

# The Research and Development of SWIM in ENRI

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Takafumi Nakada and Xiaodong Lu  
Surveillance and Communications Department  
Electronic Navigation Research Institute, Japan

May 16-18, 2016

# Agenda

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**1. Overview of ENRI**

**2. Background of SWIM**

**3. SWIM Concept**

**4. Comparison of Different Approaches**

**5. R&D in ENRI**

**6. Summary**

# Introduction of ENRI

## ➤ **Electronic Navigation Research Institute**

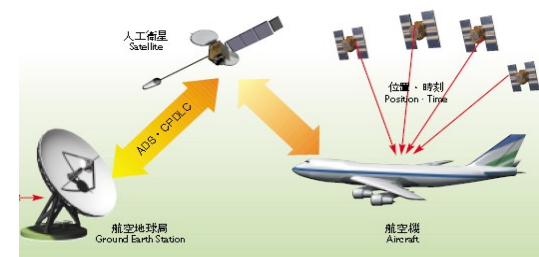
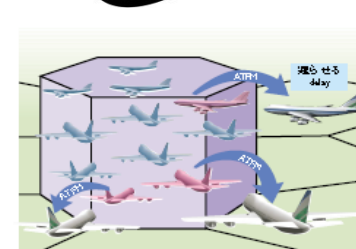
- Established in 1967 as a national laboratory
- Budget: 1.7 billion yen (FY2015)
- Personnel: 66 (46 researchers)

## ➤ **Major Research Areas**

- Air Traffic Management
- Navigation systems
- Surveillance and Communications

## ➤ **Major Roles**

- R&D and Test for future aviation systems
- Contribution to establishing technical standards for new aviation systems
- Improvement of present CNS/ATM Systems in Japan operated by JCAB



# Introduction of ENRI

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## ➤ Main Facilities

### Experimental Aircraft



King Air 350

### Radio Anechoic Chamber



Experimental Mode-S Radar

# Introduction of ENRI

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## ➤ Key Concepts of JCAB CARATS

- Trajectory-Based Operation (TBO)
- Improvement of Predictability
- Performance Based Operation (PBO)
- Total Satellite-based navigation
- Enhanced situation awareness
- Optimum human & machine capabilities
- Information sharing (SWIM) and CDM
- High density operation



ENRI will contribute to providing solutions

# Agenda

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**1. Overview of ENRI**

**2. Background of SWIM**

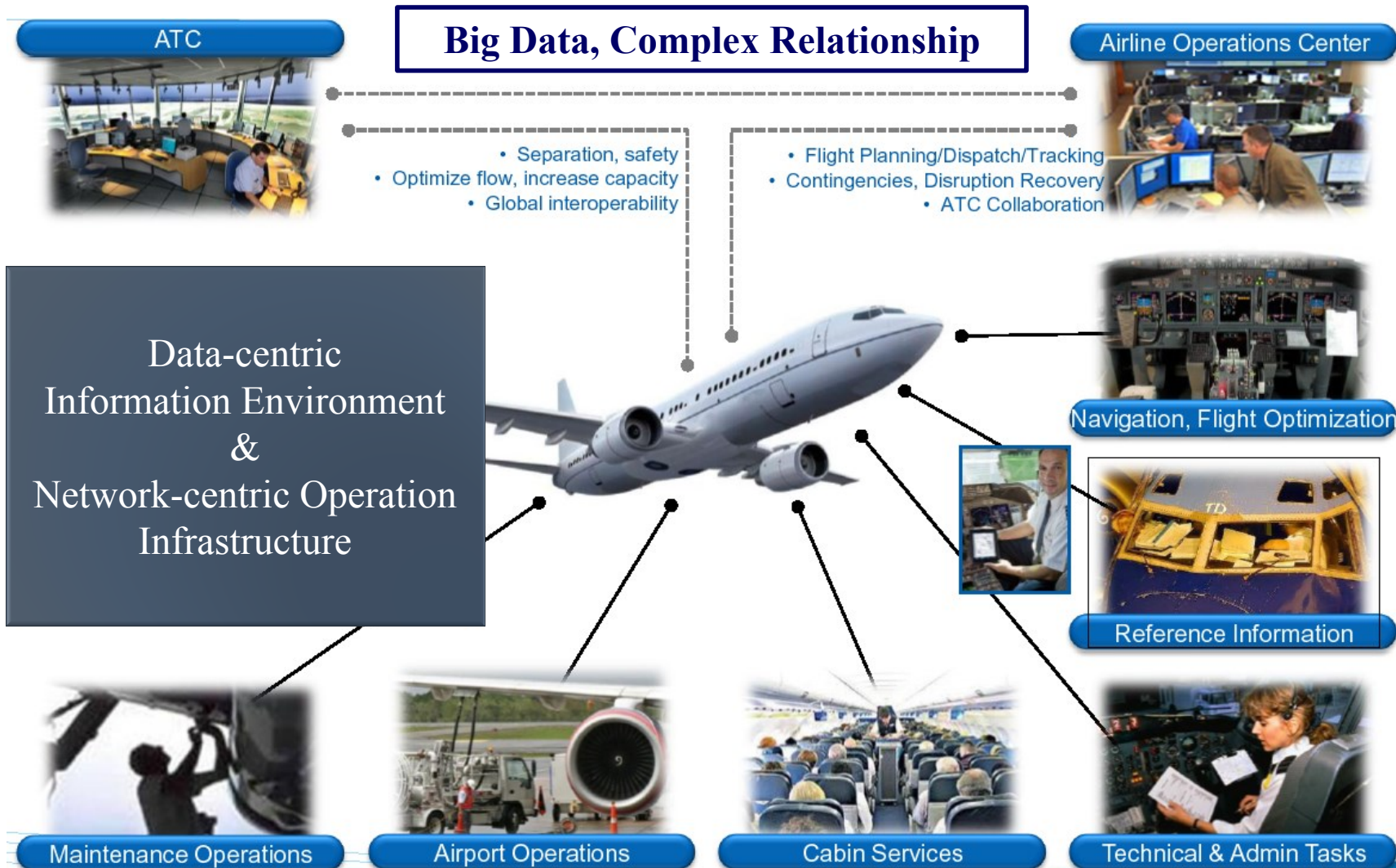
**3. SWIM Concept**

**4. Comparison of Different Approaches**

**5. R&D in ENRI**

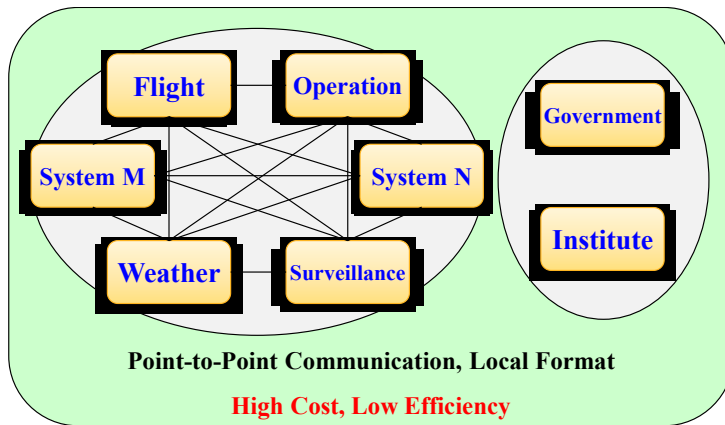
**6. Summary**

# Background: Air Traffic Management System

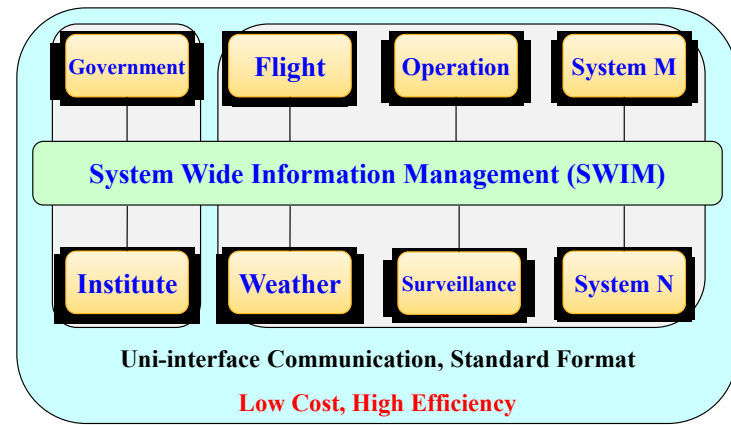


# Background: Technology Trend

**Current: Sum of Systems**



**Future: System of Systems**



	Communication	Information Exchange	Service Integration	Access	Security
Current	Point-to-Point	Local	Difficult	Local Members	Low

**Low Cost, High Efficiency, High Security**

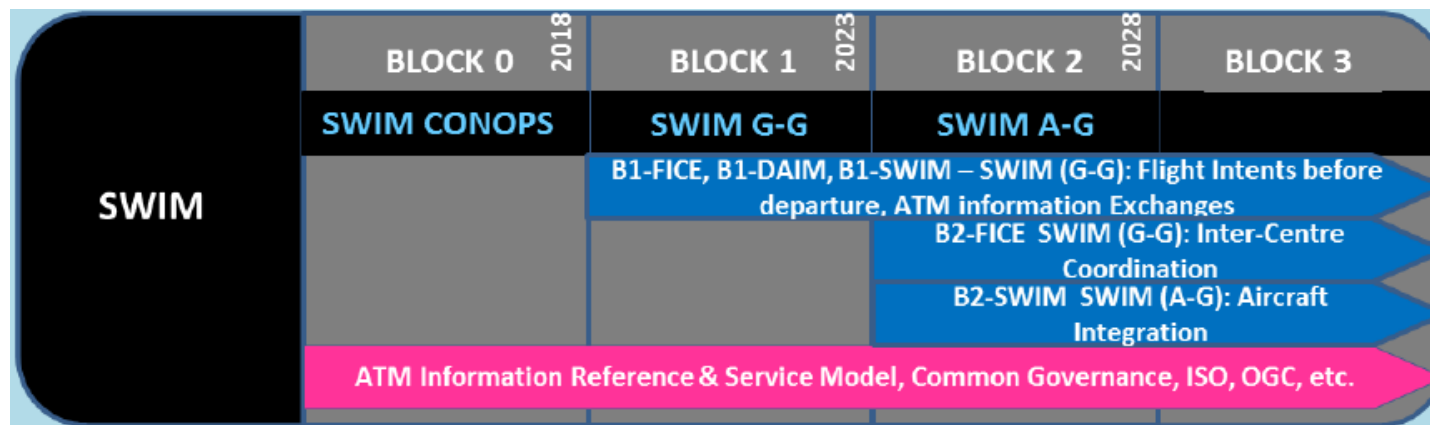
SWIM	Uni-interface	Global	Easy	Global Stakeholders	High
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# Background: International Trends

- ICAO: *Global Air Traffic Management Operational Concept* (2005) adopted the SWIM as an enabler to promote information-based ATM integration

## Aviation System Block Upgrades (2014)



Concept ⇒ Ground-to-Ground ⇒ Air-to-Ground

- EU: *Single European Sky ATM Research* (SESAR)
- US: *Next Generation Air Transportation System* (NextGen)

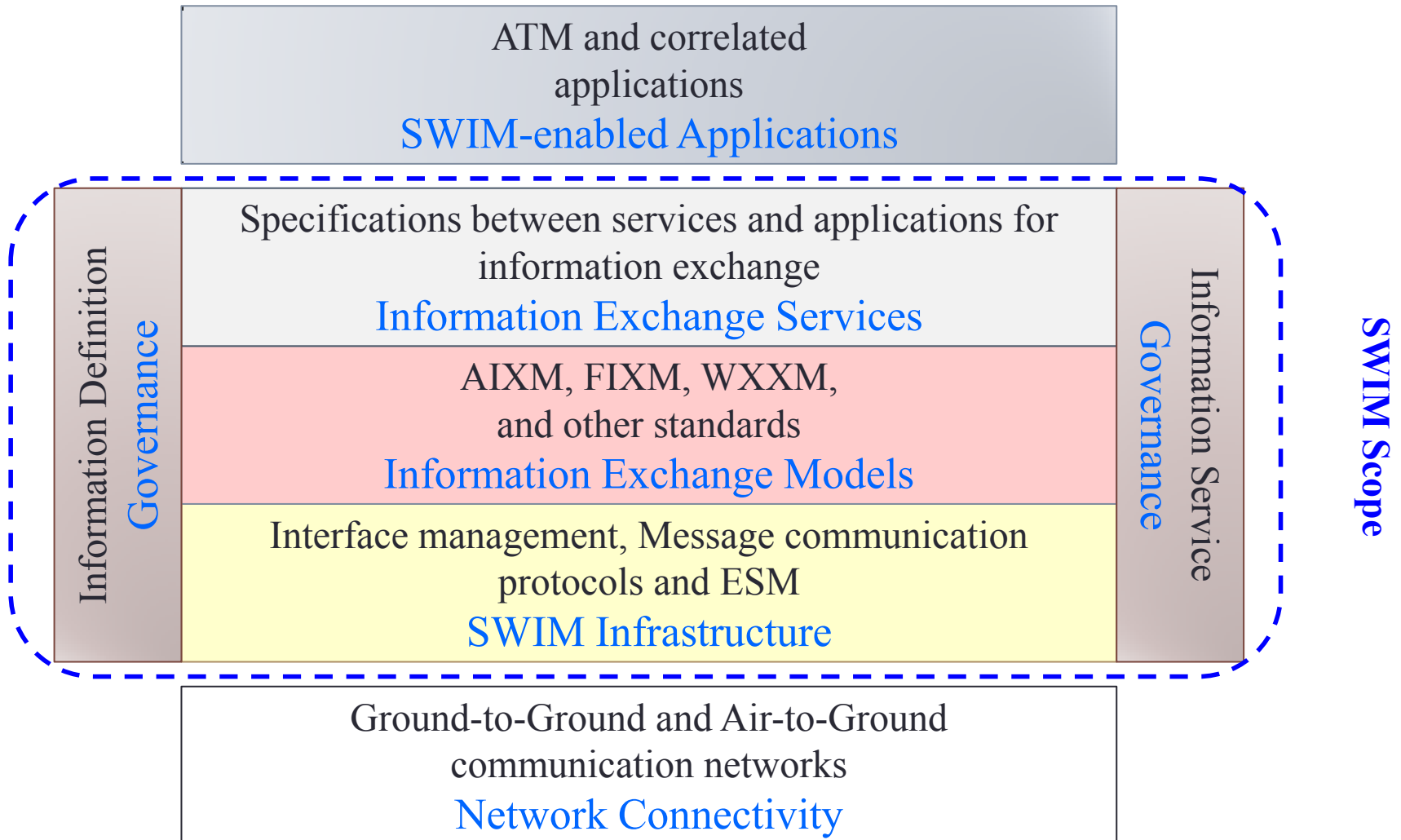
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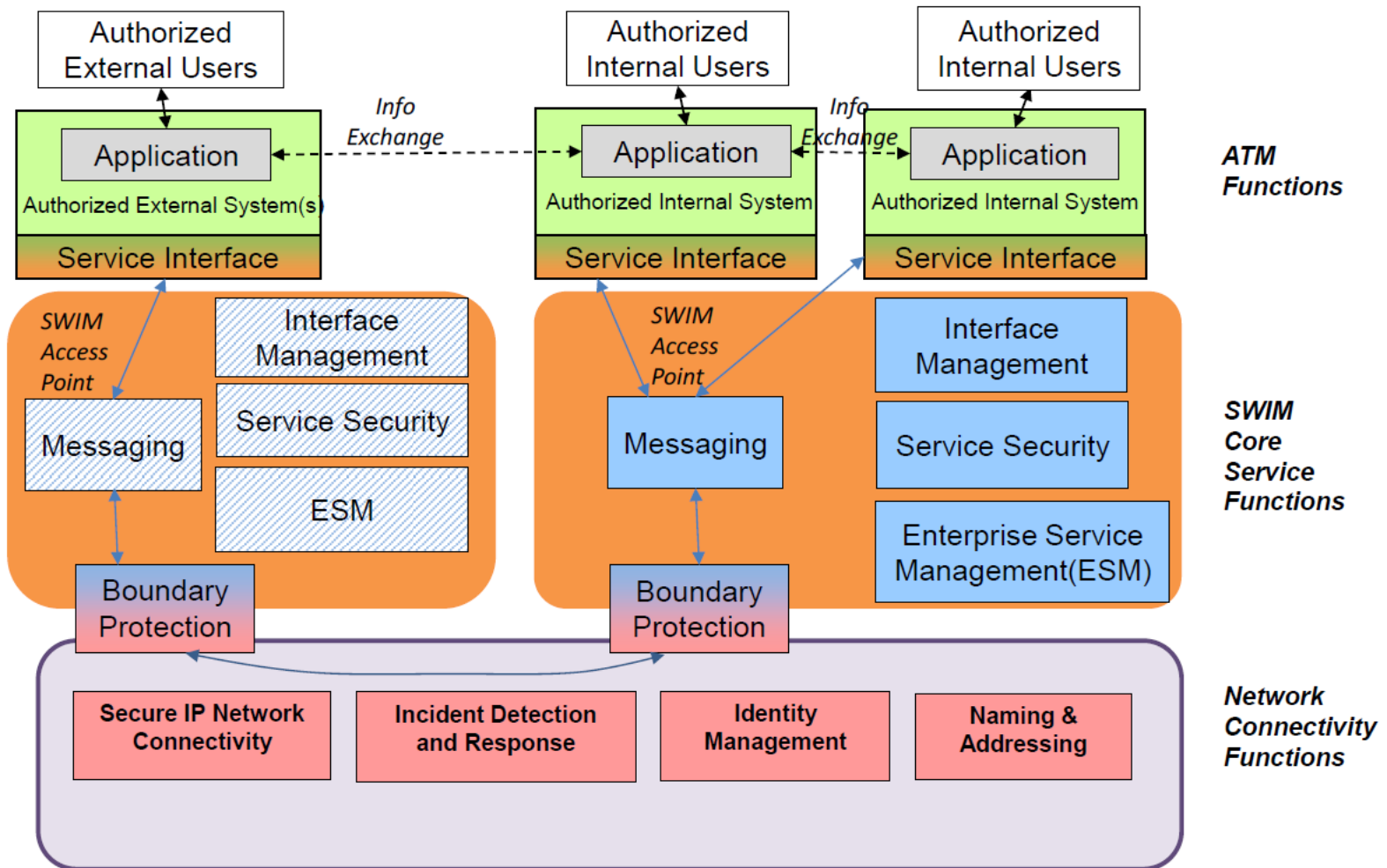
# SWIM Concept

## ➤ SWIM Framework



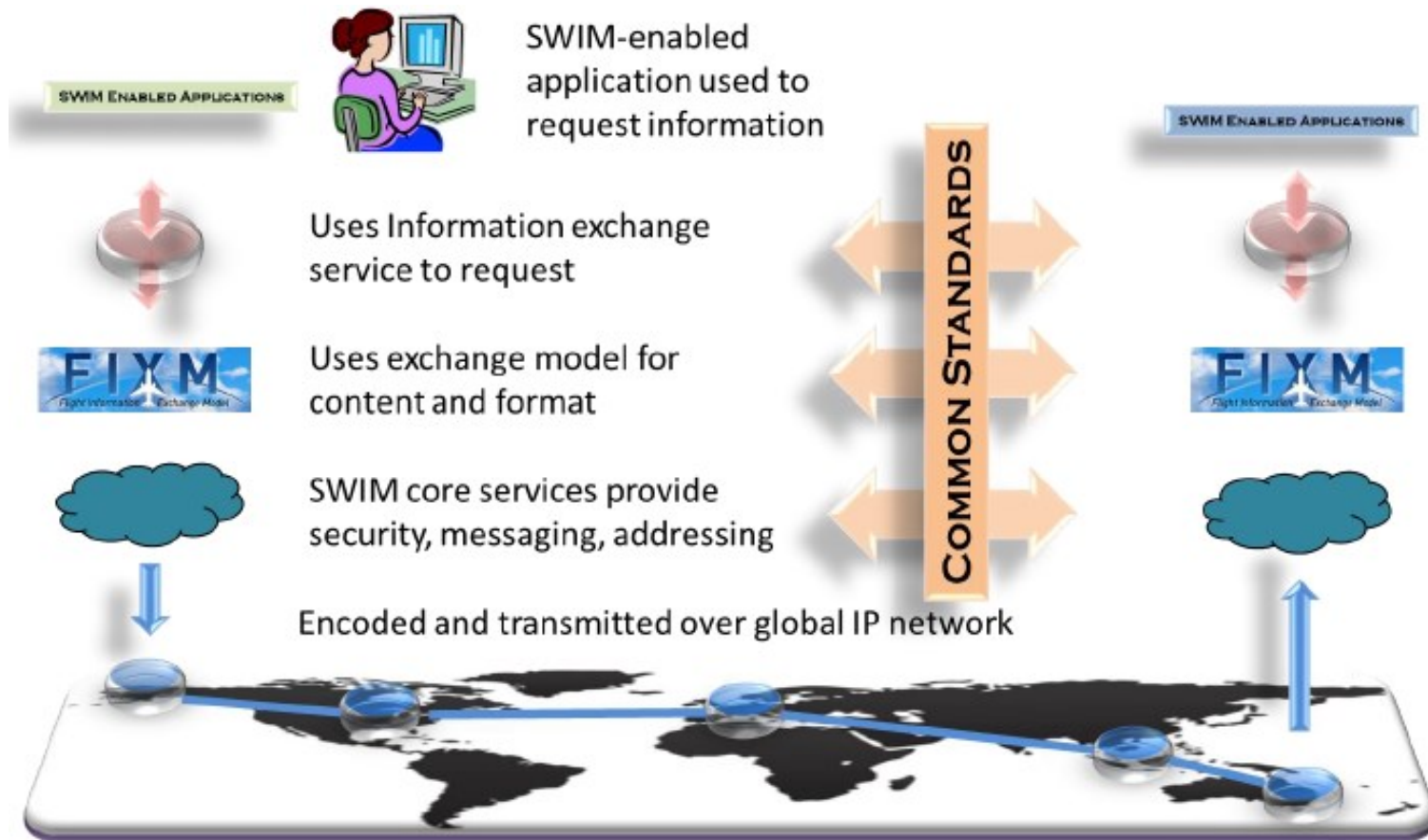
# SWIM Concept

## ➤ Functional Architecture



# SWIM Concept

## ➤ Information Exchange



# SWIM Concept

## ➤ Technical Standards

**In progress.....**

**AIXM 5.1: Aeronautical  
FIXM 3.0: Flight  
iWXXM 1.0: Weather**

**SNMP: Network Manage**

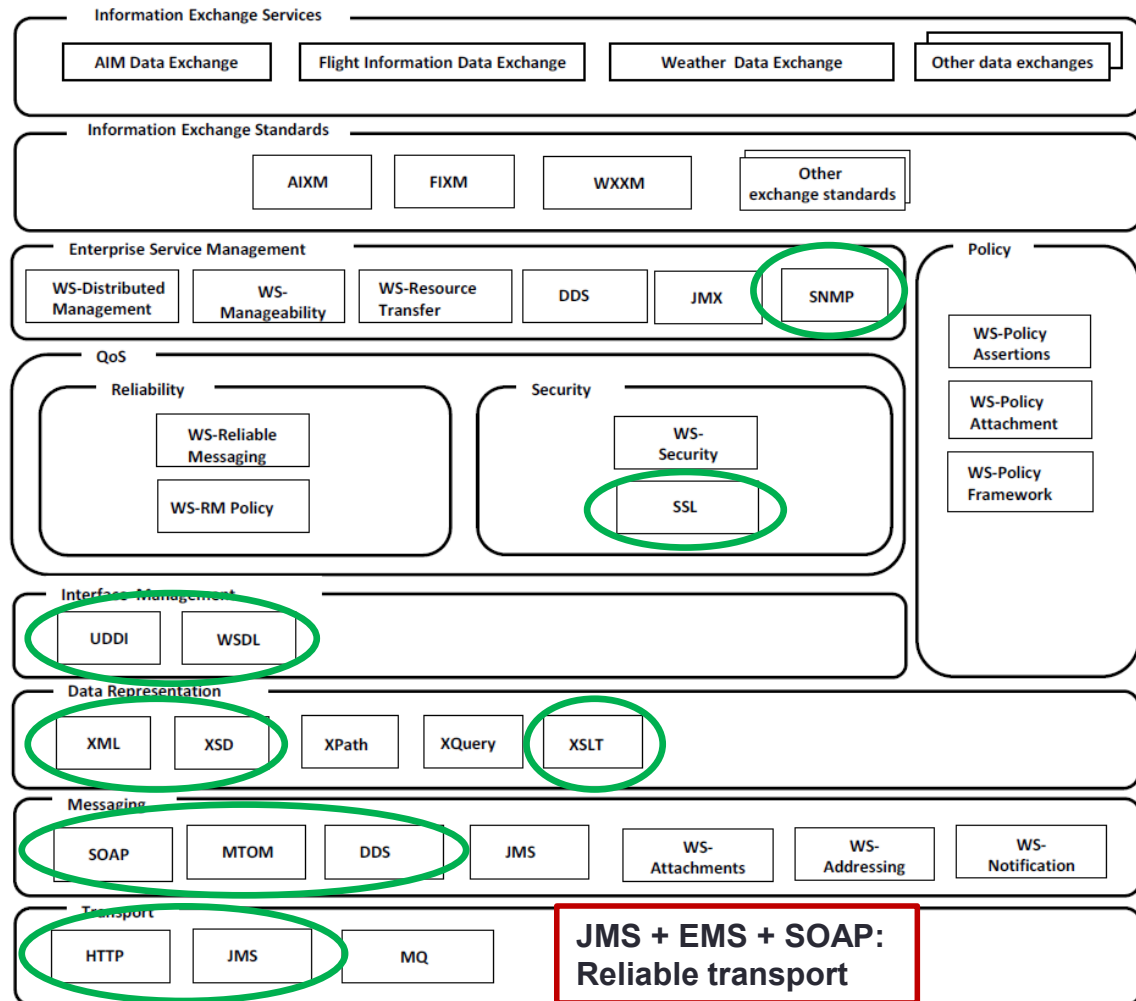
**Web Services (WS-\*) are supported by SOAP and WSDL**

**WSDL: Service  
UDDI: Discovery**

**XSD: Schema  
XSLT: Data transform**

**MTOM: Big data  
DDS: Real-time data**

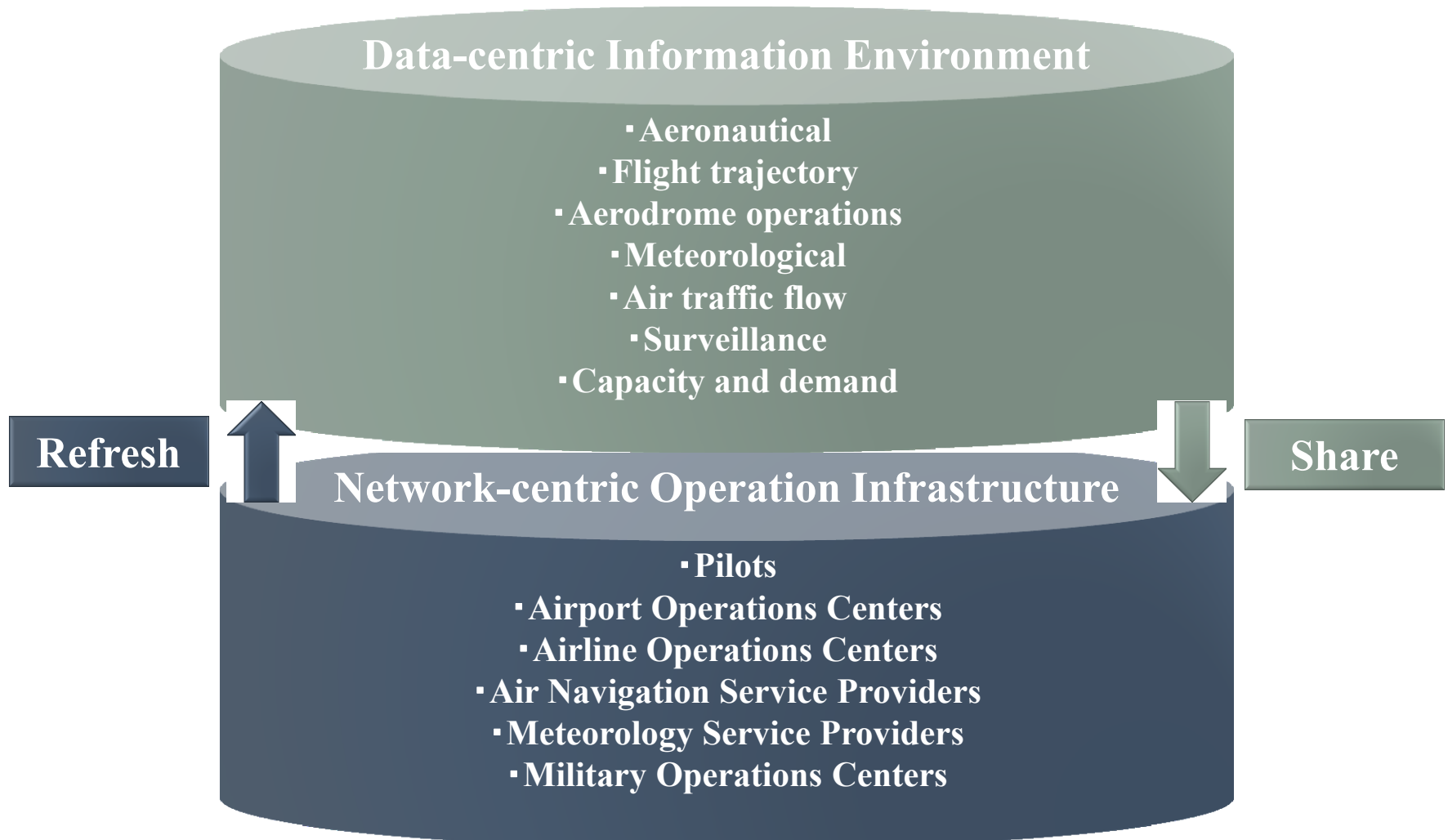
**HTTP + SOAP:  
Unreliable transport**



# SWIM Concept

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## ➤ Operation



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# Comparison of Different Approaches

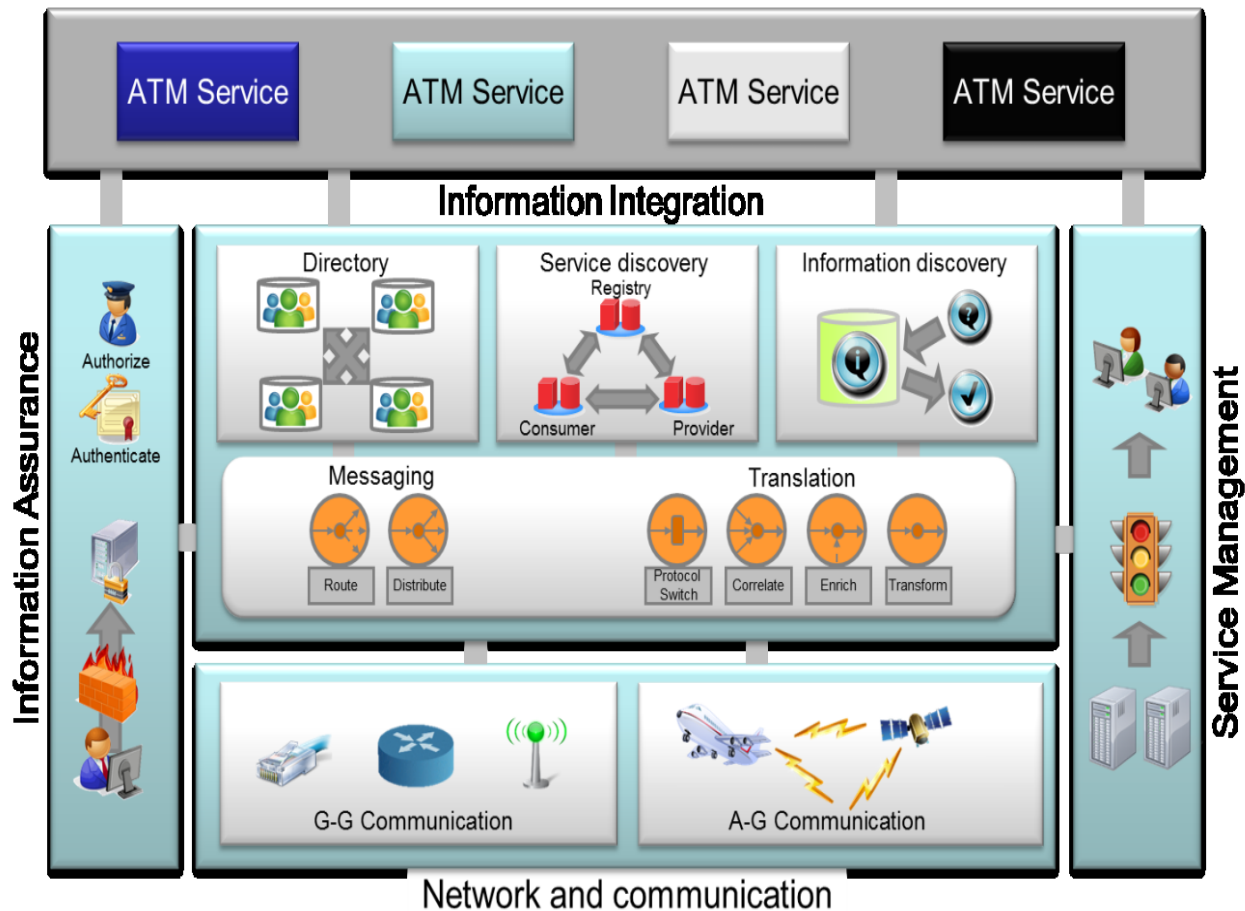
➤ **EU: SESAR**

**ATM Services and Applications**

**Standards and Services for Information Exchange:**  
**AIRM, ISRM**

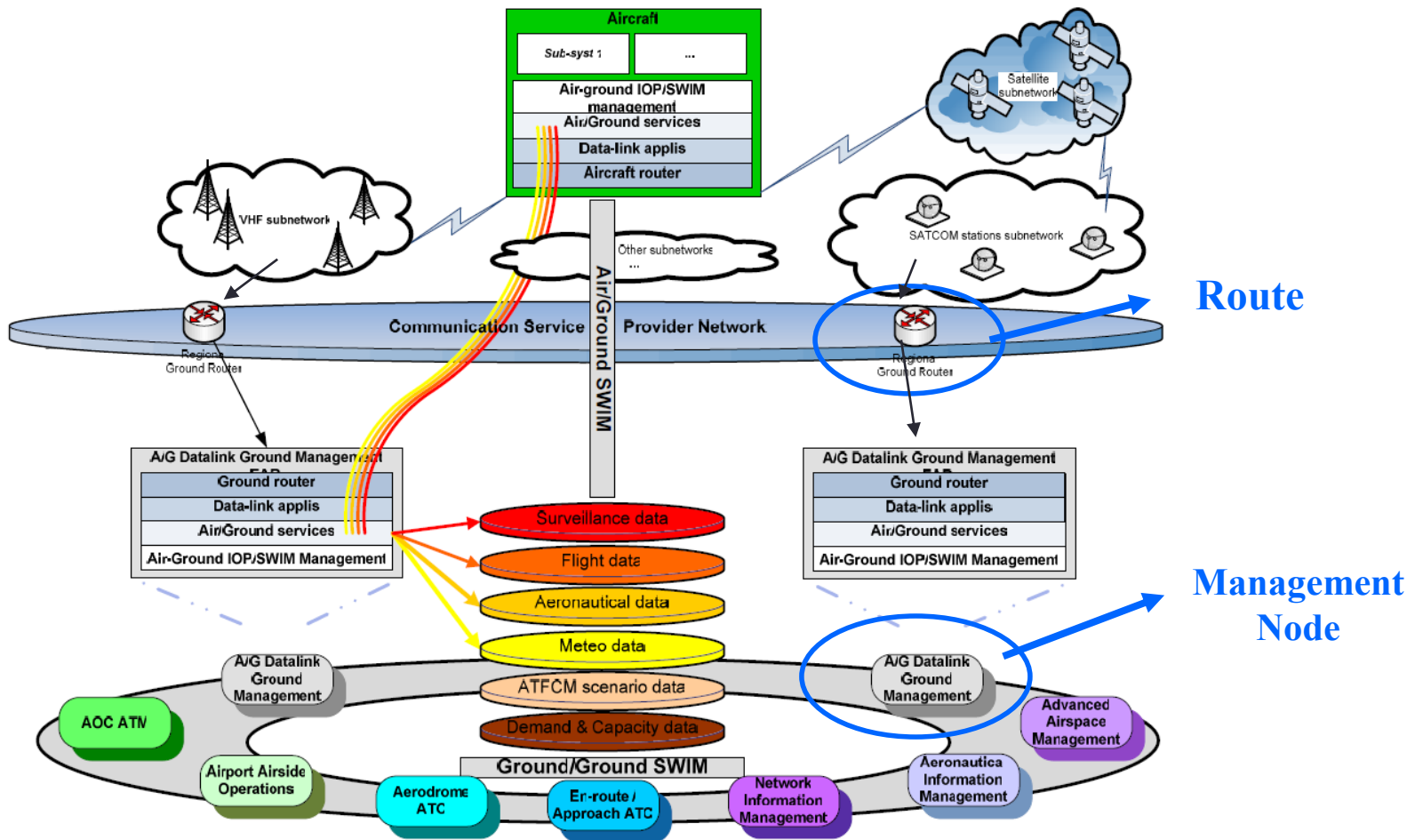
**Messaging Infrastructure:**  
**NM B2B Web Services**

**Network Infrastructure:**  
**Pan European Network System (PENS)**



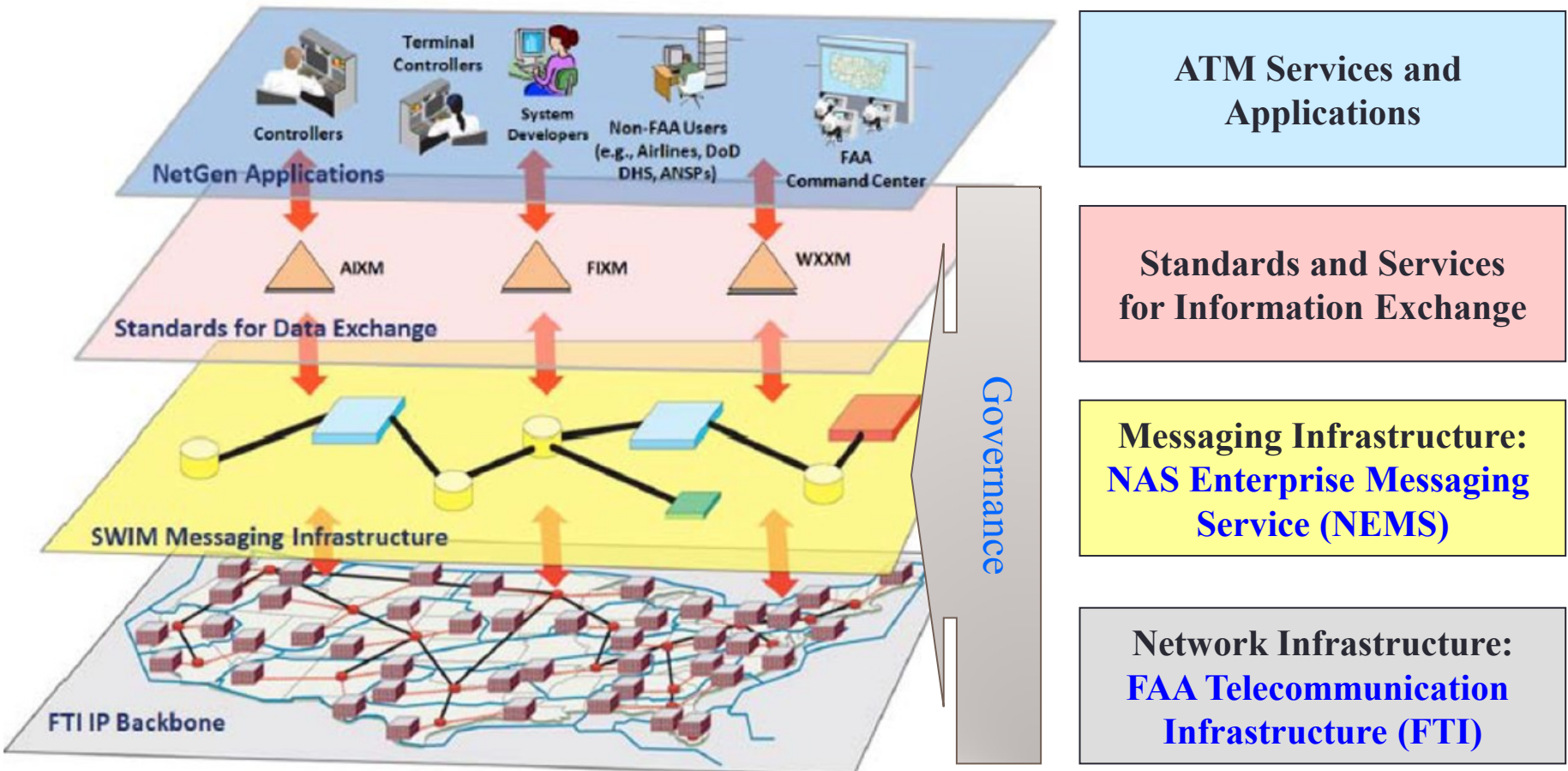
# Comparison of Different Approaches

## ➤ EU: SESAR



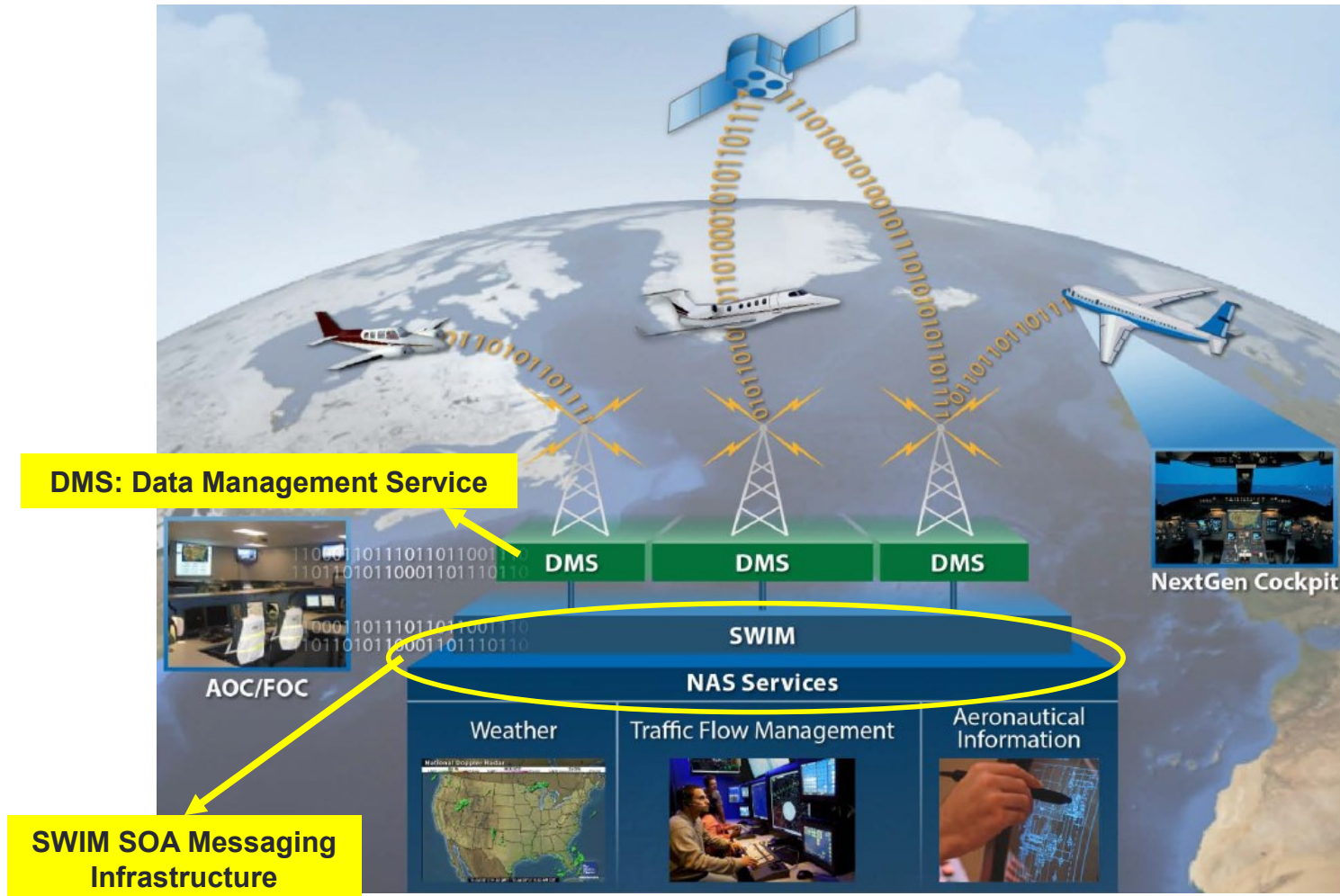
# Comparison of Different Approaches

## ➤ US: NextGen



# Comparison of Different Approaches

## ➤ US: NextGen



# Comparison of Different Approaches

## ➤ Comparison

	NextGen	SESAR
Network Infrastructure	FAA Telecommunication Infrastructure (FTI)	Pan European Network System (PENS)
Messaging Infrastructure	NAS Enterprise Messaging Service (NEMS)	NM B2B Web Services (SOAP, REST)
Standards for Data and Information	AIXM, WXXM, FIXM	AIRM, ISRM
Approach	Top-down Centralized	Bottom-up Decentralized
Governance and Supervision	FAA	EUROCONTROL

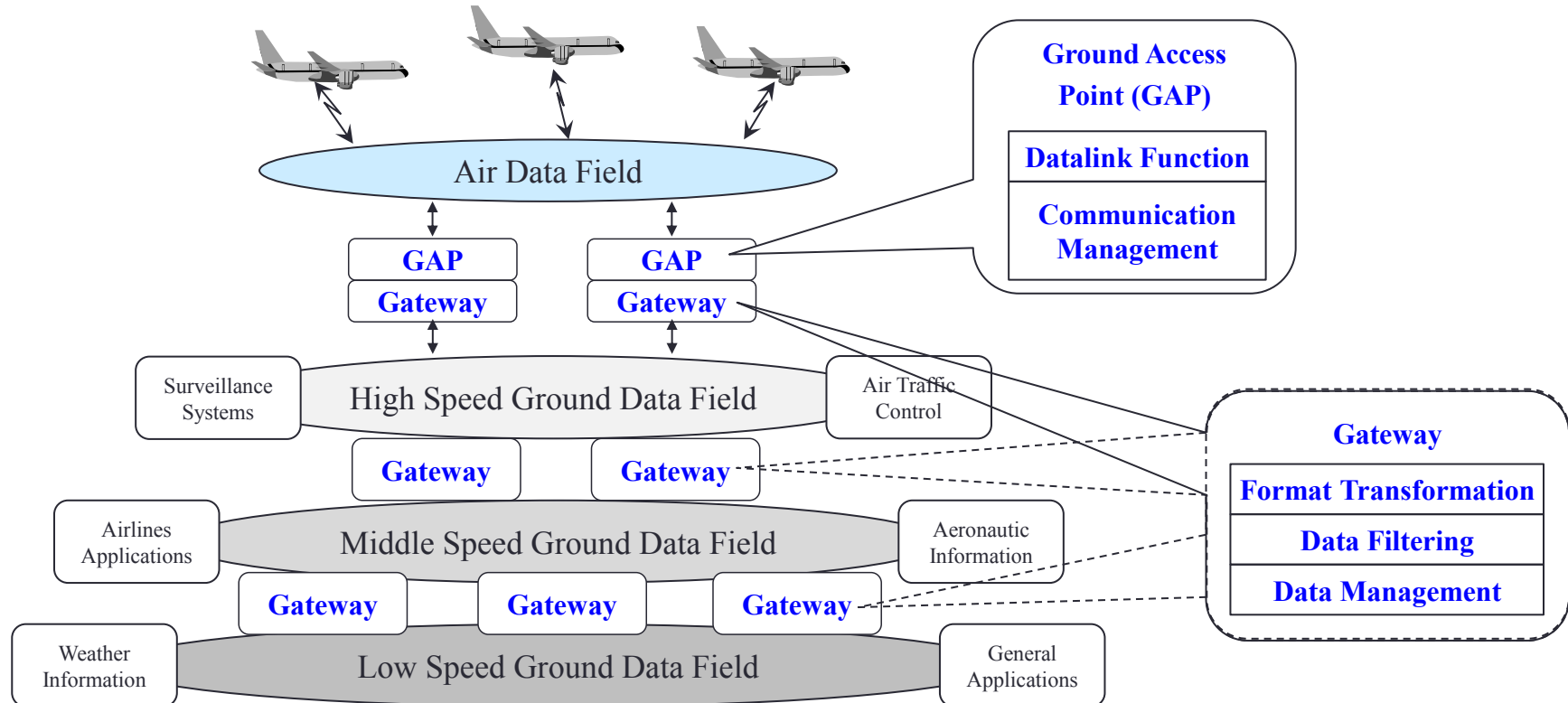
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# R&D of SWIM in ENRI

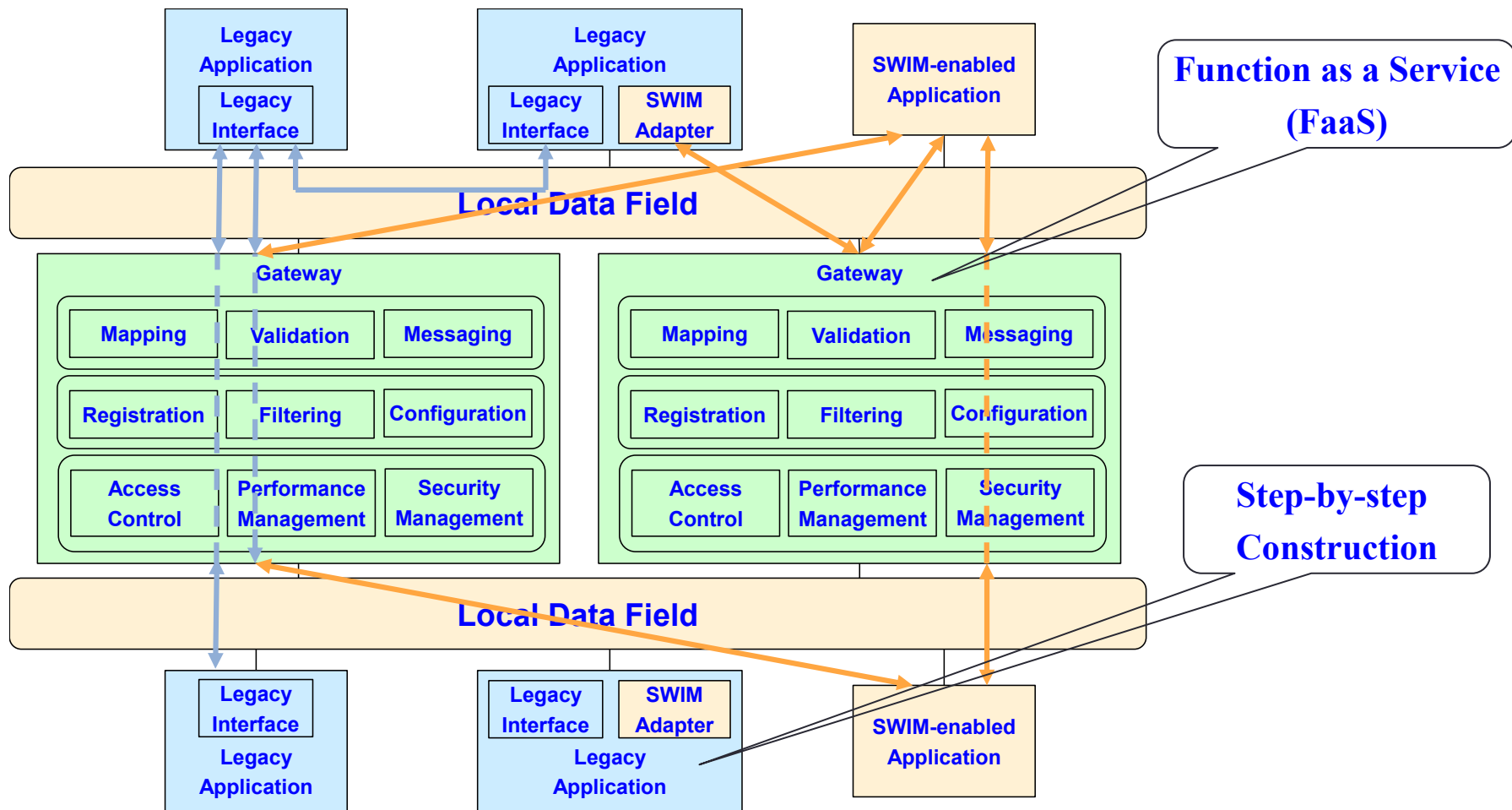
## ➤ Multi-layered System Architecture



- Information is layered by different real-time scale requirements
- Application is constructed by integrating heterogeneous information

# R&D of SWIM in ENRI

## ➤ Functional Architecture

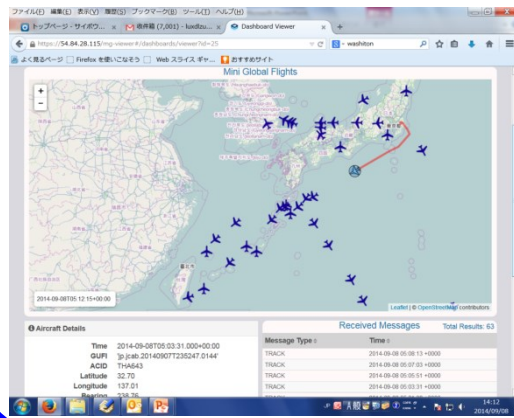




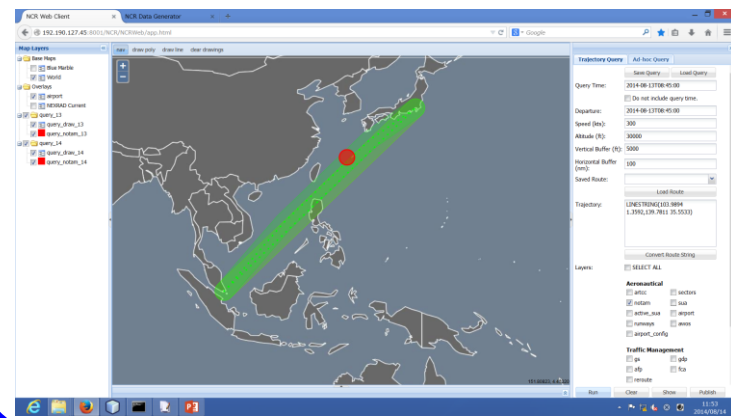
# R&D of SWIM in ENRI

## ➤ Mini Global I: Demonstration

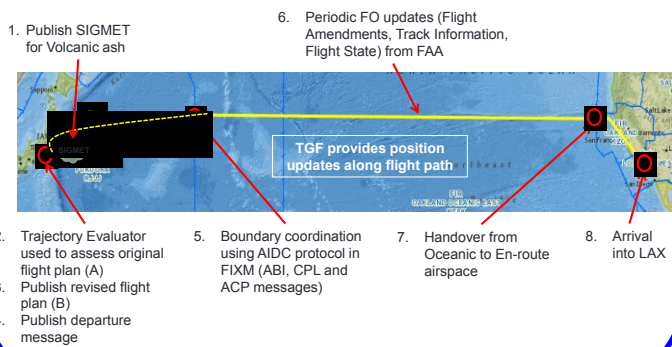
### Semi-live Flight Data



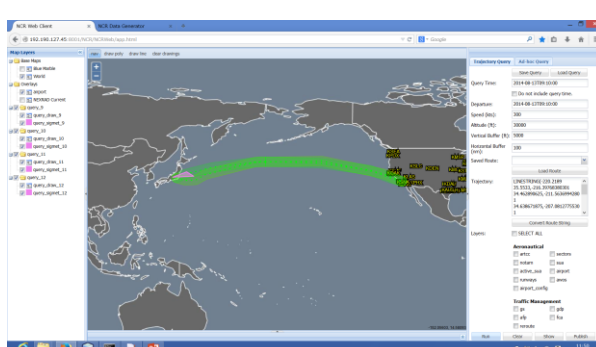
### Scenarios (CAAS and JCAB)



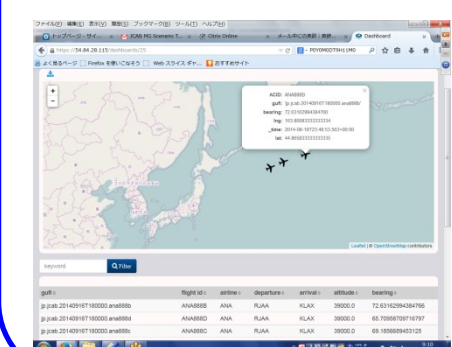
### Scenarios (FAA and JCAB)



### Information Integration



### Boundary Coordination



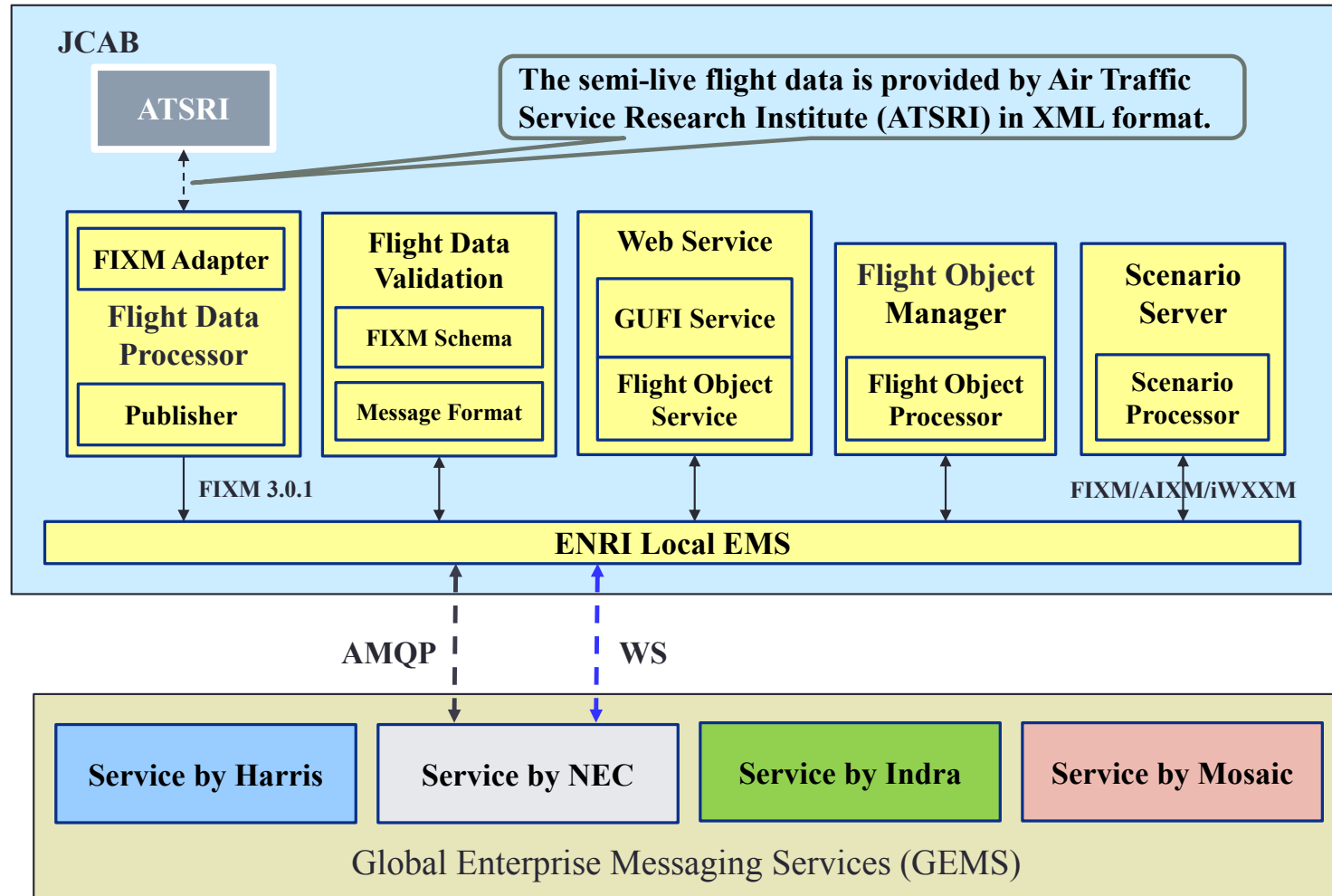
# R&D of SWIM in ENRI

## ➤ Mini Global II

	Mini Global I	Mini Global II
Overview	<p>The diagram for Mini Global I shows two main service providers: Service by Harris and Service by Indra. Service by Harris is connected to FAA (SL-4), Airservices (SL-4), JCAB (SL-4), and ROK (SL-4). Service by Indra is connected to Indra (SL-4). Above these are SL-3 entities: NavCanada, CAAS, and AEROTHAI connected to Harris; and NavPortugal connected to Indra. A dashed blue line separates the Harris and Indra sides.</p>	<p>The diagram for Mini Global II shows a 'Global SWIM' architecture. It consists of four regions: Region A (Service by Harris), Region B (Service by Indra), Region C (Service by Mosaic), and Region D (Service by Partner). Each region contains three nodes (Node 1, Node 2, Node 3). All regions are connected to a central 'Common Messaging' hub, which supports Request/Reply, Publish/Subscribe, and Open Standards.</p>
Platform	<b>Global Enterprise Messaging Service (GEMS)</b>	
Service Provider	Harris and Indra	Harris, Mosaic, Indra, NEC
Messaging Protocol	SOAP (Simple Object Access Protocol)	Pub / Sub: AMQP (Advanced Messaging Queuing Protocol) Request / Reply: SOAP, REST

# R&D of SWIM in ENRI

## ➤ Demonstration System



# R&D of SWIM in ENRI

## ➤ Services and Applications

### - Fight Object Manager

- > EMS Headers
- > Main elements
- > System time
- > FIXM message

### - Scenario Server

- > Message publish
- > Message subscribe
- > Flight viewer
- > Track generator

# R&D of SWIM in ENRI

## ➤ Services and Applications

AirCraft ID	Message Type	Gufi	Source	Time Stamp	Validation	Report
ANA77A	ARR	e1e86b3-3d22-44dc-b7fc-c9ab5509b2e9	FAA	2016-04-08T01:37:25.507Z	Invalid	
ANA77C	TRACK	e5ff089b-633f-4110-be2e-2fc175e4f353	FAA	2016-04-08T01:37:24.930Z	Success	
ANA77C	SDSS_EXTENSION	e5ff089b-633f-4110-be2e-2fc175e4f353	FAA	2016-04-08T01:37:25.504Z	Invalid	
ANA77C	TRACK	e5ff089b-633f-4110-be2e-2fc175e4f353	FAA	2016-04-08T01:37:23.931Z	Success	
ANA77C	TRACK	e5ff089b-633f-4110-be2e-2fc175e4f353	FAA	2016-04-08T01:37:21.930Z	Success	
ANA77C	TRACK	e5ff089b-633f-4110-be2e-2fc175e4f353	FAA	2016-04-08T01:37:22.929Z	Success	
ANA77C	TRACK	e5ff089b-633f-4110-be2e-2fc175e4f353	FAA	2016-04-08T01:37:19.929Z	Success	
ANA77C	TRACK	e5ff089b-633f-4110-be2e-2fc175e4f353	FAA	2016-04-08T01:37:20.930Z	Success	
ANA77C	TRACK	e5ff089b-633f-4110-be2e-2fc175e4f353	FAA	2016-04-08T01:37:17.929Z	Success	
ANA77C	TRACK	e5ff089b-633f-4110-be2e-2fc175e4f353	FAA	2016-04-08T01:37:18.930Z	Success	
ANA77C	TRACK	e5ff089b-633f-4110-be2e-2fc175e4f353	FAA	2016-04-08T01:37:15.930Z	Success	
ANA77C	TRACK	e5ff089b-633f-4110-be2e-2fc175e4f353	FAA	2016-04-08T01:37:16.931Z	Success	
ANA77C	TRACK	e5ff089b-633f-4110-be2e-2fc175e4f353	FAA	2016-04-08T01:37:13.930Z	Success	
ANA77C	TRACK	e5ff089b-633f-4110-be2e-2fc175e4f353	FAA	2016-04-08T01:37:14.928Z	Success	
ANA77C	TRACK	e5ff089b-633f-4110-be2e-2fc175e4f353	FAA	2016-04-08T01:37:12.927Z	Success	
ANA77C	TRACK	e5ff089b-633f-4110-be2e-2fc175e4f353	FAA	2016-04-08T01:37:10.927Z	Success	
ANA77C	TRACK	e5ff089b-633f-4110-be2e-2fc175e4f353	FAA	2016-04-08T01:37:11.927Z	Success	
ANA77C	TRACK	e5ff089b-633f-4110-be2e-2fc175e4f353	FAA	2016-04-08T01:37:08.927Z	Success	
ANA77C	TRACK	e5ff089b-633f-4110-be2e-2fc175e4f353	FAA	2016-04-08T01:37:09.929Z	Success	
ANA77C	TRACK	e5ff089b-633f-4110-be2e-2fc175e4f353	FAA	2016-04-08T01:37:06.927Z	Success	

```

1 <?xml version="1.0" encoding="UTF-8"?>
2 <fx:Flight centre="EEX" flightFiler="" flightType="MOM_SCHEDULED"
3   remark="" source="TBM" system="TBM"
4   timestamp="2016-03-18T15:28:05.781Z"
5   xmlns:fa="http://www.fixm.aero/ext/fa/3.0"
6   xmlns:ff="http://www.fixm.aero/base/3.0"
7   xmlns:ffn="http://www.fixm.aero/foundation/3.0"
8   xmlns:fa="http://www.fixm.aero/flight/3.0"
9   xmlns:sdas="http://www.fixm.aero/ext/sdas/3.0"
10  xmlns:xm="http://www.w3.org/2001/XMLSchema" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
11 <fx:extensions xsi:type="fa:SupplementalMeteringDataType">
12   <fa:meteringData>
13     <fa:meterReferencePointName>15K</fa:meterReferencePointName>
14     <fa:meterReferencePointType>HORIZONTAL</fa:meterReferencePointType>
15     <fa:scheduledMeterCrossingTime>2016-03-18T16:36:00.000Z</fa:scheduledMeterCrossingTime>
16     <fa:meterFixDelayTimeMa>3724000</fa:meterFixDelayTimeMa>
17     <fa:frozenFlightIndicator>true</fa:frozenFlightIndicator>
18     <fa:locationIdentifier>S46</fa:locationIdentifier>
19     <fa:source>151</fa:source>
20   </fa:meteringData>
21   <fa:meteringData>
22     <fa:meterReferencePointName>MGMAT_</fa:meterReferencePointName>
23     <fa:meterReferencePointType>VERTICAL</fa:meterReferencePointType>
24     <fa:scheduledMeterCrossingTime>2016-03-18T16:24:24.000Z</fa:scheduledMeterCrossingTime>
25     <fa:meterFixDelayTimeMa>3497000</fa:meterFixDelayTimeMa>
26     <fa:frozenFlightIndicator>true</fa:frozenFlightIndicator>
27     <fa:locationIdentifier>S46</fa:locationIdentifier>
28     <fa:source>151</fa:source>
29   </fa:meteringData>
30 </fx:extensions>
31 </fx:gufi codeSpace="urn:uuid">294609be-bde0-41d4-bd4b-0d3d8fc3370c</fx:gufi>
32 </fx:Flight>
    
```

### FIXM\_3\_0 : Schema Validation

Type	Status Message
Schema Validation Error	Line : 11 - Column : 62 :- cvc-elt.4.2: Cannot resolve 'fa:SupplementalMeteringDataType' to a type definition for element 'fx:extensions'. Line : 30 - Column : 19 :- cvc-complex-type.2.1: Element 'fx:extensions' must have no character or element information item [children], because the type's content type is empty.

### Business Rules Validation

Type	Status Message
WARNING !	* Check Fixm Format of Message

## - Flight Data Validation

- > FIXM schema validation
- > Message format validation

# R&D of SWIM in ENRI

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## ➤ Challenges

	Challenges
<b>Information</b>	<ul style="list-style-type: none"><li>• Coexistence of old and new data</li></ul>
<b>Local →</b>	<ul style="list-style-type: none"><li>• Different requirements for information qualities</li></ul>
<b>Global</b>	<ul style="list-style-type: none"><li>• Coordination of heterogeneous services</li></ul>
<b>Communication</b>	<ul style="list-style-type: none"><li>• To assure the real-time communication in different scales for heterogeneous data</li></ul>
<b>P2P →</b>	<ul style="list-style-type: none"><li>• To assure the seamless communication among</li></ul>
<b>M2M</b>	<ul style="list-style-type: none"><li>• heterogeneous systems</li></ul>
<b>Evaluation</b>	<ul style="list-style-type: none"><li>• To evaluate legacy functions in the SWIM system environment</li></ul>
<b>Closed →</b>	<ul style="list-style-type: none"><li>• To evaluate SWIM technologies in the local and global</li></ul>
<b>Open</b>	<ul style="list-style-type: none"><li>• environment</li></ul>

# R&D of SWIM in ENRI

## International Workshop on Service Assurance in System Wide Information Management

**Call for Papers**

**SASWIM 2015**  
The First International Workshop on  
Service Assurance in System Wide Information Management

March 25-27, 2015 Taichung, Taiwan.

This workshop will be held in conjunction with the 12th International Symposium on Autonomous Decentralized Systems (ISADS 2015, <http://isads2015.asia.edu.tw/>)

**General Co-Chairs:**  
Ramzi Saker, Embry-Riddle  
Aeronautical University, USA.  
Tadashi Koga, ENRI, Japan.

**Program Committee Co-Chairs:**  
Rainer Koelle, EuroControl, Belgium  
Xiaodong Lu, ENRI, Japan  
Kenji Yoshigoe, University of  
Arkansas at Little Rock, USA.

**Program Committee:**  
(Being formed)  
Naveed Al-Salhi, University of  
Kurdistan-Herbil, Iraq.  
Jiang Elam, University of Arkansas  
for Medical Sciences, USA.  
Jaeheik Chung, Inha Univ., Korea.  
Atrushi Kanao, Hosei Univ., Japan.  
Chin E. Lin, National Chen Kung  
University, Taiwan.  
Takao Okubo, Institute of  
Information Security, Japan.  
Ming Qi, CAAC/ATMB, China.  
Yusuto Sumiya, ENRI, Japan.

**Important Dates:**  
Paper submission due: ..  
October 31, 2014.  
Author notification: ..  
November 30, 2014.  
Final manuscript due: ..  
December 31, 2014.

**Contact information of the workshop organizer:**  
Xiaodong Lu, ENRI, Japan.  
luxd@enri.gov.jp.

**Scope:**  
With the advancement of business globalization and technology standardization, the requirement for constructing an "interoperability environment" which allows different stakeholders and heterogeneous systems to cope with the full complexity of real-time operational information exchanges has been increasing. To achieve harmonized and collaborative operation, the System Wide Information Management (SWIM) concept has been proposed and has been applying in the current Global Air Traffic Management (ATM) System. Service Assurance in the SWIM is defined as capability of guaranteeing the quality of data, information and service provision and utilization during the entire life cycle of a mission critical operation system under heterogeneous and changing requirements.

The objective of the Workshop is to provide the premier interdisciplinary forum for academic and industry professionals to discuss recent progress in the area of system and network architecture, software implementation, test-bed developments, experiments, evaluation and analysis of SWIM concept based global ATM integration and related applications.

Topics of interest for this workshop include, but are not limited to: ..

- SOA and Cloud technologies for service assurance.
- Communication and network technologies for service assurance.
- Modeling, simulation, evaluation, validation and analysis of SWIM concept based applications.
- Data, information and service management.
- Safe and secure air transportation system.
- Security issues for information management.
- Aircraft/airline operation for service assurance.
- Air/ground integration.
- Trajectory based operations.
- Surveillance and situational awareness.
- Improved environmental performance.
- Aviation related data, information and service delivery.
- System level standardization.

**Information for Authors:**  
Prospective authors are invited to submit full papers (IEEE double-column conference paper format, 6 pages) to describe original work (not submitted or published elsewhere). Authors are also invited to submit digest papers (IEEE double-column conference paper format, 2-4 pages) to show research results recently obtained in industry or academia. All accepted papers will be presented at the conference and published in the ISADS 2015 Proceedings. At least one of the authors of each accepted paper must register and present the paper at ISADS 2015. Authors must submit their manuscripts electronically following the instructions at the ISADS 2015 web site at: <http://isads2015.asia.edu.tw/> and choose the SASWIM2015 workshop when submitting.



March 26-27, 2015, Taichung, Taiwan



**ISADS 2015**

**2015 IEEE Twelfth International Symposium on Autonomous Decentralized Systems**

**25-27 March 2015, Taichung, Taiwan**



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# Summary

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## Background

### Glocalization

Global Business and Local Market

### Standardization

Information and Communication

## Requirements

### Interoperability

Data-centric Information

### Harmonization

Network-centric Operation

## Approaches

Promote local SWIM research and development

Enhance regional and international cooperation

# Welcome to SASWIM 2017



March 22-24, 2017, Bangkok, Thailand

