, China
Email: silinsherwin@126.com

Abstract—Service Oriented Architecture (SOA) is an approach for building distributed systems that deliver application functionality as a set of self-contained business-aligned services with well-defined and discoverable interfaces. It can use coarse-grained services as well as fine-grained services. Both of them have their advantages. In the backdrop of railway information sharing platform, we propose a division method to decide the appropriate level of service granularity. The proposed method divides the services into three parts: basic service, combination service, integrated process service. Each service has its scope and combination. An application example is used to illustrate the method.

Index Terms—railway information sharing platform, service granularity, SOA

I. INTRODUCTION

Service Oriented Architecture (SOA) is a promising architectural approach for designing, architecting and delivering loosely coupled integration where software capabilities are exposed as business-meaningful services. It promises effective business-IT alignment, improved business agility and reduced integration costs through increased interoperability and reuse of shared business services [1].

The application of SOA means using services to express the business processes and the functions. The size division of the service granularity directly affects the service quality which includes many aspects such as flexibility, efficiency. So it is important for service designers to choose the appropriate level of service granularity.

Unfortunately, there is no theory-founded method for deciding the correct level of service granularity. Many researches from academia and industry are suggesting various approaches to achieve service identification, service granularity definition and service realization.

One of the most influential approaches is IBM’s Service-Oriented Modeling and Architecture (SOMA) [2]. SOMA is a methodology for the identification, modeling and design of services that leverages existing systems. It consists of three steps: identification, specification and realization of services. It helps in the determination of services and components that realize them. However, SOMA lacks openly available detailed description of the methodology, which makes it difficult to further analyze its capabilities.

Abdelkarim Erradi, Srim Anand and Naveen Kulkarni [1] devise a SOA-specific framework to ease service identification, definition and realization. Their approach combines the top-down modeling of business processes (To-be model) with the bottom-up analysis of the existing applications portfolio (As-is Model). The methodology provides three guidelines for defining an acceptable level of service granularity. (1) Business-alignment: exposed business services need to add tangible business value and support a business use case. (2) Ease of composition: it is important that a service is defined in a way that its encapsulated functionality can be accessed and composed in different contexts with minimal effort so as to increase the service reuse potential. (3) Reduce ripple-effects of applications changes: services need to be self-contained and encapsulated in a way so that changes behind the interface can be done with minimal disruption to the service consumers.

In this paper, according to the characteristic of railway business process and railway information sharing platform, we divide the service granularity into three parts: basic service, combination service and integrated process service. We take the external consumers purchasing tickets as an example to show our division method.

The rest of the paper is organized as follows. Section 2 presents the details of the service granularity in SOA. Section 3 particularly describes the division of service granularity in railway information sharing platform and gives an example using this division method. Section 4 concludes the paper and provides some directions for future work.

II. THE SERVICE GRANULARITY IN SOA

Service granularity refers to the size of function which one service contains. According to the service’s function and the data volume of sending-receiving, we can divide the service into tow parts: fine-grained service and coarse grained service. The fine grained service offers small function units and exchanges a spot of data. We arrange plenty of fine grained services for accomplishing the complex business logic by service interactive application. Comparatively, the coarse grained service reduces the times of service interactive application. Because it encapsulates a lot of business and technology ability in an abstract interface. The coarse grained service leads the services become more complex and interact plenty of data. As a result of this, the service can not quickly adapt to the change of demand.

The characteristics of the fine-grained service and coarse grained service are shown in following table:

<table>
<thead>
<tr>
<th>Service Granularity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine-grained service</td>
<td>Small function units, exchanges a spot of data.</td>
</tr>
<tr>
<td>Coarse-grained service</td>
<td>More complex, interact plenty of data.</td>
</tr>
</tbody>
</table>
The division of service granularity depends on the intention of the software entities as following Fig. 1.

<table>
<thead>
<tr>
<th>The category of service granularity</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine grained service</td>
<td>Simple business logic, Small data volume, A number of service interactive times, A large coupling among services, Good flexibility</td>
</tr>
<tr>
<td>Coarse grained service</td>
<td>Complex business logic, Large data volume, A few service interactive times, A small coupling among services, Bad flexibility</td>
</tr>
</tbody>
</table>

The services design about the coarse-grained can reduce the coupling among services. But it enhances the complexity of services. If the service has overabundance functions, it can result in the increase of the design complexity and the maintenance difficulty. The fine-grained service can make services become simple. But lead to the increase of the service quantity. In these fine-grained services, some need combinations to achieve specific functions. The combinations increase coupling among services. So we must identify and design a moderate service granularity.

The following guidelines can help in defining an acceptable level of granularity:

- **Reusability**: Reusability is an ability which means services can apply to different environments. As the core of SOA, reusability can diminish the cost of exploitation and maintenance; shorten the cycle of application and delivery; promote the qualities. The division of the service granularity directly affects the reusability of services. Compare with the coarse-grained services, the fine-grained service is easier to be reused. It is more difficult for services to be reused when the service granularity become more coarse. Because more and more business rules and context information have been put into the business logic and the services become have specific business.

- **Flexibility**: Flexibility is an ability which means system can make change according to different circumstances. Flexibility can help system more rapidly adapt to the sustained changing business environment and betimes adjust for the change of business processes. The business logic of fine-grained services is simple and the data exchange volume is small. So the fine-grained services are easier to encapsulate and make the new business function consignation and the change of business processes more flexible. However, when we consider the flexibility, we should pay attention to the organization, efficiency and maintenance cost of backstage services. Plenty of fine-grained services can make the cost of system development become more expensive and make the maintenance be difficult. When we design moderate service granularity, we must synthetically weigh the flexibility and the adverse impact of the fine-grained services.  

- **Capability**: Service Granularity become more coarse means the services contain more functions, the business logic become more complex, the time of network delay increase and the response of client side become slow. However, service granularity become finer means the functions which services contain become simple, the execution efficiency of single service is high. But accomplishing one business task need increase the times of services invoking and the request response. The increase of the request response time means remarkable capability cost. In order to ensure the controllability of the service capability, we need not only confine the function extent and complexity of the services to make the service granularity not too coarse, but also confine the services invoking time and complexity to make the service granularity not too fine.

- **The scope of services application**: If the scope of services application is finite, for example only adapt to the scope of interior application, we can comparatively choose the fine-grained service to offer more flexibility to the service requesters. As the scope increasing, the size of service become large, for example adapt to the scope of exterior application cross systems. It need offer the coarse grained and steady service to ensure the service requesters use the exposed services of system in coincident way.

In addition to the above, there are other factors that may affect the decision of the services granularity, such as transactionality, consumability and visibility of the Service. What might at first seem to be a composite Service from the perspective of reusability might actually need to become atomic due to reasons of transactionality. Likewise, what might seem to be fine-grained for the purposes of visibility and auditing might become coarse-grained for reasons of efficiency.

Finally, we should know that the particle granularity of service in its life cycle is not static. It is adjusted with changes in business, as well as the iterative process of development services, refining evolving, and even remodeling.
A. The demand of Service Granularity division

Until to the 2008, nearly 40 railway information systems have already been used and several systems are under research and development. Each system has several functional modules and each module own many functions. When we build a public information sharing platform by integrating server resources of existing railway information systems, we need a division method to decide the appropriate level of service granularity.

B. The Service Granularity division method

In our method, we divide the services of system into three parts: basic service, combination service and integrated process service.

Basic service is the smallest granularity service which system can offer, that is, atomic services. It addresses a relatively small unit of functionality or exchanges a small amount of data. This kind of services has strong usability and can be combined into the coarse grained services.

Combination service is the simple combination of basic services. It puts the different business objects’ basic services which have same functions and different operations together and shapes a service which can offer same functions for exterior.

Integrated Process service is the biggest granularity service. It is the combination of basic services and work processes. It is one that abstracts larger chunks of capability within a single interaction. The basic services are not simply accumulated, but controlled by work processes.

In railway information sharing platform, the range and content of three services are shown in the Fig. 2:

![Figure 2: Scope and Combination of 3 type services.](image-url)

In the Fig. 2, we use the ellipses to represent railway information systems, the squares to represent the each system’s functional modules and the circle to represent basic functions which functional module contains.

Basic service: we define basic service as the basic function which belongs to information system’s functional module. As is shown in Fig. 2, basic functions point to the pentagrams which represent basic service.

Combination service: in Fig. 2, we use pentagons to represent. There are three combining forms of combination service. The first form is shown as pentagon. It is pointed by one functional module. Each functional module contains several basic services to achieve specific functions and operations, so each system functional module can be defined as combination service. The Second form is the combination among different basic services which come from different system functional modules just like the representation of pentagon[I]. The third form is the combination among basic services which come from the same system but different functional modules just like the representation pentagon[I].

Integrated Process service: in Fig. 2, we use triangles to represent. Integrated Process service has four combining forms. The first form is the combination of functional modules which come from the same system just like the representation of triangle I. The second form is combination of functional modules which come from the different system just like the representation of triangle II. The third form is the combination of functional modules and basic functions form different systems just like the representation of triangle III. The fourth form is the combination of functional modules and basic functions form one system just like the representation of triangle IV.

When we need define a service in railway information sharing platform, we can use our division method to find an appropriate service granularity. Firstly, we should locate all the information systems which may correlate with the service. Secondly, determine each system’s functional modules and basic functions. Finally, according to the service need, find an appropriate combination by using our division method.

C. An application example

The external consumers purchasing tickets service is designed for common consumers. They can use this service to achieve train information query, station information query, originating station information query, destination information query, remaining amount of tickets query, fare information query, online booking and payment in railway information sharing platform.

Firstly, according to the functions of the service, we can locate tow railway information systems: ticket system [5] and financial accounting management information system [6]. The relationship between the service’s functions and system is shown in Fig. 3:

![Figure 3. Relationship between service’s functions and systems.](image-url)
As is shown in Fig. 4, ticket system is composed by four functional modules. (1) Ticket subsystem: this part can offer basic data information, such as railway network information, train service information, station information, ticket window information, etc. (2) Ticket kernel: this section base on the railway network information and train information. It can offer passenger transport plan, scheduling order, ticket amount adjustment information, passenger reservation information, fare information, etc.(3) Ticket business subsystem: this part use trade information of passenger purchasing, booking and returning operation to product the bill of ticket order and booking. Basing on the trade information, this part can provide passenger transport statistical data, ticket selling statistical data and a basis for the analysis of passenger transport marking. (4) Ticket extending system: this section is the extending of other functional modules which is mentioned above. This part can provide payment transaction information and electronic transaction information. All of ticket system’s functional modules have connection with the external consumers purchasing tickets service.

Financial accounting management information system is composed by seven functional modules. The modules include accounting calculation, capital management, revenue management, cost management, financial analysis, capital regulation and transport liquidation. Each module has many subsystems to achieve special functions. In these functional modules and subsystems, revenue management module and transport liquidation module have connection with the external consumers purchasing tickets service. In Fig. 5, we can see the basic function subsystems which are included in these modules.

Finally, basic functions and subsystems which are included in each system’s functional modules are defined as basic services. The functional modules are defined as combination services. According to the analysis above, we can define tow integrated process services. As is shown in Fig. 6, they are consumers’ information query service and online booking service.

The consumers’ information query service is the combination of five basic services and one combination service. The five basic services include ticket subsystem’s train information query, station information query, originating station information query, destination information query and Ticket kernel’s fare information query. The combination service is the remaining amount of tickets query. It is the combination of ticket kernel’s ticket amount adjustment information, passenger reservation information and ticket business subsystem’s ticket order bill, ticket booking bill.

The online booking service is the combination of two basic services and two combination services. The two basic services are the ticket extending system’s payment transaction information and electronic transaction information. The two combination services are the revenue management module and transport liquidation module which are from the Financial accounting management information system.

Through the combination of services, the consumers’ requirements can be appropriately met. The division fully meets the need of service’s reusability, flexibility, capability, application scope.

IV. CONCLUSION

In this paper, we propose a division method to decide the appropriate level of service granularity in railway information sharing platform. Through the analysis of the information system, functional module and basic function, the structure and relationship of systems are clearly shown. We can easily choose appropriate services to combine by using our method. Our design is in the backdrop of railway information sharing platform. Because the railway information systems have been operated for several years and the description of the systems’ structure, functional modules, basic functions is...
particular and comprehensive, it is easy for us to use these materials to locate services and combine services. In other industry and field, the usability and adaptability of our method remains to be proven. This will be our future study direction.

ACKNOWLEDGMENT

This work was supported by the Project of Railway Information Sharing Platform, Ministry of Railways and Beijing Jiaotong University in 2009.

REFERENCES


