International Civil Aviation Organization

The Sixth Meeting of System Wide Information Management Task Force (SWIM TF/6)

Video Tele-conference (VTC), 17 – 20 May 2022

Agenda Item 4: Updates on the assigned tasks by task leads/contributors, including progress report and issues

b) SWIM Infrastructure

- Task 2: Regional SWIM Infrastructure

SWIM-TI Interface Binding to Achieve Interoperability

(Presented by JAPAN/ENRI)

SUMMARY

This paper clarifies the required indicators for IP-based network that should be considered to construct the APAC regional SWIM and the current capabilities of Common aeRonautical Virtual Private Network (CRV) that can provided to support the regional SWIM implementation at the beginning of the shift. During the transition to a global SWIM environment, the interoperability between legacy and SWIM-enabled systems is required by different operations. Moreover, the flexibility of a wide variety of information utilization is required by different applications. To satisfy these different requirements, this paper presents an interface binding approach for SWIM Technical Infrastructure to achieve both operational interoperability and applicational flexibility by considering the CRV based regional SWIM implementation.

1. INTRODUCTION

1.1 During the transition to a global SWIM environment, legacy systems and SWIM-enabled systems will have to coexist for a longer period of time. To assure the interoperability, SWIM-enabled system is required to implement information services not only according to SWIM but also supporting the legacy systems. This is especially important during the transition period, because a legacy system may not have the capability to adapt to the new approaches introduced by SWIM. As the legacy AFTN/AMHS is used by nearly all member states, it is necessary for the SWIM Technical Infrastructure (TI) to support the message transport between the SWIM-enabled systems and AFTN/AMHS using legacy systems.

1.2 Currently, in the APAC region, a Common aeRonautical Virtual Private Network (CRV) that is IP-based VPN using a private commercial network to provide service for the exchange of AMHS data and potentially other types of data has been constructed. In addition, as a strong candidate to provide the network connectivity service for SWIM, how to support regional SWIM implementation

has been discussed at meetings of the CRV OG. Furthermore, some SWIM based solutions and SWIM-enabled applications have been proposed by the service provider of CRV.

1.3 The main objective of SWIM is not only to enable seamless information sharing among the multiple stakeholders in the ATM domain but also to achieve interoperability and harmonization of global operation in the air transportation field. Therefore, as the backbone for ATM modernization by delivering the right information to the right decision-maker at the right time and location, the high-capacity IP-based network is needed. Moreover, the implementation of SWIM has also opened the door for a variety of new, non-traditional aviation information sharing partners, seeking to introduce innovative solutions using data and information that became available after applying SWIM. Therefore, both operational interoperability and applicational flexibility should be considered for the development and implementation of regional SWIM. The required indicators for IP-based network that should be considered to construct the regional SWIM and the current capabilities of CRV that can provided to support the regional SWIM implementation are shown in Table 1.

Table 1. Requirements of SWIM and Capabilities of CRV

Indicator	SWIM Requirement	CRV Capability
Performance	High-speed IP network connection with large bandwidth and low latency for various kinds and a large mass of information exchange among SWIM-enabled systems	Limited bandwidth to support conventional message exchange and operation
Accessibility	Open and easy connected platform not only for traditional aviation partners but also for multiple non-aviation enterprises for the initial development of SWIM	Decided Air Navigation Service Providers (ANSPs)
Connectivity	Cross-border network connections not only for other SWIM-enabled systems in the APAC region but also to other SWIM platforms that have been deployed in other ICAO regions	The connection of other SWIM-enabled systems is not supported
Cost	Reduced cost for conventional message exchange, and low cost or free of cost for SWIM information exchange and sharing	The cost for SWIM information exchange is not clarified according to needs, benefits and affordability

1.4 As the CRV has been applied for current legacy system upgraded to IP-based network, it is necessary to be considered by SWIM solutions for achieving the interoperability. However, as shown in Table 1, the current capabilities of CRV are not sufficient to meet the requirement of SWIM for new operational and applicational needs. Moreover, due to the current transition period, the performance based, vendor neutral and technological flexible approach of the SWIM implementation, different solutions are possible. According to the practical tests in other tasks, the different models have been analysed and a strategic approach for CRV based regional SWIM implementation has been proposed at

the Task 2 - SWIM Architecture. In this paper, to satisfy these different requirements, an interface binding approach for SWIM TI to achieve both operational interoperability and applicational flexibility by considering the CRV based regional SWIM implementation is presented.

2. DISCUSSION

2.1 To ensure the technical and operational interoperability of ATM systems and facilitate homogeneous and non-discriminatory global and regional traffic flows is a main expectation of the GATMOC (Doc9854). Achieving interoperability between providers and consumers of SWIM information services is one of the key challenges for SWIM to overcome. In order to achieve its purpose of managing and exchanging information in support of ATM operations, SWIM needs to build on global standards and uniform principles to ensure that different implementations of information management systems work seamlessly together.

2.2 In the APAC region, due to the different levels of operational needs and limited capability of current CRV, different options can be contemplated for the transition period regarding interoperability. Some member states and third-party SWIM service providers have developed some information services on their local SWIM-enabled systems that cannot directly connect to the CRV at current stage. Actually, each defined SWIM service may have different specifications; therefore, the transition period and interoperability arrangements can be different for the different services and implementation levels.

2.3 As discussed at the fourth meeting of SWIM Task Force (SWIM TF/4), to assure the performance of CRV for conventional AFTN/AMHS applications and improve the flexibility required for regional SWIM implementation, it is recommended to divide the CRV communication and SWIM communication into different layers. The regional SWIM will be progressively implemented by different stakeholders and aligned with the implementation of the services it supports. If the CRV can satisfy the requirements of different SWIM services and users during transition period, it is possible for these two logical communication layers on one IP network segment. However, due to the current situation, it is necessary for us to consider how to achieve the interoperability between the CRV and some SWIM-enabled systems in different IP network segments.

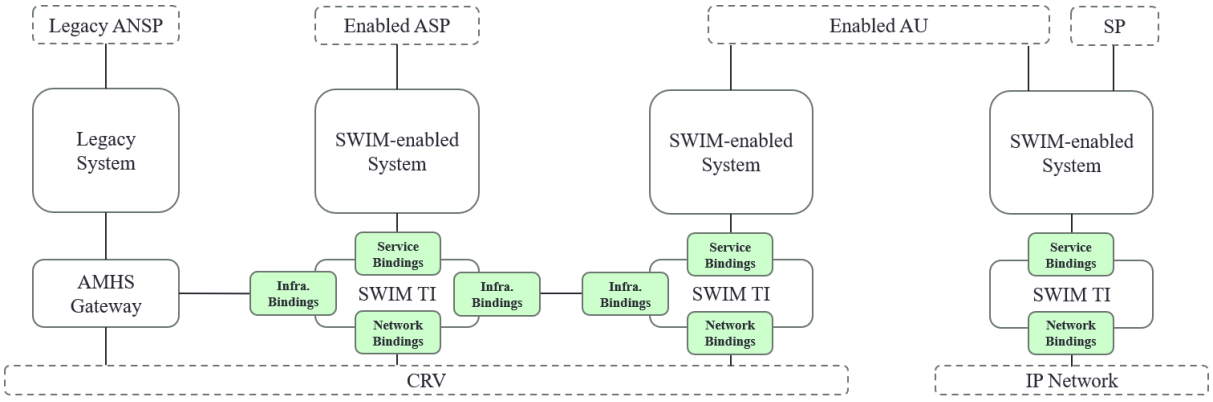

Figure 1. User-based Access for Interoperability

2.4 The SWIM TI enables the implementation of interfaces between systems, providing technical capabilities for secure, high performing and reliable information exchange. It enables technical interoperability based on interface that use industry standards. The SWIM TI interface bindings specify the protocols for information exchange between systems. Interface bindings play a critical role in enabling technical interoperability in SWIM and are highlighted as specific TI components. As shown in Figure 1, based on the functional position of SWIM TI, not only network bindings and service

bindings but also infrastructure bindings are required to achieve interoperability between different internal and external infrastructure systems.

- Network Bindings: Specify what is expected by the SWIM TI to communicate over the IP network, including protocols from the network and transport layers;

- Service Bindings: Specify the service interface technical interoperability, including protocols to interface with the ATM applications;

- Infrastructure Bindings: Specify the interface used by a SWIM TI to communicate with other infrastructure systems, including protocols for communication with internal and external services.

2.5 There are two approaches to deal with a need of Enabled Airspace Users (AUs) to access a service in the different network segment from the CRV. One approach is called user-based access that means a service consumer is possible to participate in different network segments. Of cause, it is required the Service Producer (SP) to provide its information services not only to internal users but also external users. At current stage, this is an easy way to ensure interoperability between the SWIM-enabled systems in different network segments. This case is represented in Figure 1. However, there are also some challenges introduced by this approach. For example, it may bring some problems for the management of each network segment. In addition, participation as a consumer in different network segments could be incompatible with the required QoS (Quality of Service) from the service perspective.

2.6 The other approach is called SWIM-based access that means the infrastructure bindings can specify the definition and implementation of service interface between different SWIM TI systems in different network segments. This case is shown in Figure 2. The infrastructure bindings can provide interoperability to internal and external interfaces with different specifications within same network segment or different network segments. Moreover, it can be expected that this approach would be possible for SWIM services for which there is a straightforward mapping with existing AFTN/AMHS messages. On the other hand, the use of infrastructure bindings introduces a number of non-trivial challenges. Due to the different operational requirements and specifications, it will increase the complexity of implementation and make mapping of some specific functionality difficult. Furthermore, for message format change and protocol conversion, it is difficult to achieve end-to-end visibility and message level security. Awareness of these challenges in the architectural decision process could lead to mitigation or avoidance of these challenges if taken into account.

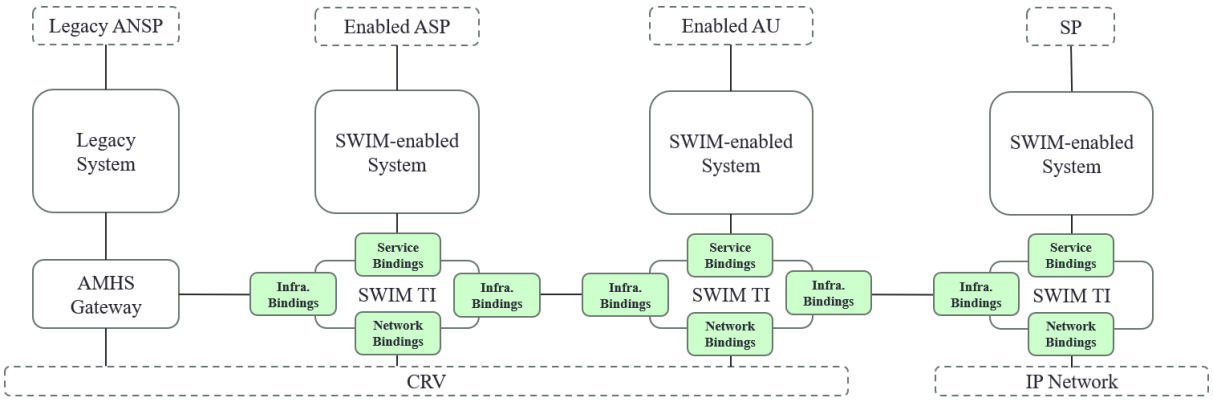

Figure 2. SWIM-based Access for Interoperability

2.7 The messaging, security and management capabilities are related to the technical configuration of SWIM TI interface bindings. The key element of such technical configuration is the binding specification. The following elements should be considered for all types of interface bindings. Table 2 illustrates an example of protocols and specifications of these elements related to network bindings, service bindings, and infrastructure bindings.

- Technology Standard: This element describes the protocol stack specified in this binding for information exchange between systems.

- Message Exchange Patterns (MEP): This element enumerates all types of MEP supported by the interface in this binding. The MEP used in any given exchange is directed by the information service provider to meet information service objectives. The allowed types for MEPs are defined in the SWIM Manual documents.

- Security: This element enumerates for each security need of a defined set, the location of the security control or security controls, that will support the security requirement in this binding. The defined set of security controls consists of Confidentiality, Integrity, Authenticity, Authorization, Non-repudiation.

- Interface Management: This element describes the fault handling and enumerates defined message formats and encodings that are supported by both sides of the interface in this binding.

Table 2. Example of Protocols for Interface Bindings

Element	Network Bindings	Service Bindings	Infrastructure Bindings
Technology Standard	TCP/IP	AMQP	HTTP
MEP	One-way	Publish/Subscribe	Request/Reply
Security	VPN	TLS	PKI
Interface Management	SNMP	FIXM	IWXXM

2.8 As the number of potential technologies are possible to be used for interface bindings and the number of information services are required to support different operation levels, it is difficult to provide technical interoperability between different systems in same network segment or different network segments. Moreover, consuming from SWIM-based interface bindings selected by service providers may increase the complexity of users' implementation. For these reasons, it is good practice to consolidate the interface bindings around mainstream standards. This will then enable cost benefits and other synergies among the SWIM stakeholders.

3. CONCLUSION

3.1 Under current situation, due to the limited capabilities of CRV and different operational needs for information services, it is required for SWIM-enabled systems to support users to access information services provided not only in the same network segment but also in different network segments. There are two approaches to deal with a need to access a service in one network segment from another network segment. As the regional and global ATM is a highly federated environment, based on the number of

stakeholders, new entrants and complexity of airspace services, multiple users participate multiple network segments could become unmanageable. Therefore, the user-based access should be a temporary solution during the transition period. To achieve technical interoperability, it requires solutions that can scale to support the demand of seamless information exchange between service producers and consumers. Therefore, Task 2 clarifies the interface bindings of SWIM TI, which is a possible approach for CRV based regional SWIM implementation to satisfy the information exchange between different infrastructure systems both in a same network segment and different network segments.

3.2 Task 2 presents a technical perspective for the implementation and evolution of SWIM TI interface bindings on a global scale. Task 2 identifies relevant approaches for achieving interoperability at the SWIM TI level as described in the ICAO SWIM Manual. The following Draft Conclusion is expected to be considered by the meeting.

<table>
<tr><td colspan="2">Draft Decision SWIM TF/6/* – Infrastructure Bindings of SWIM TI in APAC Region</td></tr>
<tr><td>What: The CRV-based Interoperable SWIM Architecture in which the Infrastructure Bindings specify the interface used by a SWIM TI to communicate with other infrastructure systems in the same network segment or different network segments to achieve technical interoperability during the transition period with the collaboration between CRV and SWIM Service Providers, is adopted for the APAC SWIM Infrastructure.</td><td>Expected impact:
☐ Political / Global
☐ Inter-regional
☐ Economic
☐ Environmental
☒ Ops/Technical</td></tr>
<tr><td>Why: The CRV-based architecture is required for regional SWIM implementation during the transition period. The CRV-based Interoperable SWIM Architecture is considered as an appropriate approach in the APAC Region. However, the current capabilities of CRV are not sufficient to meet the requirement of SWIM for new operational and applicational needs.</td><td>Follow-up: ☒ From States</td></tr>
<tr><td>When: 17-May-22</td><td>Status: Draft to be adopted by Subgroup</td></tr>
<tr><td colspan="2">Who: ☒Sub groups ☒APAC States ☐ICAO APAC RO ☐ICAO HQ ☐Other</td></tr>
</table>

4. ACTION BY THE MEETING

4.1 The SWIM TF/6 is invited to:

a) Note and review the content of this working paper;

b) Agree to provide this document to the related Task groups under SWIM TF and other APANPIRG Working Groups/Task Forces for further deliberation; and

c) Discuss any relevant matters as appropriate;

d) Discuss the draft conclusion for final report.

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