System Wide Information Management Architecture Designing

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Abstract. As an important technical support platform of the next generation air traffic management concepts, Civil Aviation Wide Information Management System is responsible for providing various types of interactive information to relative business departments. This paper took SOA approach to analyze and design the function architecture of SWIM. And focused on the different technical approaches and deploying integration levels, it analyzed two kinds of SWIM technical architecture selections. This paper is funded by the National Science and Technology Supporting Program "Civil Aviation Wide Information Management Technology and Platform" (No. 2011BAH24B07) Project.

Introduction

As we all known that flight operation is a very complex process. It is related to the information and data sharing and exchanging among those business systems of the airlines, airports, air traffic management department and other departments. In order to achieve this goal, the applications of civil aviation need to migrate into a loosely coupling and web-centric computing environment. Thus, they share the flight, flow management (TFM), aeronautical information and meteorology data with a safe and easy management way. Then owners of these applications can lower their costs and risks by providing services. And the life cycle and value of these applications can be improved through reusing. For those purposes, System Wide Information Management (SWIM) [1,2,5] was designed out. It could provide the information sharing, exchanging and managing services among the different business systems of the civil aviation.

Functional Structure Designing

In terms of the functional architecture, SWIM services could be divided into the following kinds: SWIM Core Service, Business Service, SWIM Support Service, and Technical Infrastructure Service.

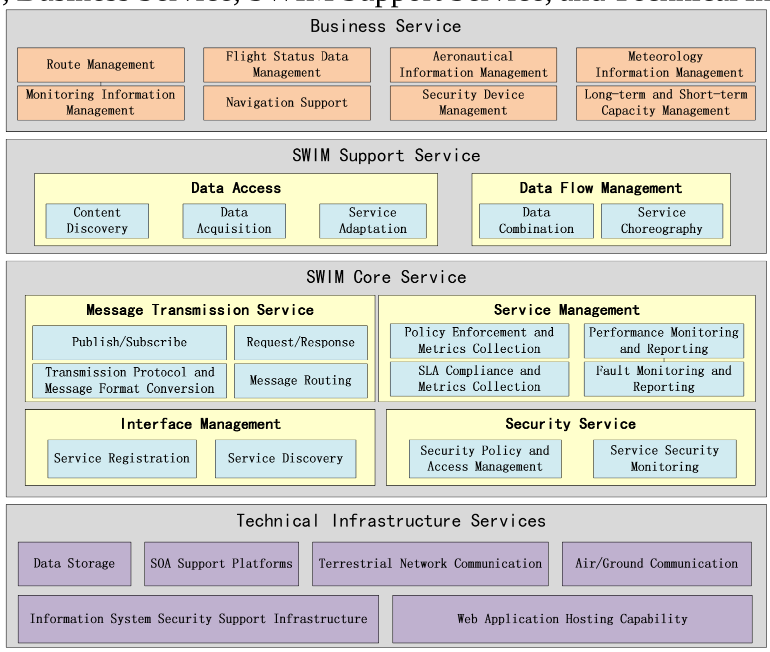

Fig1. SWIM Functional Architecture

SWIM Core Service

SWIM Core Service is composed of the message transmission service, enterprise service management, interface management and security service, etc.

Message transmission service: It includes some general services. They are used to provide communication and safety message transmission. Including: a) Publish/Subscribe: Service publisher will send a message to the transmission channel. This message will be copied. And then, it will be sent to each consumer who subscribed the message in this transmission channel. b) Request/Response: The requester sends a request to a service provider, and then receives a response from this provider. c) Message Routing: It provides the static routing and dynamic routing that based on message content and context. d) Transmission Protocol and Message Format Conversion: It is used to achieve the modulation and conversion of the different data models, format and transmission protocol among the different participants.

Interface Management Service: The core function of Interface Management Service is to ensure that the service providers can release their service information, and the service consumers can discover the published information. The information includes: the published and consumed service, definition of the syntax and semantics of data, the information of different versions of service and data schemas, and the information of Service Level Agreement (SLA), etc. In addition to the basic publication and discovery functions, user registration and subscription for notification are also associated supporting functionalities.

Service Management: Service Management is the synthetically monitoring and management capabilities when the service is running. It includes: service exception, fault monitoring and reporting, service performance monitoring and reporting, SLA compliance and metrics collection monitoring, as well as service policy performance monitoring and metrics monitoring, etc.

Security Service: It includes the following functions: security policy execution, service access and management, and security service monitoring. An example, when accessing service and data resources, it needs to follow the safety management measures which are based on authentication of the accessing entities, organization roles or other attributes.

Business Service

Business Service provides the function for accessing the essential information and resources in daily operation, including route information, meteorology information, navigation information, flight status, and aeronautical information. Information provided by these services is mainly shared by the current or the next generation business systems. These systems will follow SWIM standards, and use the core services and the support services provided by SWIM.

SWIM Support Service

SWIM Support Service provides the information management functions to the upper business service. They can be used to extract, combine and transfer information from business, and ensure that the information can be transmitted to the correct consumer. These functions need to be dependent on the support of the underlying SWIM core services, such as the publish/subscribe transmission mechanism, route based on content, etc.

Technical Infrastructure Service

Technical Infrastructure Service includes IT and ISS (Information system security) infrastructure service. These services are the basis of the communication and interaction between SWIM and civil aviation business systems. It includes the following functions: terrestrial network communication services and air/ground communication services, data storage, computing platform service, web service[3] hosting capability, boundary protection, information system security support Infrastructure, etc.

Analysis and comparison of alternative technical framework

Considered from the technical approaches SWIM took and the deployment of integration extent, this paper discussed the following two architectures of SWIM: a) Basic transmission architecture based on Message-Oriented Middleware, b) Core architecture based on ESB.

The relationship of the two architectures above is incremental in technical complexity and the integration and centralized management. For the SWIM system realization, we can firstly choose the relatively simple architecture - basic transmission architecture based on Message-Oriented Middleware. With the gradual progressed system realization and improved management solutions, we can evolve this architecture into the core architecture based on ESB. Now, we could discuss the framework of these two architectures as well as their advantages and disadvantages, respectively:

Basic Transmission Architecture Based On Message-Oriented Middleware

This architecture is based on the technology of Message-Oriented Middleware and Web Services Framework. It provides a unified SWIM core service platform to achieve message transmission backbone, and some basic support operation to manage message-oriented middleware agents and their related applications. At the same time, it also provides the service register and enterprise service management functions on the core service platform. This architecture only realizes a basic identity and password authentication management function. In addition, it is not guaranteed to provide a unified support of all levels of civil aviation applications. Each business system connected to SWIM core service just needs to follow the provisions of the service interface to connect to this service, and achieves the service message transmission function in SWIM platform.

Advantages: firstly, it provides a unified basic message transmission backbone in SWIM core service. Some message-oriented middleware and WSF framework may provide MQ Bridge or WS Bridge to achieve transparent service address and service participants decoupling. Secondly, since this architecture only takes message-oriented middleware and Web Services framework, the technical difficulty and the development costs and risks are relatively lower.

Disadvantages: firstly, SWIM core service platform does not provide functions completely for all levels in SWIM Functional Architecture. And it cannot provide a unified Support Services. Secondly, Enterprise Service Management can only provide limited unified management capabilities. Due to the absence of a unified container management, all aspects of this management may be difficult to achieve automatic synchronization management and operation of management information.

The network deployment architecture diagram of this architecture is shown below:

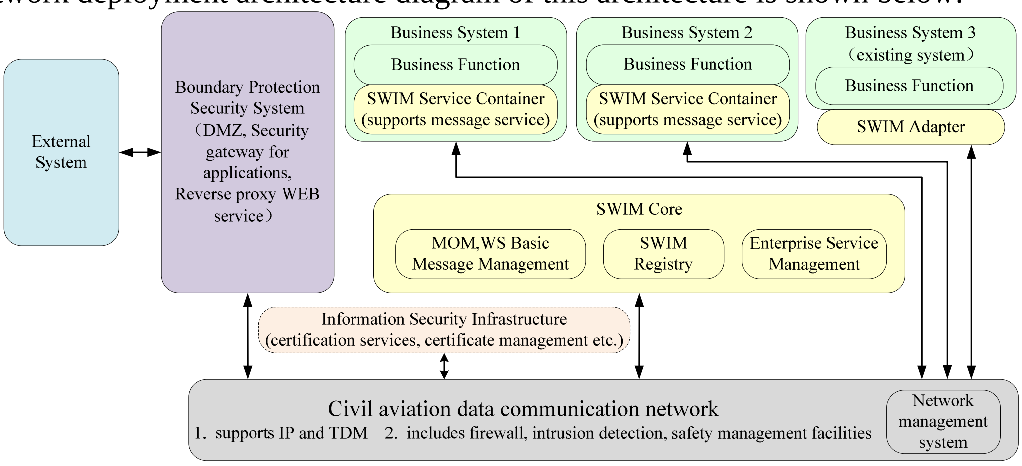

Fig2. Basic Transmission Architecture Based on Message-Oriented Middleware

Core Architecture Based On ESB

This architecture uses ESB product to achieve the SWIM core service, and build a unified SWIM core service platform. It will be able to provide the message transmission, support service of SWIM function architecture, as well as service registration, enterprise service management and unified integration management. In this case, it can help to construct a new service through the support service. And the enterprise service management function can synchronize and unified manage the service registration and runtime service positioning. We can also provide better monitoring functions for fault and performance, and security management functions such as centralized identity and password management, identity authentication, authorization decision, etc. However, the complexity and integration level of this architecture will have a great relationship with the advanced management capabilities of ESB product used by SWIM core service.

Advantages: it can better decouple the service for each application connected to SWIM. It can support the rapid development and deploy new information service. Especially, it can better help to enhance the interconnection interoperability for the next generation of civil aviation business systems. By providing a unified security management and operational maintenance management function, it can effectively enhance the security and operational management level of the SWIM platform, and help to enhance the fast positioning ability and the problem solving ability.

Disadvantages: its technical difficulty and risks are relatively higher, and also its development cost. But in terms of the long-term development of the civil aviation business systems, its development cost is gradually decreased.

The network deployment architecture diagram of this architecture is shown below:

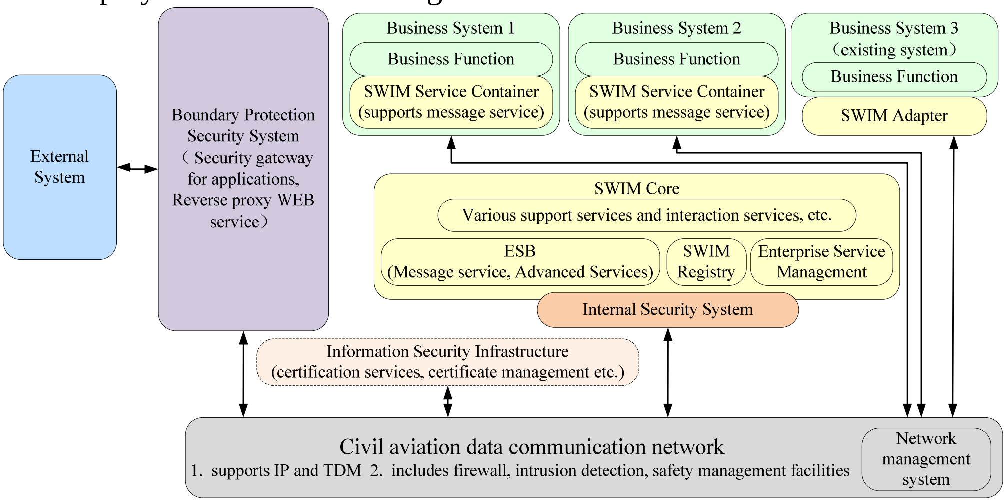

Fig3. Core Architecture Based On ESB

Conclusion

Based on the design of the function architecture of Civil Aviation Wide Information Management System, as well as the analysis and comparison of the three alternative technical architectures, this paper determined the functions SWIM system needed to achieve and the technical architecture SWIM system took. This laid the foundation for the realization of SWIM. Since SWIM system needs to improve and upgrade with the development requirements of the civil aviation business, and the technologies and standards of SWIM are also in progress and development, SWIM system will also be a system evolved and perfected continuously. The architecture model based on SOA [4] approach in this paper provides a good foundation platform for the future improvement and perfection of SWIM system.

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