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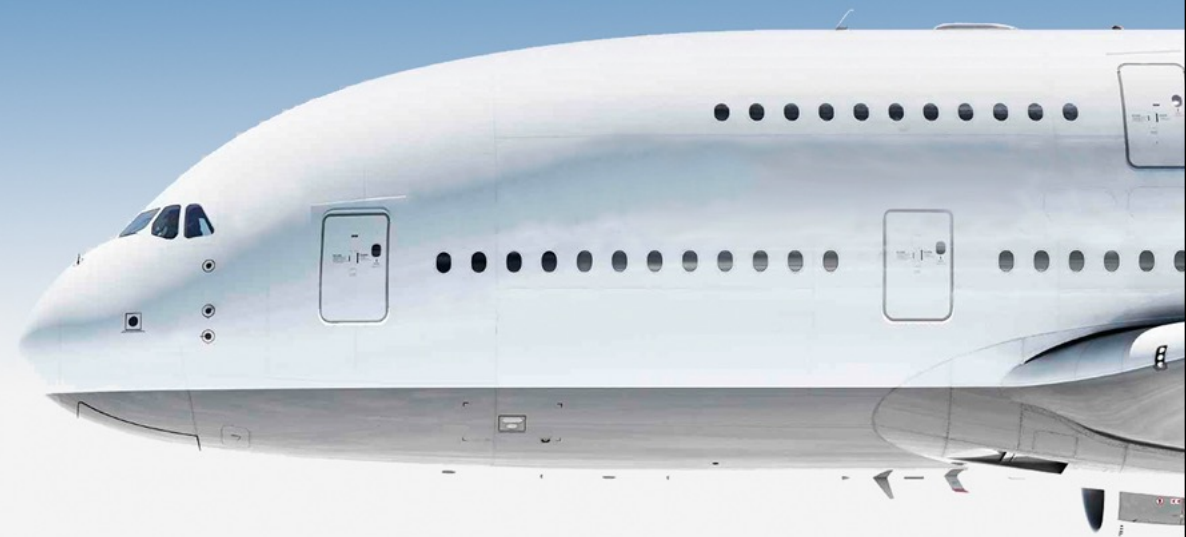
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# ROK's SWIM Journey

**Lifecycle of information  
from Provider to Consumer  
in ROK's SWM Trial Operation**



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# CONTENT

01

## Introduction

02

## ROK (KAC) SWIM Testbed

- Information Source
- Consideration on Information Source
- Information Handling
- Business Service Category

03

## ROK SWIM Trial Operation

04

## Lessons Learnt



## Introduction

- Ministry of Land, Infrastructure and Transport (MOLIT) established the National ATM Reformation And Enhancement(NARAE) master plan following GANP/ASBU, and as part of NARAE, KAC has been conducting SWIM R&D since 2016
- ROK SWIM testbed(i.e., KAC SWIM testbed) is located in Gimpo International Airport(GMP), Seoul. It re-routes or, collects standard or legacy data (e.g., ASTERIX, FPL 2012) from stakeholders, processes them to a standardized format if needed, and provides them through SWIM services
- At the 1<sup>st</sup> SWIM Workshop in 2021, ROK presented “[Republic of Korea’s SWIM Journey](#)” and shared lessons learnt from SWIM service implementation for surveillance and flight information
- ROK SWIM trial operation with SWIM stakeholders is in progress using ROK SWIM testbed



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## **Today's Topic**

# **Lifecycle of Information from Provider to Consumer**

**How information is handled in the SWIM environment?  
in ROK's SWM Trial Operation**

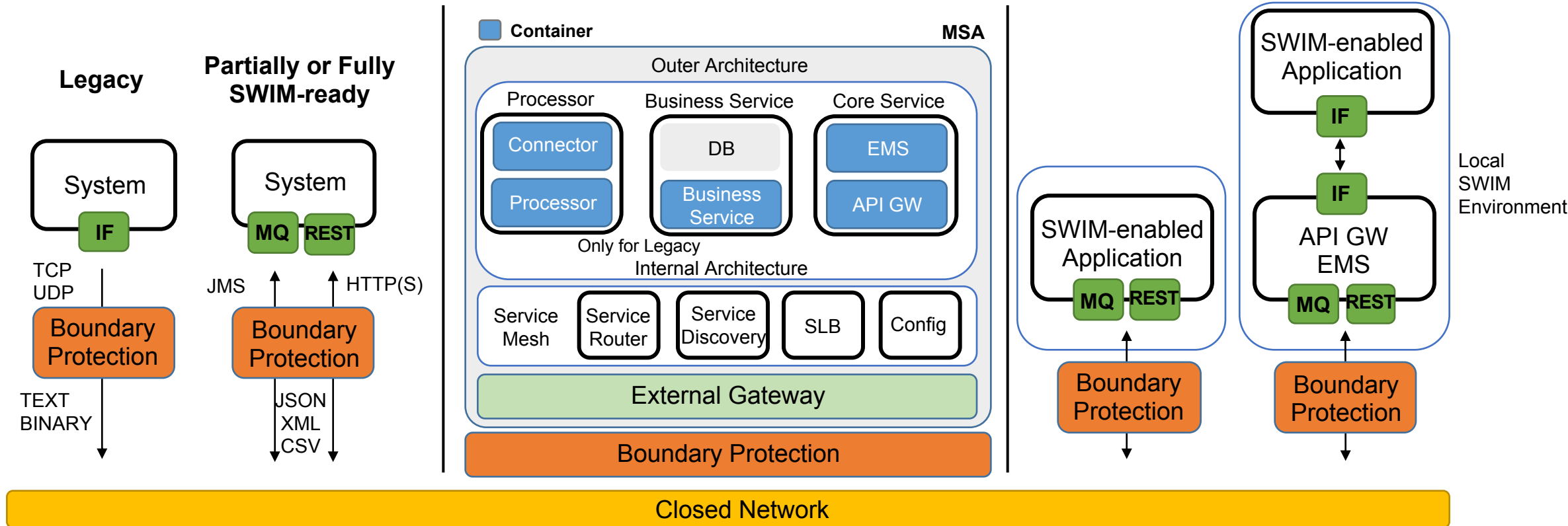


# ROK (KAC) SWIM Testbed (Overall)

Service Provider  
Data Originator

ROK  
SWIM Testbed

Service Consumer  
(Trial Operation)





## Information Source in ROK SWIM Testbed

- There are six types of information domains as shown in the below
- When information is published or collected from information provider (or data originator), some information is in standardized format (e.g., XM) with SWIM-compliant API, but others information is delivered in legacy way
  - Standardized Format : XML or JSON (IWXXM, FIXM, or Custom Scheme)
  - SWIM-compliant API : Messaging Service (AMQP) or Web Service (REST-API)

Domain	Information	Format	
Flight	- Flight Plan	FPL 2012	
	- IFIS	CSV (Custom-Scheme)	
Surveillance	- Enroute Radar (SMR)	ASTERIX	CAT62
	- ASDE (RKSS, RKPC)		CAT10
	- MLAT (RKSS, RKPC)		CAT 19, 20
	- ADS-B (RKSS, RKPC)		CAT 21, 23
	- ASDE/A-SMGCS (RKSI)		CAT 11



## Information Source in ROK SWIM Testbed (cont')

Domain	Information	Format
Aeronautical	- NOTAM	AIXM v5.1.4
	- AMDB	AIXM v5.1.4
MET	- METAR	IWXXM v2.0 IWXXM v3.0
	- TAF	
	- AIRMET	
	- SPECI	
	- SIGMET	
	- AMOS	CSV (Custom-Scheme)
FLOW	- Trajectory	FIXM v4.2 (with APAC extension)
	- Flow	
Geographical	- Map (Tile)	Multi-media (jpeg, png)
	- FIR, Way/Fix Point, Route	Multi-media (jpeg, png), JSON
	- Buildings and Terrain (3D Tile)	Multi-media (b3dm, terrain)

with KARI only



## Information Source in ROK SWIM Testbed (cont')

- There are four types of information provider (or data originator) in ROK SWIM testbed, most information provider only push information for distribution purpose. But ROK SWIM testbed also supports bi-directional message exchange when if required
- Some information providers are SWIM-ready, but most information providers are not SWIM-ready. ROK SWIM testbed has broker/gateway and mediation capability to enable not SWIM-ready providers to be able to communicate in the SWIM environment

Type	Standardized Format	SWIM-compliant API	ROK SWIM Testbed Case
1	X	X	ADS-B, ASTERIX, UDP AMOS, CSV, FTP (C/S)
2	O	X	-
3	X	O	IFIS, CSV, JMS
4	O	O	METAR, IWXXM v2.0, REST-API NOTAM, AIXM v5.1.4, HTTP-API



## Consideration on Information Source

- Identified or considered characteristics of information source when ROK implements the SWIM testbed are as follows:

### Surveillance Information

- 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;



## Consideration on Information Source (cont')

### Flight Information

- FPL Distribution System (FDS) uses RS232 or socket (TCP) interface, and FPL is delivered in FPL 2012 format
- Consumption of FPL by external stakeholders requires Peer-to-Peer (P2P) network connectivity under the strict security procedure and condition (e.g., domestic ATFN);

### MET and Aeronautical Information

- METs and aeronautical systems are digitally transformed by the relevant organization, and systems are able to provide information in XM format using a web service
- In case of AMOS, it uses FTP for data transmission as it is not the part of IWXXM scope

### Geographical Information (GIS)

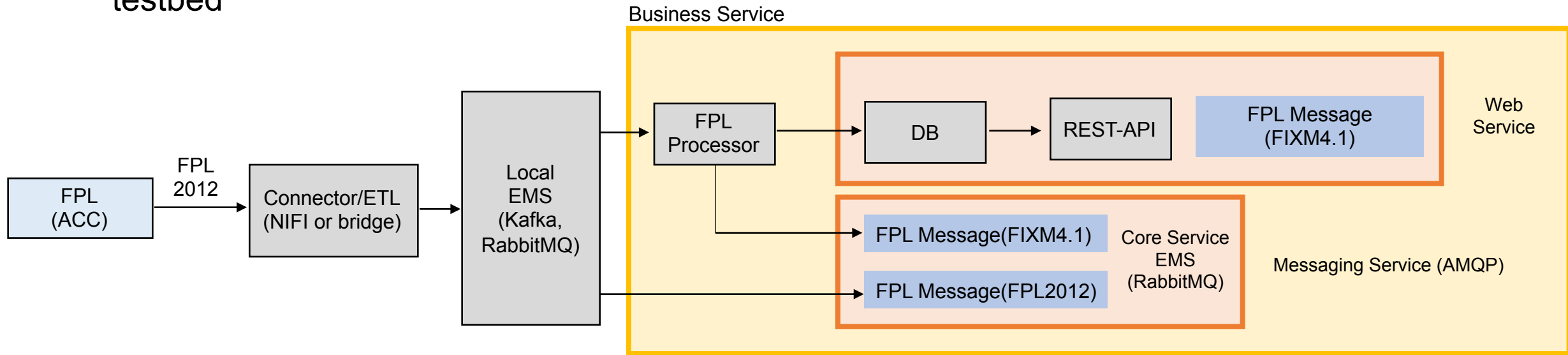
- There is no common Web Map Service(WMS) for geographical information for as it has been deployed for each project that requires GIS



## Information Handling in ROK SWIM Testbed

Non-standardized information delivered in non SWIM-compliant method (or API)

- Non-standardized information is transformed to XM (e.g., FIXM) or JSON (e.g., custom schema) in ROK SWIM Testbed
- Information collected in non SWIM-compliant method (or API) (e.g., socket, TCP/UDP) from the information source is delivered using business SWIM service developed in ROK SWIM testbed



Information Handling Example - FPL



## Information Handling in ROK SWIM Testbed (cont')

Non-standardized information delivered in non SWIM-compliant method (or API)

Text (FPL 2012) / Pub/Sub (AMQP)

<b>Payload</b> 469 bytes Encoding: string	<pre>x-first-death-exchange: x.acc.fpl x-first-death-queue: q.acc.fpl.delay.tmp x-first-death-reason: expired  (FPL - GTI8643/A4473 - IS - B744/H - SDE1E2E3FGHIJ3J5M1P2RWXYZ/LB1D1 - PANC2105 - N0481F320 SOA J501 BET DCT NANZA R220 NIKLL/M084F320 R220 NIPPI/N0477F320 R220 NUBDA/N0484F340 R220 NANN0</pre>
--	--



## Information Handling in ROK SWIM Testbed (cont')

Non-standardized information delivered in non SWIM-compliant method (or API)

XML (FIXM v4.2) / Pub/Sub (AMQP)

<b>Payload</b> 8902 bytes Encoding: string	<pre>&lt;?xml version="1.0" encoding="UTF-8" standalone="yes"?&gt; &lt;msg:FficeMessage xmlns:msg="http://www.fixm.aero/app/ffice/1.0" xmlns:flight="http://www.fixm.aero/flight/4.2" xmlns:base="http://www.fixm.aero/base/4.2"&gt;   &lt;msg:flight&gt;     &lt;flight:aircraft&gt;       &lt;flight:aircraftAddress&gt;718F55&lt;/flight:aircraftAddress&gt;       &lt;flight:aircraftApproachCategory&gt;C&lt;/flight:aircraftApproachCategory&gt;       &lt;flight:aircraftType&gt;         &lt;flight:type&gt;           &lt;flight:icaoAircraftTypeDesignator&gt;B772&lt;/flight:icaoAircraftTypeDesignator&gt;         &lt;/flight:type&gt;       &lt;/flight:aircraftType&gt;       &lt;flight:capabilities&gt;         &lt;flight:communication&gt;           &lt;flight:communicationCapabilityCode&gt;E1 E2 E3 H M1 P2 Y&lt;/flight:communicationCapabilityCode&gt;           &lt;flight:datalinkCommunicationCapabilityCode&gt;J3 J5&lt;/flight:datalinkCommunicationCapabilityCode&gt;           &lt;flight:otherDatalinkCapabilities&gt;1FANS CPDLCX&lt;/flight:otherDatalinkCapabilities&gt;           &lt;flight:selectiveCallingCode&gt;BRDF&lt;/flight:selectiveCallingCode&gt;         &lt;/flight:communication&gt;         &lt;flight:navigation&gt;           &lt;flight:navigationCapabilityCode&gt;D F G I M X&lt;/flight:navigationCapabilityCode&gt;           &lt;flight:performanceBasedCode&gt;A1 B1 C1 D1 L1 O1 S2&lt;/flight:performanceBasedCode&gt;         &lt;/flight:navigation&gt;       &lt;/flight:capabilities&gt;     &lt;/flight:aircraft&gt;   &lt;/msg:flight&gt; &lt;/msg:FficeMessage&gt;</pre>
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# Information Handling in ROK SWIM Testbed (cont')

Non-standardized information delivered in non SWIM-compliant method (or API)

JSON (custom schema) / Request/Reply (REST-API)

Curl

```
curl -X 'GET' \
'http://192.168.1.58:9080/flight/history/TWB9011/RKSS/RKPK/221123' \
-H 'accept: */*'
```

Request URL

http://192.168.1.58:9080/flight/history/TWB9011/RKSS/RKPK/221123

Server response

Code	Details
200	<p>Response body</p> <pre>{   "id": "637d78f964a3f15c19e28215",   "fid": "TWB9011RKSSRKPK221123",   "gufl": "4eae3acc-194c-4b71-9463-61cef55b8427",   "created": 1669167353.502,   "msgtype": "FPL",   "acid": "TWB9011",   "ssrmode": "A",   "ssrcode": "7462",   "rules": "I",   "type": "S",   "type": "B738",   "wtc": "W",   "sur": "LB1",   "dep": "RKSS",   "eobt": "0205",   "route": "N0450F230 DCT OSPOT Y782 TGU Z83 MASTA DCT",   "arr": "RKPK",   "arret": "0041",   "alt": "RKTN",   "other": "PBN/A1B1CID1L101S1S2 D0F/221123",   "dof": "221123",   "pbn": "A1B1CID1L101S1S2",   "origin": "(FPL-TWB9011/A7462-IS -B738/M-SDE2E3FGHIRWY/LB1 -RKSS0205 -N0450F230 DCT OSPOT Y782 TGU Z83 MASTA DCT -RKPK0041 RKTN -PBN/A1B1CID1L101S1S2 D0F/221123)" }</pre>

Download



## Information Handling in ROK SWIM Testbed (cont')

Non-standardized information delivered in non SWIM-compliant method (or API)

Binary (ASTERIX) / Pub/Sub (AMQP)

<p><b>Payload</b> 83 bytes encoding: base64</p>	<p>x-first-death-exchange: <u>x.rkrr.asr</u> x-first-death-queue: <u>q.rkrr.asr.delay.tmp</u> x-first-death-reason: <u>expired</u></p> <p>PgBTn9+PCv/uC08nAGYyuAF9SWcRyDUAJsH82/+7AAAGucCG1iRRpDTEAAACcQUBAQYBAAAGQAAAIAAAAs0ABOM0CPsUHeEXHjBY0qI/pwZABrk=</p>
---	--



## Information Handling in ROK SWIM Testbed (cont')

Non-standardized information delivered in non SWIM-compliant method (or API)

JSON (Custom Schema) / Pub/Sub (AMQP)

<p>Payload 226 bytes Encoding: string</p>	<pre>x-first-death-exchange: x.rkrr.asr.json x-first-death-queue: q.rkrr.asr.json.delay.tmp x-first-death-reason: expired  [{"area": "rkrr", "arr": "ZHHH", "gufi": "0bddf5ae-f7c1-42be-9878-32ce5191ce29", "fl": "0", "tod": "4652.3047", "alt": "17100.0", "lon": "125.80069", "source": "asr", "tid": "TWB615", "dep": "RKSI", "ssr": "7162",</pre>
---	--

\* After combining with FPL



## Information Handling in ROK SWIM Testbed (cont')

Non-standardized information delivered in non SWIM-compliant method (or API)

JSON (custom schema) / Request/Reply (REST-API)

```
Curl
curl -X 'GET' \
'http://192.168.1.58:9080/rkrr/targets' \
-H 'accept: */*'

Request URL
http://192.168.1.58:9080/rkrr/targets

Server response
Code    Details
200

Response body
[
  {
    "area": "rkrr",
    "ssr": "5021",
    "fl": "0",
    "tod": "8000.117",
    "alt": "32000.0",
    "lon": "124.847046",
    "source": "asr",
    "tid": "VJC939",
    "lat": "31.796902"
  },
  {
    "area": "rkrr",
    "arr": "KDTW",
    "gufi": "a171db33-6caf-467e-b9a2-1cd25bec05d8",
    "fl": "0",
    "tod": "7997.867",
    "alt": "35000.0",
    "lon": "131.9735",
    "source": "asr",
    "tid": "DAL150",
    "dep": "RKSI",
    "ssr": "4157",
    "dof": "221123",
    "lat": "37.640915"
  }
]
```

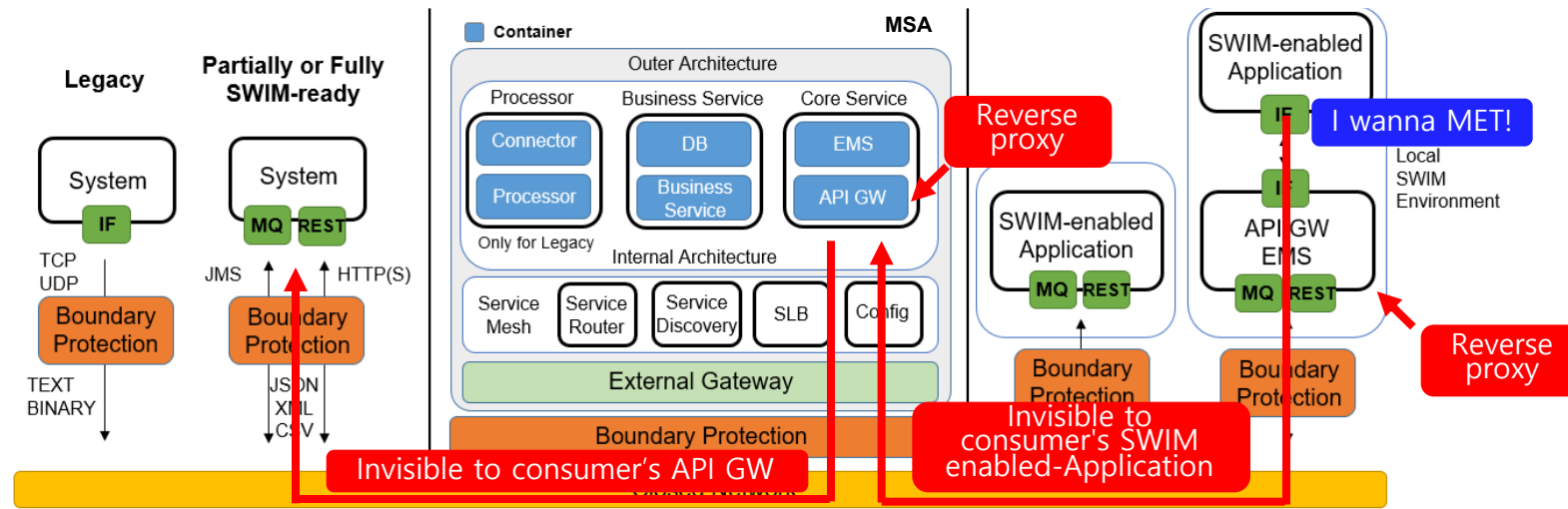
\* After combining with FPL



# Information Handling in ROK SWIM Testbed (cont')

Standardized information delivered in SWIM-compliant method (or API)

- If service provider is able to handle information in SWIM compliant method (e.g., REST-API), ROK SWIM testbed acts like an API GW (or reverse proxy) that re-routes consumer's request to service provider, and returns response to service consumer
- API GW in SWIM testbed is an single access point for service consumer and provider, so service provider's endpoint address is invisible to service consumer (and vice versa)



Information Handling Example - MET

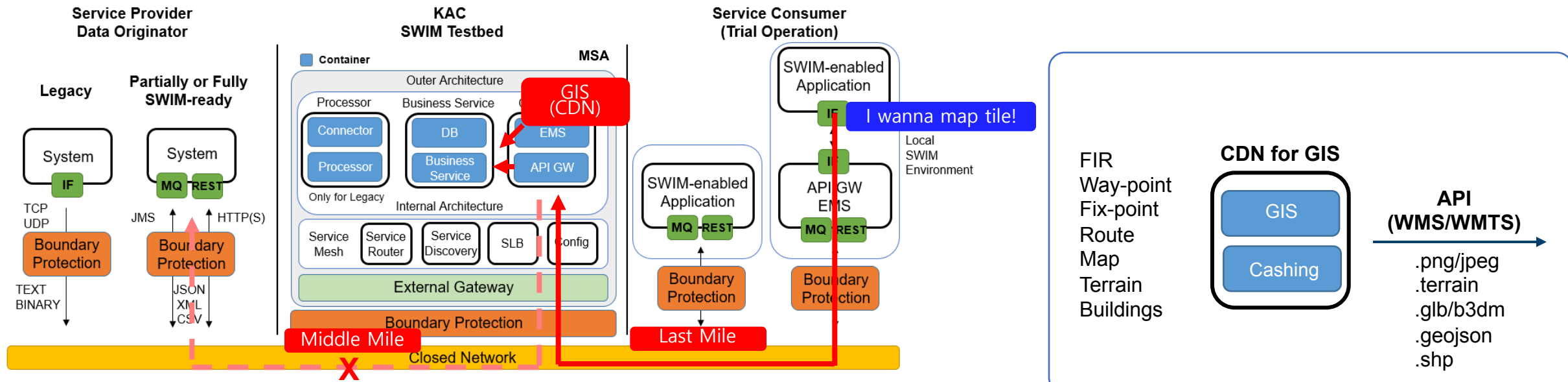




# Information Handling in ROK SWIM Testbed (cont')

## Static and large scale information (e.g., Geographical Information(GIS))

- Static and large scale information like geographical information (e.g., map tile, 3d buildings, 3d terrain) consumes huge amount of network bandwidth
- Deploying business service like GIS service using CDN (Content Delivery Network) concept provides effective way to solve middle-mile problem and improve overall usage of bandwidth



Information Handling Example – Map Tile



# Information Handling in ROK SWIM Testbed (cont')

**KAC SWIM Dashboard**

Home Map Layers Services Tools | Display(252)

2021-11-19 00:28:31 (UTC) | View: Airport / Projection: 3D

**Gimpo Int'l Airport (RKSS)**  
Local: 09:28(UTC+09:00) / Elevation: 6000ft

**Weather Information** 2021-11-19T00:00:00Z  
 13 Cel Temperature, 11 Cel Dew Point, 2500 m Visibility, 1018 hPa Air Pressure, 190 Deg 3 Kni Wind

**Departure** | **Arrival**

Time	Flight	To
00:05	JNA389	RKPU
00:10	ABL8091	RKPC
00:20	AAR8781	RKPC
00:30	JJA141	RKPC
00:30	ABL8807	RKPK
00:35	TWB707	RKPC
00:40	JNA307	RKPC
00:40	JJA276	RKPK
00:40	AAR8751	RKPC
00:50	JJA306	RKJY

**Track Information**

**RKPC** | **RKSS**

Departure | Arrival

**JNA402** | **5147**  
Callsign | SSR

37.5426 Latitude | 126.8136 Longitude | 100ft Height

Last Update 2021-11-19 09:28:30

**Annotations:**

- Terrain (terrain / dem)
- Map Tile (Sat) (png / jpeg)
- Tiled AMDB (png / jpeg)
- Map Tile (png / jpeg)
- Buildings (b3dm)

Information Handling Example – Map Tile

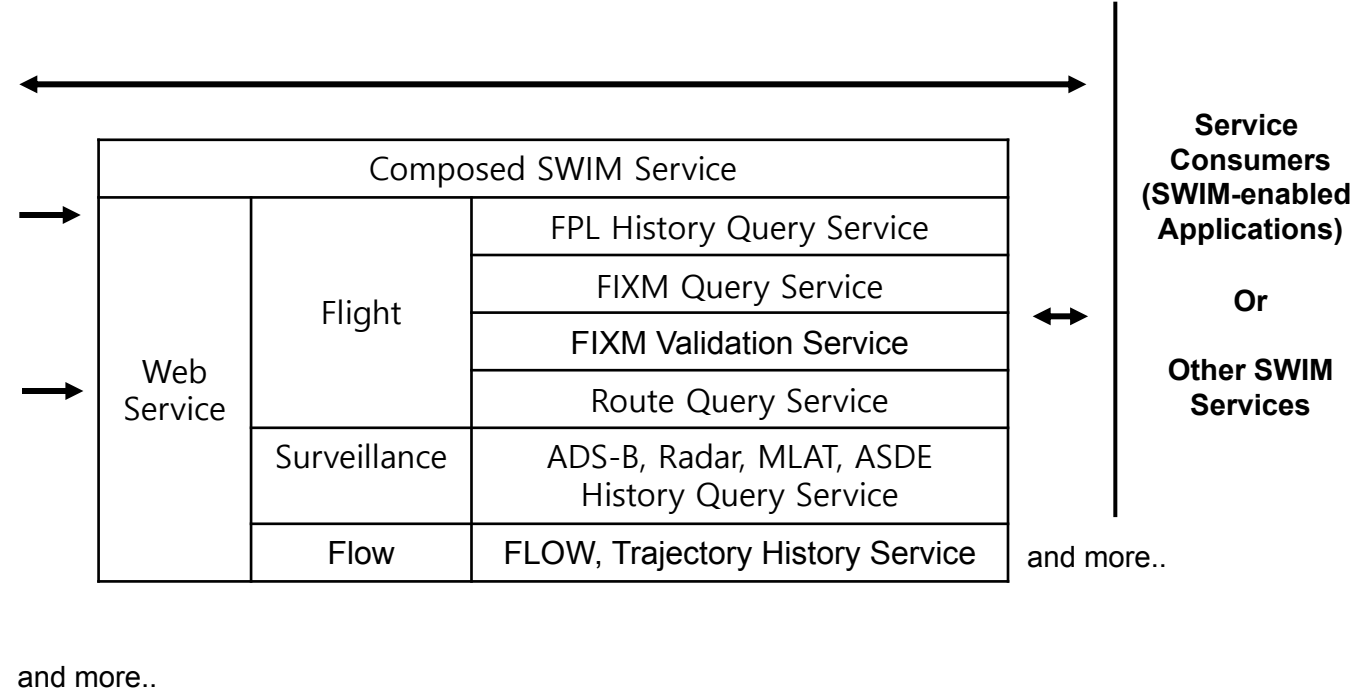


# Business Service Category in ROK SWIM Testbed

## Types of SWIM Services (FFICE ConOps, Doc9965)

- **Basic Service**
  - **Basic Data Service** : This reads or writes data to or from one back-end, data should not be structured as a complex database but should consist of simple types
  - **Basic Logic Service** : This requires some input data and produces data as output. This will require processing from a single back-end
- **Composed Service** : This is derived from the execution of multiple basic services or composed services. This may require services from one or more back-ends

Basic SWIM Service		
Web Service	Flight	FPL Query Service
	Surveillance	ADS-B, Radar, Query Service
		MLAT, ASDE Query Service
	MET	MET (+AMOS) Query Service
	Aeronautical	NOTAM Query Service
	GIS	WMS, WMTS
Messaging Service	Flight	FPL Distribution Service
	Surveillance	ADS-B, Radar, Distribution Service
		MLAT, ASDE Distribution Service
	Flow	FLOW, Trajectory Distribution Service





# ROK SWIM Trial Operation

- Trial operation with SWIM stakeholders is in progress using KAC SWIM testbed. Stakeholders receives information using messaging (AMQP) or web services (i.e., REST-API)

Stakeholder	Method	Domain
DATM Center, National Information Resources Service	Messaging Service	Surveillance
Korea Aerospace Research Institute	Messaging Service	Surveillance, Flight, MET, FLOW, GIS
Air Traffic Center, Daegu	Web Service	Surveillance, Flight, Aeronautical, MET, GIS
Air Traffic Center Regional Office, Incheon	Web Service	Surveillance, Flight, Aeronautical, MET, GIS
NAVAIDS Business Center, Seoul Regional Aviation Administration	Web Service	Surveillance, Flight, Aeronautical, MET, GIS
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	Surveillance, Flight, GIS

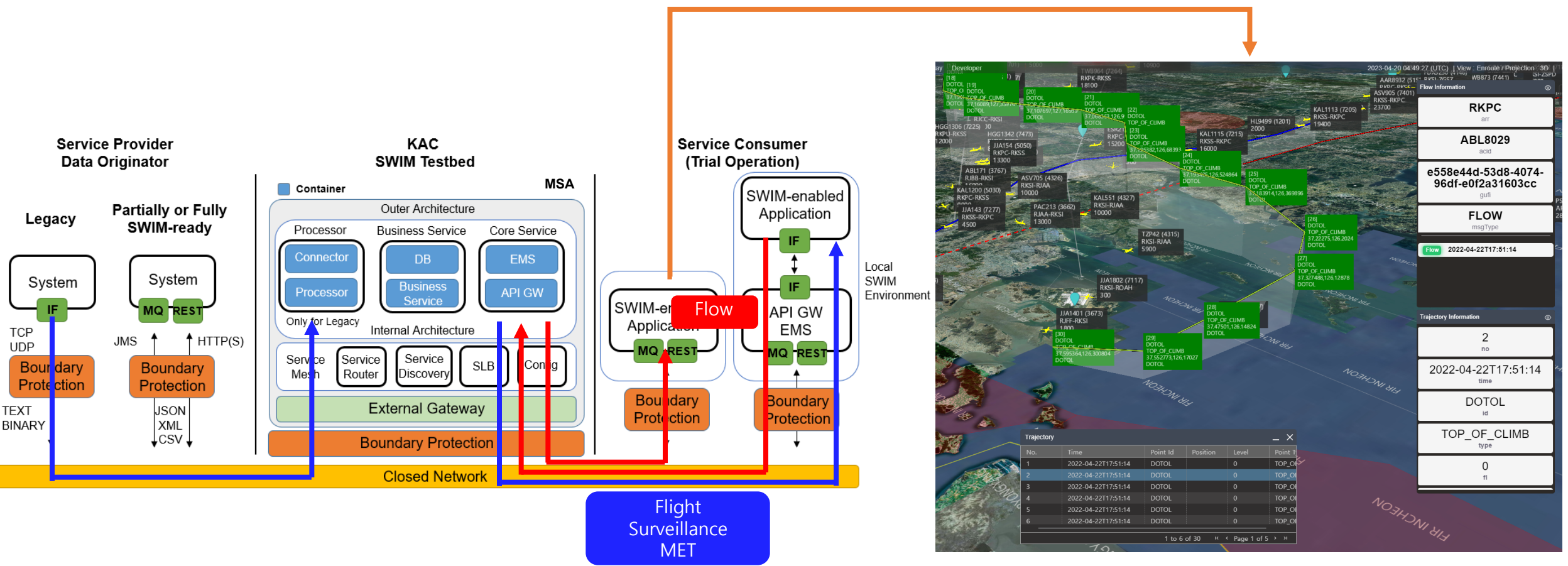


## ROK SWIM Trial Operation - KARI

- Korea Aerospace Research Institute (KARI) is a government-funded research institute in charge of aerospace science and technology research. And KARI conducts a Research and Development (R&D) of CTFMS (Collaborative Tactical Flow Management System)
- KARI's CTFMS receives all information needed through ROK SWIM testbed.
  - Messaging Service (AMQP)
    - Flight Plan (FPL) both in FIXMv4.2 and FPL 2012
    - En-route surveillance data in ASTERIX
    - Surface movement data of Gimpo and Jeju and Incheon Intl Airport in ASTERIX
  - Web Service (REST-API) via ROK SWIM testbed
    - MET information from KAMO in IWXXM v2.0
- KARI publishes calculated trajectory and flow to Messaging Service (AMQP) or Web Service, and another participant in SWIM trial operation is able to get access to the flow information



# ROK SWIM Trial Operation – KARI (cont')



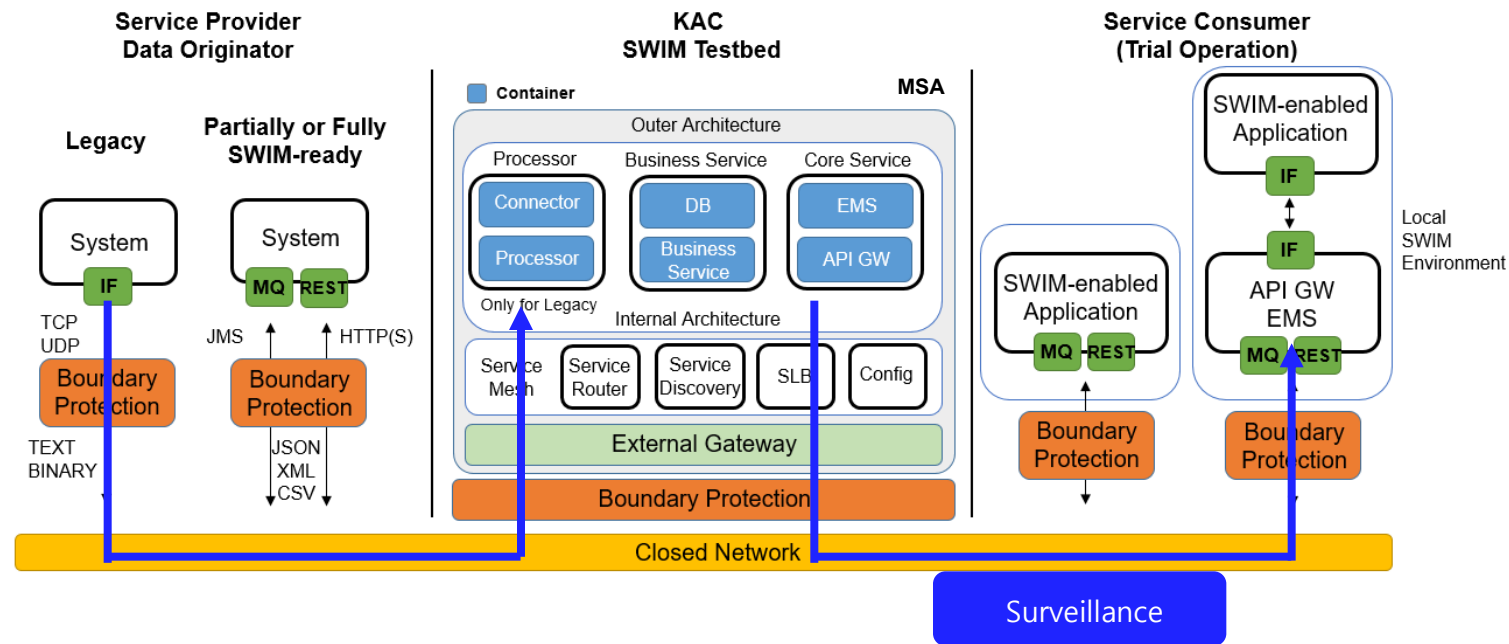


## ROK SWIM Trial Operation – DATM, NIRS

- Digital Air Traffic Management (DATM) Center, National Information Resources Service is a big-data platform (or data warehouse) that collects information from ATM stakeholders and conducts Extract, Transform, Load (ETL), and analysis
- It provides a visualization tool and a portal to deliver an analyzed result to the users
- DATM center receives en-route surveillance data in Incheon Flight Information Region (FIR) and surface movement data of Gimpo and Jeju international airport.
- Surveillance data is delivered in ASTERIX format using an AMQP messaging service



# ROK SWIM Trial Operation – DATM, NIRS (cont')



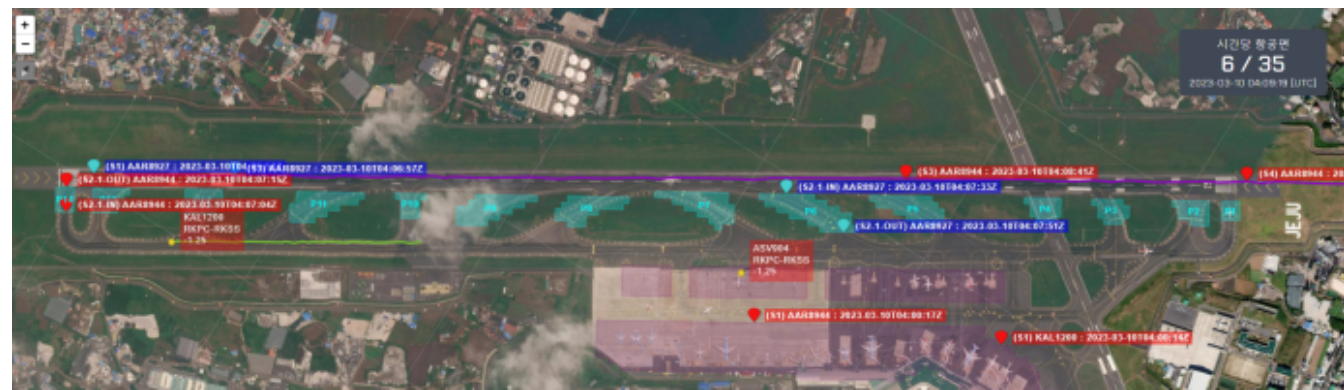
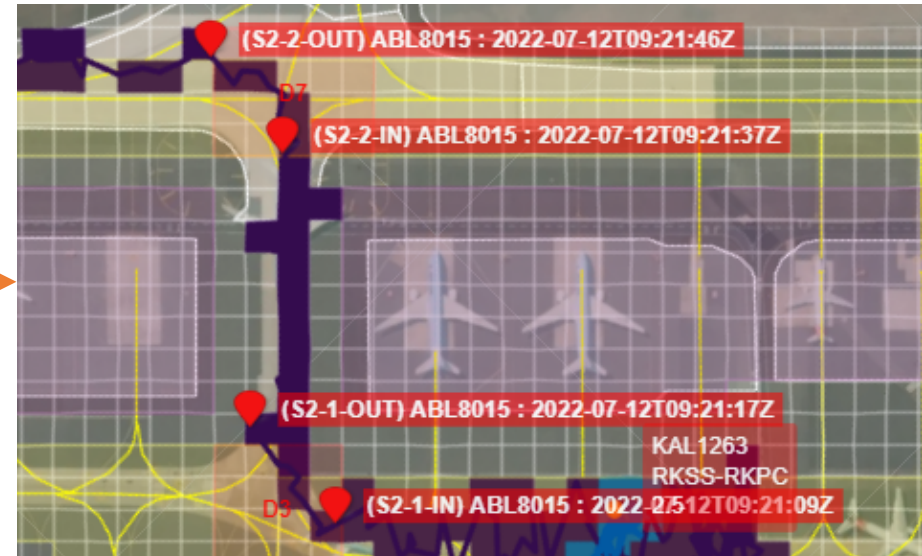
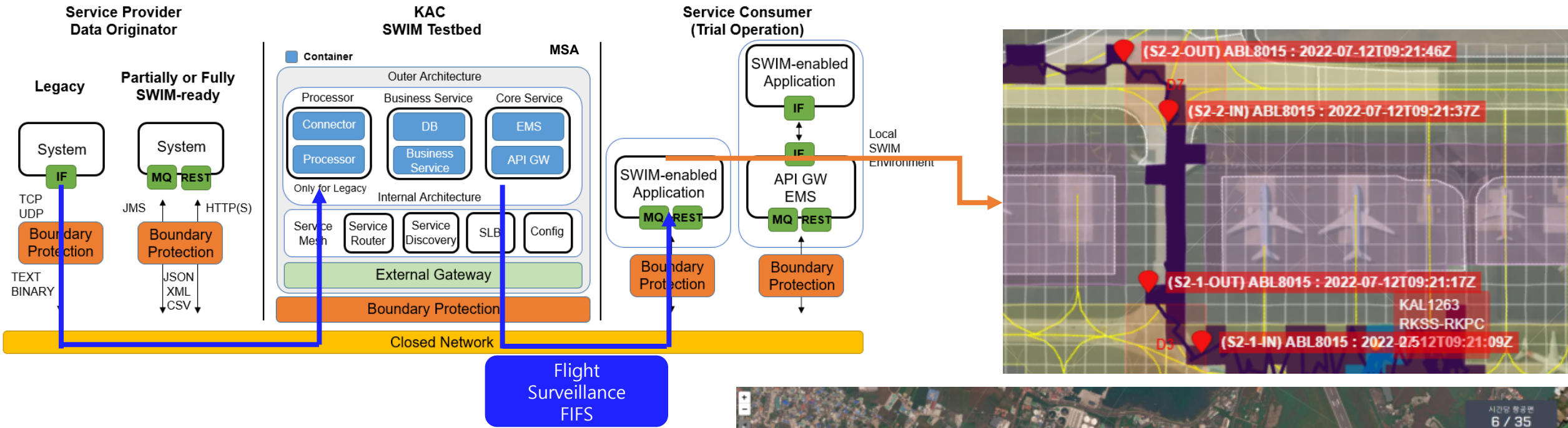


## ROK SWIM Trial Operation – OCC, KAC

- Operations control center, Headquarter(HQ), Korea Airports Corporation (KAC) manages airport operations plan and airport slot.
- Timestamping of a journey of an aircraft at an airport for key milestones and archiving data provides a rational foundation for airport slot analysis.
- The center receives surface movement data of Gimpo and Jeju Intl Airport in custom JSON format using an AMQP messaging



# ROK SWIM Trial Operation – OCC, KAC (cont')



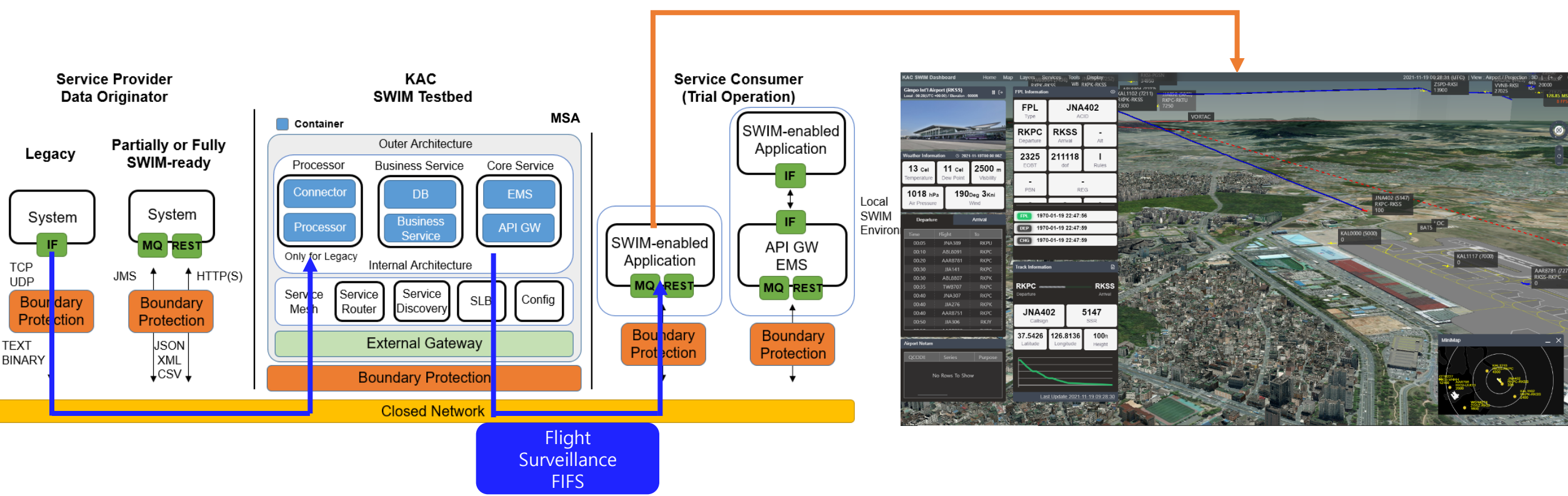


## ROK SWIM Trial Operation – Others

- Navigational Aid (NAVAID) business center monitors NAVAID facilities in ROK.
- Airside control tower, Gimpo international airport controls traffic in the airside area.
- Airport operation control center, HQ, Korea Airports Corporation (KAC), monitors 13 airports in ROK
- Participants receive information FPL, en-route surveillance data in FIR, surface movement data of Gimpo, Jeju and Incheon international Airport, and meteorological information (e.g., Meteorological Terminal Aviation Routine Weather Report (METAR), Significant Meteorological Information (SIGMET), Airmen's Meteorological Information (AIRMET), Terminal Area Forecast (TAF), Automated Meteorological Observation System (AMOS) using web service, and displays it to the 3D map application,



# ROK SWIM Trial Operation – Others (cont')





## Lesson Learnt

- Legacy systems should be prepared to provide information in the SWIM environment, and open-source or COTS products in the IT industry could help information processing and distribution
- Information in legacy formats also can be delivered using SWIM services. For example, ASTERIX is an efficient and commonly used format in the aviation industry, and there still is a need of consuming surveillance data in ASTERIX format. And, this might be needed during transition period.
- There should be an exchange model of information to be delivered in the SWIM environment (e.g., schema of XML or JSON) and the model should be defined and controlled by the eligible governance body.
- SWIM could be the robust enabler to share surveillance information seamlessly.
- SWIM service can contribute to providing information required for daily operations, especially for stakeholders who couldn't receive information before. (e.g., surveillance data)



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