Study on Aeronautical Information Data Domain for SWIM

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Summary
In order to solve problems that existing aeronautical telecommunication network has, SWIM (System Wide Information Manager) is conducting a study focusing on world's leading aeronautical countries including U.S. and Europe. In Korea, SWIM local server was proposed by using SWIM network architecture that is based on Enterprise service bus. This paper describes the AID that processes the aeronautical data as one of proposed SWIM local server functions and proposes the data that needs to be processed as well as adaptable AID for proposed SWIM local server with requirements satisfied.

Key words:
SWIM, AXIM, AICM, AID

1. Introduction

The existing aeronautical telecommunication network uses the system individually as the network is configured with point-to-point method by aviation stakeholder. The data is inefficient and there are many problems including having a limited actions that can be taken upon special cases and difficult service application due to the absence of standard data format. That is why U.S. and Europe are conducting a study for SWIM(System Wide Information Management) that can provide the data for flights and airports with all aeronautical telecommunication network integrated quickly and accurately. [1, 2, 3, 4, 5, 6].

In Korea, we are proposing SWIM local server using SWIM network architecture based on Enterprise service bus and developing a test-bed[7].

Thus this paper proposes the design of AID, one of several domains in SWIM local server that was proposed previously. SWIM should be designed following the requirements because the goal to develop and use the interface to make a simple management and access. Also the aeronautical information and related data exchange model uses AIXM(Aeronautical Information Exchange Model) as an international data exchange model[1].

Therefore AID of SWIM local server that is proposed should be designed using AIXM.

The following is the composition of this paper. The chapter 2 describes the existing study of SWIM, chapter 3 describes the requirement of AID and contents of data that needs to be processed, chapter 4 describes AID composition and procedure as well as interface and chapter 5 contains a conclusion.

2. SWIM Related Research

2.1 SWIM

ASBU (Aviation System Block Upgrade) is made in the 37th session (2010) of the general meeting of ICAO (International Civil Aviation Organization) for the purpose of stability. ASBU is a solution for an improvement of system performance and it consists of 4 PIA(Performance Information Area) as it is shown in Fig. 1. PIA is composed of 4 blocks of 5 years/unit and it includes detailed contents of international interoperability system and data as it is shown in Fig. 2. SWIM, the Aeronautical Data Management Network is a research content that is related to B1-31 of block 1. In the future ATM environment that ICAO is hoping to construct includes the information of SWIM basis of PIA 2 [8, 9, 10].

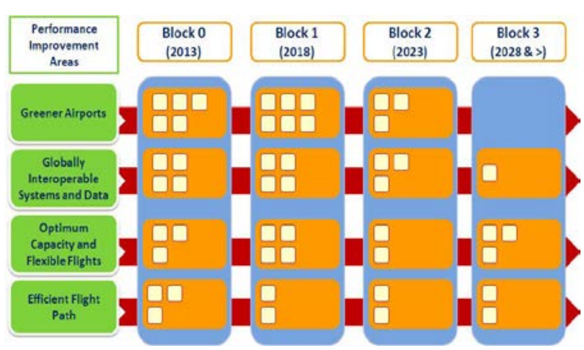

Fig. 1 Introduction of ASBU

Manuscript received August 5, 2015
Manuscript revised August 20, 2015

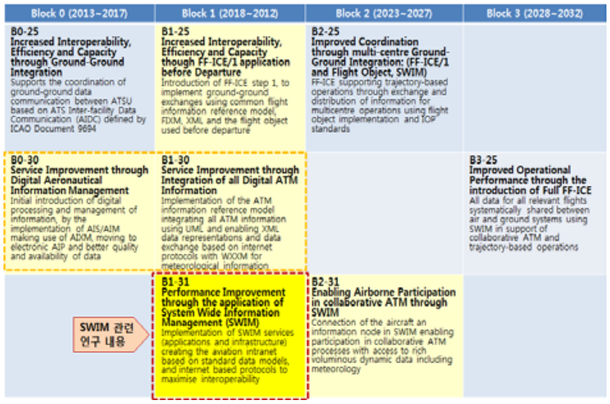

Fig. 2 Detail Contents of ASBU PIA2

The existing aeronautical telecommunication network is physically connected and operated through a dedicated international line of point-to-point method of aviation stakeholders. By using an individual system of each facilities, a compatibility and security of network becomes difficult and delays are arisen for aviation data management and synchronization. Therefore s SWIM technology is being studied to upgrade an aeronautical telecommunication network into the data integrated network to provide the data that are being used for flights and airport quickly and accurately [2, 8, 9].

SWIM can be defined as a technology that integrates several aeronautical telecommunication networks using the internet protocol as it is shown in Fig. 3. This SWIM technology utilizes a new information interchange model with SOA (Service Oriented Architecture) for the management and exchange of aeronautical data. The utilized service for SOA is an activity that is provided by an interface contract between components, therefore it provides a frame work that connects a service provider and user effectively. By using SOA, the service user can search for necessary data for business process activity through a single application. Also SWIM converts the existing voice and text base data into different formats and uses them. These information interchange models allow aeronautical information of several formats to be processed efficiently and quickly [11, 12].

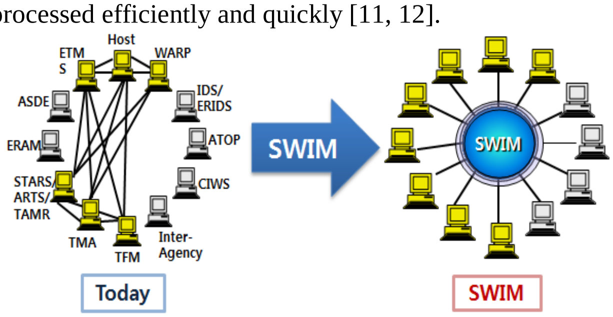

Fig. 3 Improvement of the Aviation Communications Network which SWIM Implementation

Therefore the SWIM technology where SOA is applied is operated as a message sending system in internet protocol network as it is shown in Fig. 4. Also any data provider or user can use aeronautical data if standard data interchange format is used. The standard data interchange format in SWIM includes AIXM(Aeronautical Information Exchange Model), aeronautical data, FIXM(Flight Information Exchange Model), a format for aeronautical data and WXXM(Weather Exchange Model), data format for weather information.

SWIM can reduce the cost of aeronautical telecommunication network development and provide a service through a connection of new application by using an open and standardized interface. Also it makes a reuse of information and connection to other system possible through a standardizing of service.

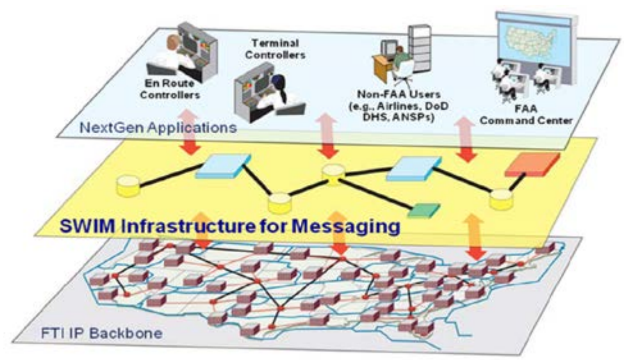

Fig. 4 Concept Diagram of SWIM

2.2. SWIM Local Server

Currently, the SOA architecture of SWIM complying the considerable characteristics and requirement for SWIM is being studied. SWIM network architecture that uses the proposed Enterprise Service Bus is shown in Fig. 5. [7] The inside of SOA architecture divides the data and service that were provided by the existing operating system into small units and connects to Enterprise Service Bus. Thus Enterprise Service Bus manages the functions of service integration, user verification/security and etc. Only unit functions can perform aviation related information service, therefore it is possible to construct in the simplest format and in a distributing architecture. Also depending on the Enterprise Service Bus, a reuse of aviation related information service and flexible configuration can be possible [7].

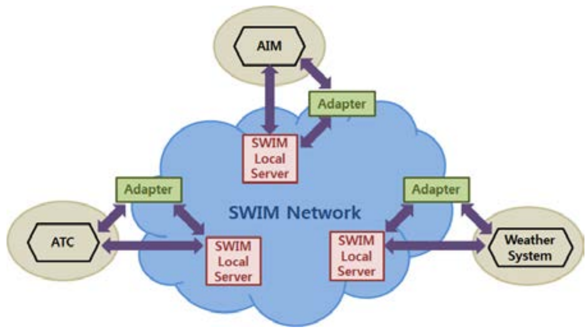

Fig. 5 Proposed SWIM Network Structure

Also SWIM local serves is used for the interface in proposed SWIM network and it is shown in Fig. 6 [7]. SOA telecommunication module is composed of internal modules from SWIM local server and these configure SOA telecommunication modules organically and perform functions related to SOA telecommunication [2, 7].

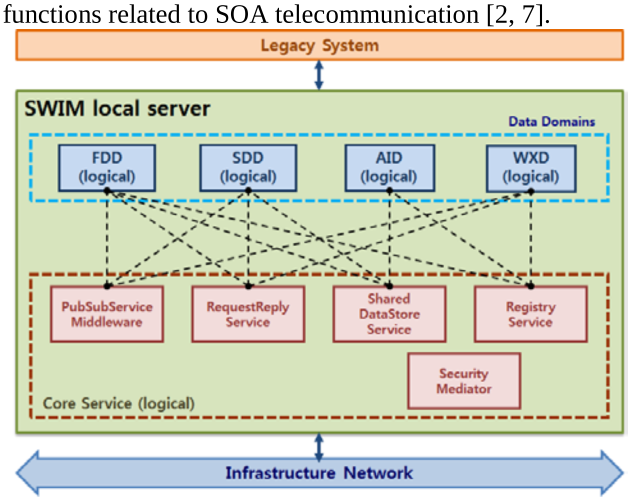

Fig. 6 Existing SWIM Local Server

This paper proposes Aeronautical Information Data Domain that is responsible for aeronautical information management as it is shown in Fig. 7.

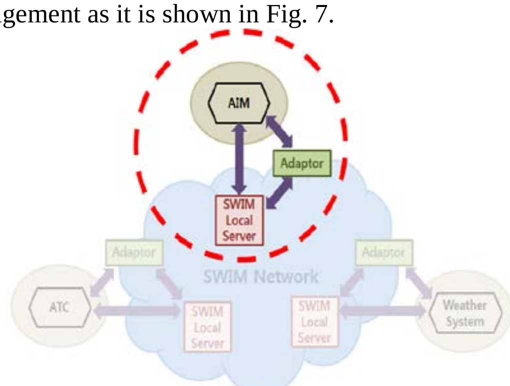

Fig. 7 AIM of SWIM Network Structure

3. AID Requirement

3.1. Requirement of AID(Aeronautical Information Data Domain)

SWIM integrates existing systems that are in operation and constructs an interface in order to make an access and management simple. The followings are the considerations. Firstly, since SWIM and Legacy System are synchronized, it must be possible to implement Legacy System without any separate modification. Secondly, in order to secure a normal operation of aviation system, the level of safety and security must be assured. Thirdly, no limitation for connected service of SWIM middleware can be a major problem for system extension.

The followings are the requirements of AID that deals with aeronautical data of SWIM. Firstly, the registration/ cancellation of aeronautical information service must be implemented. Thirdly, aeronautical information service provider must register the newest service information in registry. Fourthly, a function that allows aeronautical information service consumer to search through a registry must be implemented.

3.2. AID Processing Domain

AID utilizes AIXM 5.1 for processing data that are related to aviation. The data is composed of aerodrome data, topography/obstruction data, aircraft data, airspace data and navigation safety facility data.

The aerodrome data includes the location/structure and plan of aerodrome according to the time. The structure of aerodrome is data that represents an overall structure of aerodrome and it includes runway, taxiway, apron structure, service road and terminal building. For the location of aerodrome, it shows 3-D location and form information of each part that are included in the aerodrome location. The aerodrome configuration and plan data include long-term, short-term, current status and tomorrow's data. Aircraft capacity plan is expressed as runway, taxiway, and stand capacity value. Aside from this, the connection that shows connecting parts between aerodromes, aerodrome lights that light up the inside of aerodrome facility, aerodrome data that shows the surface of aerodrome are included in the aerodrome data.

Topography/obstruction data is the data that shows the information of topography and obstruction. Topography shows topography information related to ATM according to the agreed level of accuracy on space, class and time. Mountains, hills, ridges, valleys, waterway, firn-ice are excluded. For the obstructions, it describes a temporary or permanent obstruction that get in a way of movement of aircraft and helicopter. The obstruction data includes location, form, and light and indicator information.

Aircraft data includes model, standard performance, technology, equipment, symbol, verification of environment. The model of aircraft includes wake vortex categories, weight and size information. The standard performance that is shown for each model is marked in a aircraft model and performance data and maximum/minimum levels are provided. The aircraft technology represents the information of individual aircraft and also a registration number, A/C model, 24-bit address.

In case of aircraft equipment, a telecommunication, navigation, surveillance and ATM capability are marked. The aircraft symbol can be different depending on the manufacturer of aircraft and the symbols are configured upon take-off, cruising and landing status. For the aircraft environment verification data, every information about aircraft environment is included as well as engine exhaust and aircraft noise.

Airspace data represents airway, airspace capacity, airspace sectorization and airspace definition and includes a plan for each item. For the airway, a structure, form, stopover structure for expressing a complete route system, terminal procedure, SID(Standard Instrument Departure), and STAR(Standard Arrival Route).

The airspace capacity displays a capacity of configurating sector and capacity of aircraft located in the airspace. The technology and setting for sector name, location and frequency are displayed by using airspace sectorized data. Aside from this, FIR, management history and geography are expressed by airspace definition data. For the airspace capacity and airspace sectorization, the changes that appear by time is expressed though an air space capacity plan, airspace sectorization plan of each airspace. Also when the assignment of civil and military are switched due to the time, it is expressed with airspace availability plan data. Aside from this, availability plan for every altitude can be expressed by using an airway availability plan.

The navigation safety facility data includes approach lighting system, DME, TACAN, NDB, VOR, Marker and etc. that are necessary for navigation safety.

The data of Navigation Safety Facility expresses the defining point that defines the flying airway and reference point that represents the location of aerodrome or heliport as a defining point/reference point. Also the data that shows the structure, location and status of approach lighting system, DME, ILS, TACAN, NDB, VOR, and Marker. Aside from this, configuration plan data that represents the configuration of each system, Beacon monitoring plan, navigation system item that represents the navigation system. Item that represents the navigation system.

3.3. AXIM

AID(Aeroneutical Information Service Domain) has a role of exchanging aviation safety and regulation information such as x-NOTAM, e-AIP and PIB. The data that AID processes are aerodrome, geography and obstruction airport, aircraft, airspace and navigation safety facility that were explained in 3.2.

This data implements with the data from previously constructed Legacy System or shares the data that is changed through NOTAM. The aviation related data standard uses the AIXM that was decided after 36th ICAO assembly in 2007.

In order to show related information by using geographical information, WMS(Web Map Service) and WFS(Web Feature Service) are used. The goal of AIXM is to convert a paper type of aviation information into a digital data. The current version is AIXM 5.1[13].

AIXM encodes and distributes aeronautical information digitally using an actual published aeronautical information and data for supporting 15 international flights. The other standards and best performance history or unofficial requirements are also considered.

AIXM is composed of e-AIP(e-Aeronautical information Publication), xNOTAM(Notice to Airmen), PIB(Pre-Flignt Notice Bulletin), AMDB(Aerodrome Map data mase) and eTOD(e-Terrain and Obstacle Data). e-AIP is a publication of aviation information that is permanent which is necessary for an air-navigation. Our country has completed digitalizing e-AIP in 2010. xNOTAM is an information that aeronautical staff must know and it includes aeronautical facility, task procedure, failure situation and changes of all these. xNOTAM was constructed and has been operating since 2011. PIB is a presentation of valid NOTAM that is important during the operation. This is written before flying. It is composed of PIB related to airport facility or service, PIB related to facility or procedure regarding the region, route PIB regarding the aeronautical information area and narrow route PIB for narrow routes. Our country has completed the construction in 2012 and it is under the test operation. Aside from this, there is ADMDB which is a aerodrome map database as well as a data called eTOD which is for landmark and obstructions [2, 8, 9, 13].

This AXIM model is composed as a concept model (AICM) and AXIM schema which is a data encoding specification [14].

Table 1: AIXM Structure

Cat.	Item	Content	Remark
AXIM 5.1	AICM	Directory Structure	Tree structure for arrange of Aeronautical Information Data
		UML	Program language for providing of Aeronautical Information Data
		Web View	
		XML	Developed program language for Aeronautical Information Data exchange among each country
	AIXM SML Schema	XML Sample	
		XSD	XML Schema Definition
		Annotated XSD	
	Publication	Schema Generation	
		XSD mappng	

AICM is a necessary model for system development or database development and it is composed of directory structure, UML, Web View and XML as it is shown in Fig. 8. If AICM is utilized, aeronautical information that was programmed as UML is provided through directory structure. XML is used when aeronautical information is interchanged between countries.

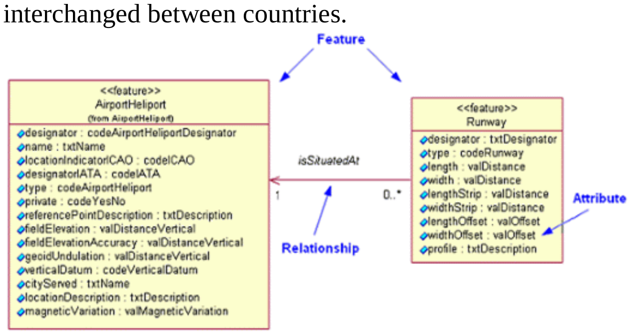

Fig. 8 AICM Block Diagram

AXIM schema structure is encoded in an aviation information related data standard format. This schema is made by mapping feature, attribute, business rule and etc. of AICM as XML. In Fig. 9, the diagram shows how a runway is displayed as AIXM XML shema and feature is wrapped as RunwayTimeSlice and the inside is composed of attributes. AIXM XML is used for AIP automatic publication, automatic flight chart generation and publication system, integrated NOTAMs and AMDB related application.

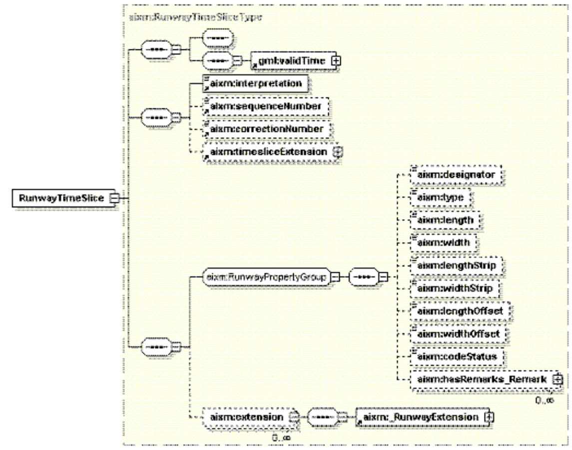

Fig. 9 XML Schema Example

4. Proposed AID

4.1. Interface between AID and Adapter

Fig. 10 shows the interface between AIXM Adapter and AID in SWIM local server. The interface is composed of Registry subsystem, Security subsystem and Req/Res service. Registry subsystem decides whether the service including message security is going to be called through local or remote interface. The Adapter can achieve available AIS service information when using the service lookup function of Registry. The security subsystem manages the signature and password of policy. The message is sent using Req/Res service and aeronautical data is queried through AID Basic Service interface.

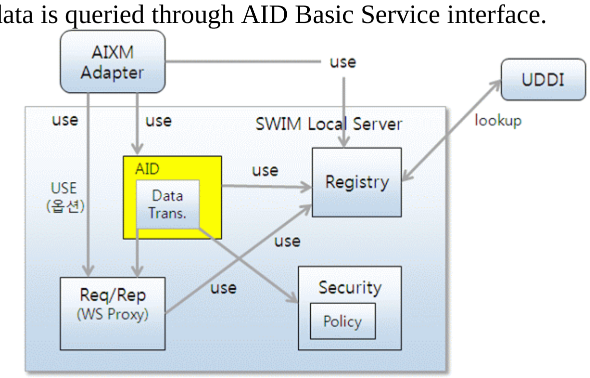

Fig. 10 AIXM Adapter and SWIM Local Server Interface

4.2. Adapter and Legacy System Interface

Fig. 11 shows the interface between AXIM Adapter and Legacy System. From the Lagacy System, AIXM data in Local or Remote is requested to AIXM Adapter or the result is received from AIXM Adapter.

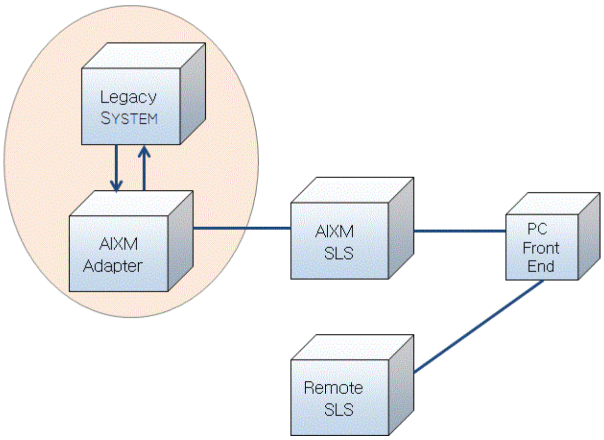

Fig. 11 AIXM Adapter and Legacy System Interface

4.3. AID Function

Fig. 12 is a sequence diagram that shows procedures of AID service request and provision process. The aeronautical information Domain (AID) provides read-only information service such as SDO Queries, reports, basic web feature service. The general interaction pattern is request/response. Request/response pattern is sometimes called request/response. As it is shown in Fig. 12, the service is not notified to the service provider directly but through AID in SWIM Local Server.

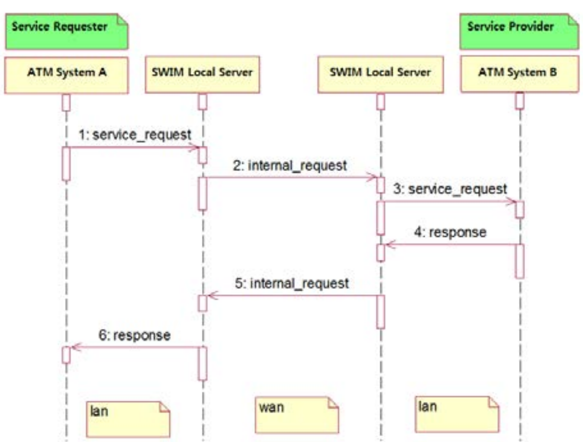

Fig. 12 AID request/response pattern

Table. 2 show the function of service request and provision. The advantage of this type of approach method is that the data is encoded and compressed by wan and sent. The message routing solution is necessary since the service does not notify the provider directly. The message routing relies on registry subsystem. The service provider registers all the supportable service from SWIM node to SWIM local server of approachable registry that is containing information of final destination. The service consumer can assign service end point to route service provider. In case the endpoint is not known, queries can be made to the registry. The example of making a query to registry is shown in the Figure 'AID Request/Response Pattern that calls Registry Service'.

Table 2: AID Function

No.	Function
1	Request Data at SLS by Requester
2	Request Data at Provider SLS
3	Internal Response by Provider ATM SLS
4	Response Requester SLS data by Provider SLS
5	Response to Requester SLS by Provider SLS
6	Response Requester ATM by Requester SLS

AID data, a function that takes the data from other Legacy System and implement must be developed in the future and this function will be defined as it is shown in Table. 3.

Table 3: Report and WFS Function

No.	Function
1	Publish Report of aeronautical information
2	Check AIS Data by selection standard
3	Make Graph or Drawing of AIS Data using Basic Web Feature Service

Conclusion

This paper explained about SWIM, which is a solution for the existing aeronautical telecommunication network. This paper also proposed Aeronautical Information Data Domain that is responsible for aeronautical information management which is a function of previously proposed SWIM local server.

When the development of function where AID data takes a data from other Legacy System and implement is completed, the proposed AID is expected is implemented as a system that processes aeronautical information in SWIM local server which is being developed. Therefore various information can be utilized at low cost and this will strengthen the aeronautical information interacting capability between countries. Also by using a data exchange model of open format and standardized interface, the cost of development will be reduced which will allow new service developments.

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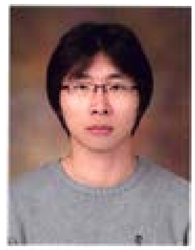

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