International Civil Aviation Organization

Third Meeting of the Surveillance Study Group (SURSG/3)

(Hong Kong China, 22– 24 March 2023)

Agenda Item 7: States' experience for Surveillance data sharing

Lessons Learned in Sharing Surveillance Data using SWIM Information Service

(Presented by Republic of Korea)

SUMMARY

This paper presents ROK's lessons learned in the exchange of surveillance data through a SWIM information service. It describes architectural, topological, and technical consideration and practical implementation of surveillance information service.

1. INTRODUCTION

1.1 Since 2016, ROK has been engaged in a SWIM R&D project that encompasses the implementation of the ROK SWIM Testbed, the development of SWIM information services, and trial operations with SWIM stakeholders.

1.2 The SWIM information services deployed in the ROK SWIM Testbed are categorized into aeronautical, flight, weather, and surveillance information domains. Regarding the surveillance domain, ROK has been conducting research to improve the utilization of surveillance data in the SWIM environment.

1.3 At the 1st SWIM Workshop in 2021, ROK delivered a presentation entitled "ROK's SWIM Journey on SWIM Service Implementation for Flight and Surveillance Information," in which ROK shared a technical experience and lesson learned in on SWIM service implementation for flight and surveillance information.

1.4 ROK is currently executing a trial operation with SWIM stakeholders, and this includes the exchange of surveillance data through a SWIM information service.

1.5 This paper presents ROK's experience and lessons learned in sharing surveillance data via a SWIM information service specifically through the utilization of the Advanced Message Queuing Protocol (AMQP) based messaging services.

2. CHARACTERISTIC OF SURVEILLANCE DATA

2.1 ROK operates several ground facilities for surveillance. These collect and transmit surveillance data in real-time from the aircraft to the ground, and uses various surveillance technologies such as radar, Automatic Dependent Surveillance-Broadcast (ADS-B), and Multilateration (MLAT).

2.2 The All Purpose Structured Eurocontrol Surveillance Information Exchange (ASTERIX) is the de-facto format for the exchange of Air Traffic Services (ATS) information, particularly surveillance

data, due to its lightweight and bandwidth efficiency. It is binary data exchange format and supports various categories (i.e., CAT x) to deliver many different information from different data sources.

2.3 Identified or considered characteristics of surveillance data when ROK implements the SWIM Testbed (including development of a SWIM information service) are as follows:

- The surveillance data that a ground facility generates is typically fixed when a facility is deployed (e.g., ASTERIX type, contents to fill in), and once operational, the change isn't flexible;

- Surveillance data is shared in a limited environment, usually within the local network. It uses the User Datagram Protocol (UDP) in multicast environment where the transmission of data packets is propagated to a group of hosts simultaneously, using a single transmission from the source. It is typically shared within the Layer 2 (L2) networking;

- Consumption of surveillance data by external stakeholders requires Peer-to-Peer (P2P) network connectivity under the strict security procedure and condition. Technically, ROK requires physical network separation through the security gateway (i.e., data diode);

- Each UDP packet has one or more pieces of ASTERIX data, and fragmentation of the UDP packet is occurred. As the UDP is Out-of-Order delivery and loss permissible, these should be considered when it comes to consuming surveillance data;

- Including Flight Plan (FPL) into the ASTERIX data generated by a ground facility for surveillance is possible, as some ASTERIX categories allow for including the FPL as an optional field. However, this practice can result in the generation of jumbo UDP packets, which can decrease bandwidth efficiency;

- As ground facility for surveillance is not yet able to provide surveillance data in SWIM environment natively

2.4 Surveillance data is provided by many different sources. However, for the ROK SWIM R&D project, only a subset of the surveillance data is used, as follows:

Where	Type	Format	Category
Air Traffic Control (ATC), Incheon	(EnRoute) SMR	ASTERIX	CAT 62
Gimpo Int'l Airport	ASDE		CAT 10
	MALT		CAT 20
	ADS-B		CAT 21
Jeju Int'l Airport	ASDE		CAT 10
	MALT		CAT 19, 20
	ADS-B		CAT 21, 23
Incheon Int'l Airport	ASDE (A-SMGCS)		CAT 11

3. IMPLEMENTATION OF SWIM INFORMATION SERVICE FOR SURVAILLANCE DATA

3.1 ROK implemented SWIM information services for surveillance data, that are currently working on the SWIM testbed, and this chapter describes considerations considered for implementation.

Architectural Aspect

3.2 The ROK SWIM Testbed (including SWIM information service implemented) follows the Service Oriented Architecture (SOA) concept defined the ICAO SWIM Concept (Doc. 10039). ROK has further explored to apply Micro Service Architecture (MSA) to SWIM, that can be seen as an evolution of SOA, with a greater focus on modularity and independence between services.

Topological Aspect

3.3 As a surveillance ground facility for surveillance are not yet able to provide surveillance data in SWIM environment natively, there needs to have a gateway (or broker) and provision service allowing surveillance data to be shared in the SWIM environment. Several topologies (e.g., federated, centralized) were considered, and ROK decided to adopt centralized topology.

3.4 A ground facility for surveillance only transmits data in legacy method, and a gateway and provision service located in the SWIM Testbed enables data to be shared in the SWIM environment.

Network & Security Aspect

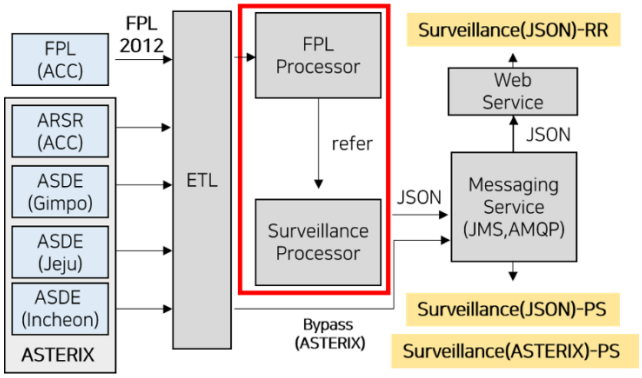
3.5 In the network and security aspect, a closed-telecommunication-network operated by the Ministry of Land, Infrastructure and Transport (MOLIT), ROK is used for data transmission. This network connects from facilities to SWIM Testbed.

3.6 To protect the facilities against cyber-threat, unidirectional security gateway (i.e., data diode) is installed in data originator side, and it conducts physical network separation. Only permitted surveillance data is transmitted in UDP to SWIM Testbed.

SWIM Information Service

3.7 As there is no surveillance service provider capable of publishing data to the SWIM environment, the ROK SWIM Testbed has a service, which performs service provider role by receive the UDP packet and publish it to the SWIM infrastructure (i.e., SWIM core service)

3.8 A SWIM information service for surveillance data operated in the ROK SWIM Testbed supports two message exchange patterns: request/response or publish/subscribe. The former is implemented through a web service based on Representational State Transfer (REST)-ful Application Programming Interface (API) while the latter is implemented as a messaging service based on AMQP.



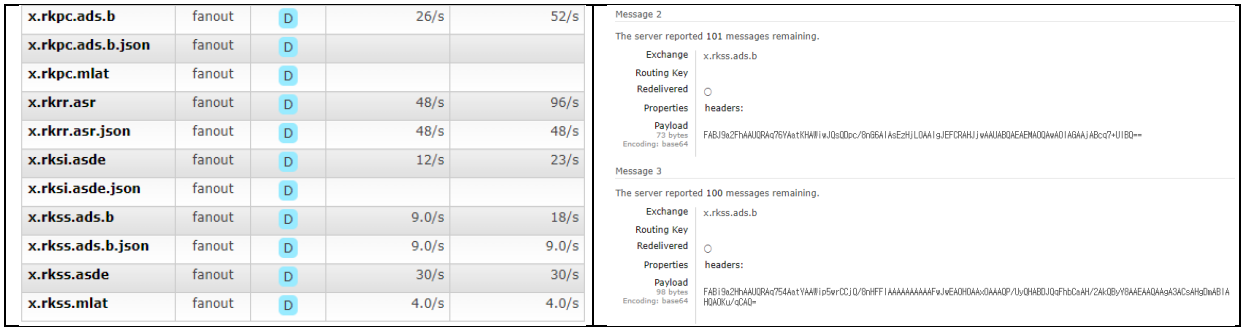
<Surveillance Data in SWIM Testbed (legacy to SWIM)>

3.9 To implement messaging service using the AMQP, ROK SWIM Testbed uses the RabbitMQ that is one of the popular open-source brokers in the IT industry. The RabbitMQ provides benefits such as 1)

reliable message delivery, 2) decoupled architecture, 3) cross-platform interoperability, 4) asynchronous processing and 5) security and authentication.

3.10 As there is no surveillance service provider capable of publishing data to the SWIM environment, the ROK SWIM Testbed has a service, which performs service provider role by receive the UDP packet. Once it receives a packet, it publishes the ASTERIX data (i.e., bypass) or performs conversion to the JavaScript Object Notation (JSON) and publish to the SWIM infrastructure (i.e., SWIM core service)

3.11 Adopting the JSON is the experimental approach to share surveillance data in modern way, as the JSON has some benefits such as 1) a lightweight 2) readability both by human and machines, 3) platform independence, 4) compactness, 5) security, and allowing easier development of interoperable, efficient, and secure applications.



x.rkpc.ads.b	fanout	D	26/s	52/s
x.rkpc.ads.b.json	fanout	D		
x.rkpc.mlat	fanout	D		
x.rkrr.asr	fanout	D	48/s	96/s
x.rkrr.asr.json	fanout	D	48/s	48/s
x.rksi.asde	fanout	D	12/s	23/s
x.rksi.asde.json	fanout	D		
x.rkss.ads.b	fanout	D	9.0/s	18/s
x.rkss.ads.b.json	fanout	D	9.0/s	9.0/s
x.rkss.asde	fanout	D	30/s	30/s
x.rkss.mlat	fanout	D	4.0/s	4.0/s

<Surveillance Data in Message Broker (ASTERIX)>

/rkrr/targets	{ "area": "rkrr", "arr": "RKPC", "gufi": "1a652da5-234f-4850-a3cf-ea145e1c4d76", "fl": "0", "tod": "23777.39", "alt": "12000.0", "lon": "126.83229", "source": "asr", "tid": "JJA511", "dep": "RKPK", "ssr": "7251", "dof": "230215", "lat": "33.79665" },	Exchange x.rkrr.asr.json Routing Key Redelivered Properties headers: Payload 226 bytes Encoding: string [{"area":"rkrr","arr":"RCTP","gufi":"99720ca4-d285-439a-9491-14dcad132591","fl":"0","tod":"23625.055", "alt":"38000.0","lon":"125.13284","source":"asr","tid":"AAR713","dep":"RKSI", "ssr":"7165","dof":"230215","lat":"30.493155"}]

<Surveillance Data in Web Service and Messaging Service (JSON)>

<u>Trial Operation</u>

3.12 ROK conducts a SWIM trial operation with SWIM stakeholders. In the aspect of surveillance data, participants consume surveillance data through SWIM information service as follows:

Stakeholder	Service	Format
DATM Center, National Information Resources Service	Messaging Service	ASTERIX
Korea Aerospace Research Institute	Messaging Service	ASTERIX, JSON
Air Traffic Center, Daegu	Web Service	JSON
Air Traffic Center Regional Office, Incheon	Web Service	JSON
NAVAIDS Business Center, Seoul Regional Aviation Administration	Web Service	JSON
Korea Airports Corporation - Operations Control Center (HQ) - Airside Control Tower, Gimpo Int'l Airport - Airport Operation Control Center, Gimpo Int'l Airport - Instrument Landing System (ILS) Department, , Gimpo Int'l Airport	Web Service	JSON

4. LESSON LEARNED

4.1 SWIM could be a robust enabler to share surveillance data between the ATM stakeholders.

4.2 A ground facility for surveillance is not yet prepared for the SWIM environment, there should be a broker or gateway allowing surveillance data providers to join the SWIM environment. There should be a various topology depending on local environment or requirement.

4.3 Using an open source or Commercial, Off the Shelf (COTS) supporting the AMQP could boost up the implementation of a messaging service for surveillance data in scalable and reliable way.

4.4 Surveillance Data is timely critical data, so the latency should be strictly controlled following the Quality-of-Service (QoS) defined in the Service Level Agreement (SLA) in the operational phase.

4.5 Tracking a timestamp of milestones during the journey from data source to information service consumer could be useful in the aspect of maintaining a QoS in the time-critical manner.

5. ACTION BY THE MEETING

5.1 The meeting is invited to:

a) note the information contained in this paper; and

b) discuss any relevant matter as appropriate
