

# SWIM実証実験の報告と分析

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2016年6月10日

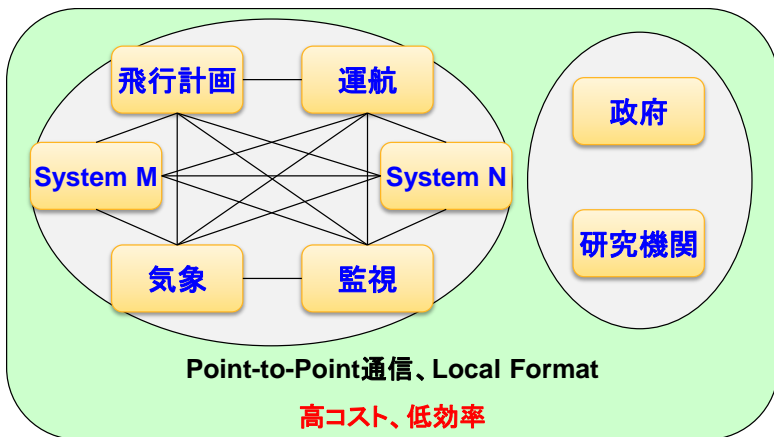
# Agenda

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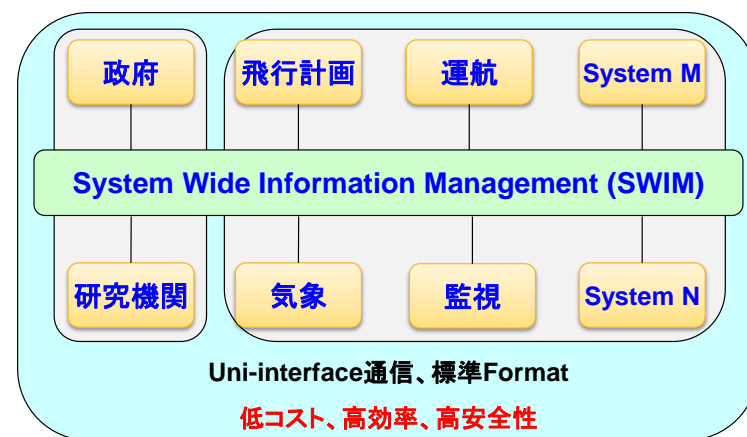
1. 背景
2. SWIMの概念
3. Mini Global Demonstration
4. 実験システムとシナリオ
5. 分析評価
6. まとめ

# 背景：航空交通情報システム

現在：Sum of Systems



将来：System of Systems



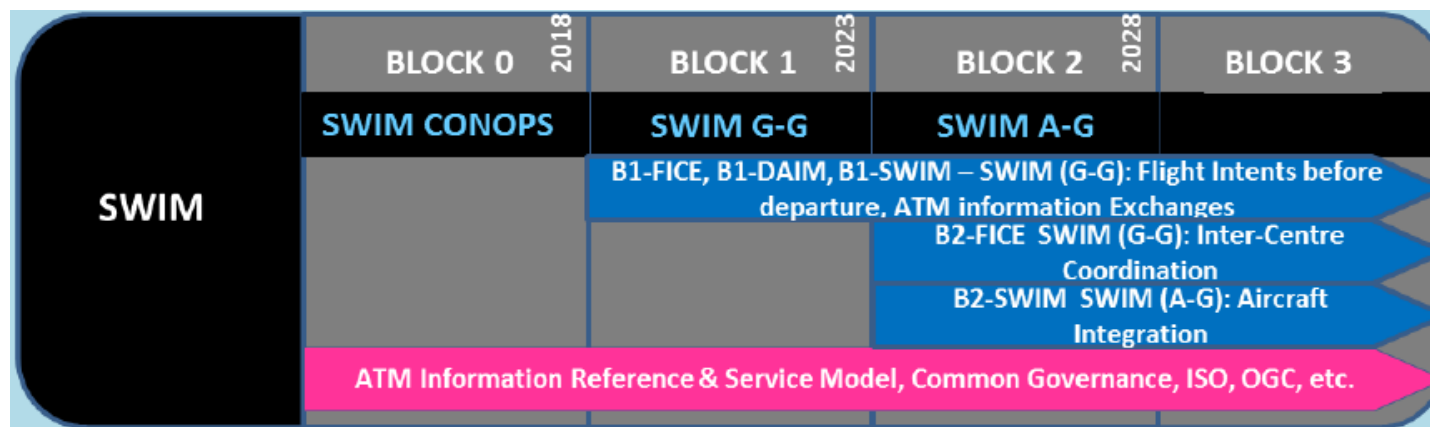
	通信	情報交換	サービス融合	アクセス	Security
現状	Point-to-Point	Local	個別運用、困難	特定少数	低

- ・次世代のシームレスな航空交通管理を実現するため、必要な者が必要としている情報をいつでも利用可能な環境
- ・世界規模による協調的な意思決定に耐え得る品質が確保できる情報管理の仕組み

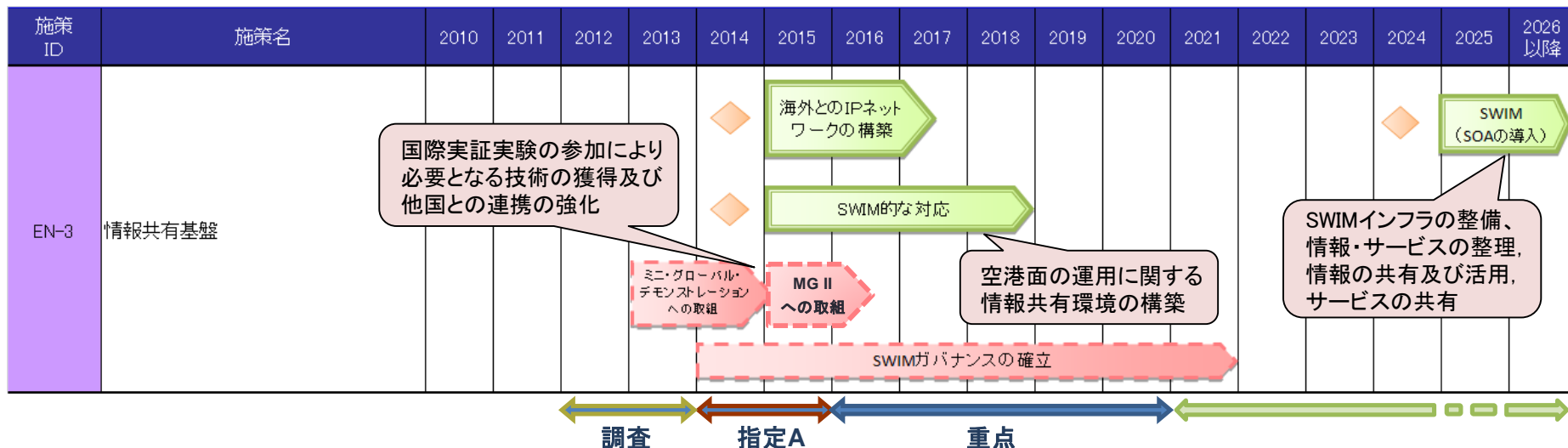
SWIM	Uni-interface	Global	標準化、容易	特定多数、または不特定多数	高
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# 背景：技術ロードマップ

## ➤ ICAO: Aviation System Block Upgrades (2014)



## ➤ CARATS: 技術ロードマップ(2015)



# 背景: 研究開発動向

	米国	欧州	日本	アジア 太平洋
航空交通専用 ネットワーク インフラ	有 FAA Telecommunication Infrastructure (FTI)	無 Pan European Network System (PENS)を利用	△ Cas.Net	構築予定
航空交通専用 メッセージング インフラ	有 NAS Enterprise Messaging Service (NEMS)	無 NM B2B Web Services を使用	無	無
情報、 サービスの構造	FIXM, AIXM, WXXM NCR (NAS Common Repository)	AIRM ISRM	無	無
システム アーキテクチャ	NEMS based 集中型システム	Web based 分散型システム	統合型	連携型
評価用 テストベッド	有 Mini Global Demonstration	有 SWIM Master Class	無 実証実験参加	無
Approach and Governance	Top-down FAA	Bottom-up EUROCONTROL	産官学	SWIM-WG

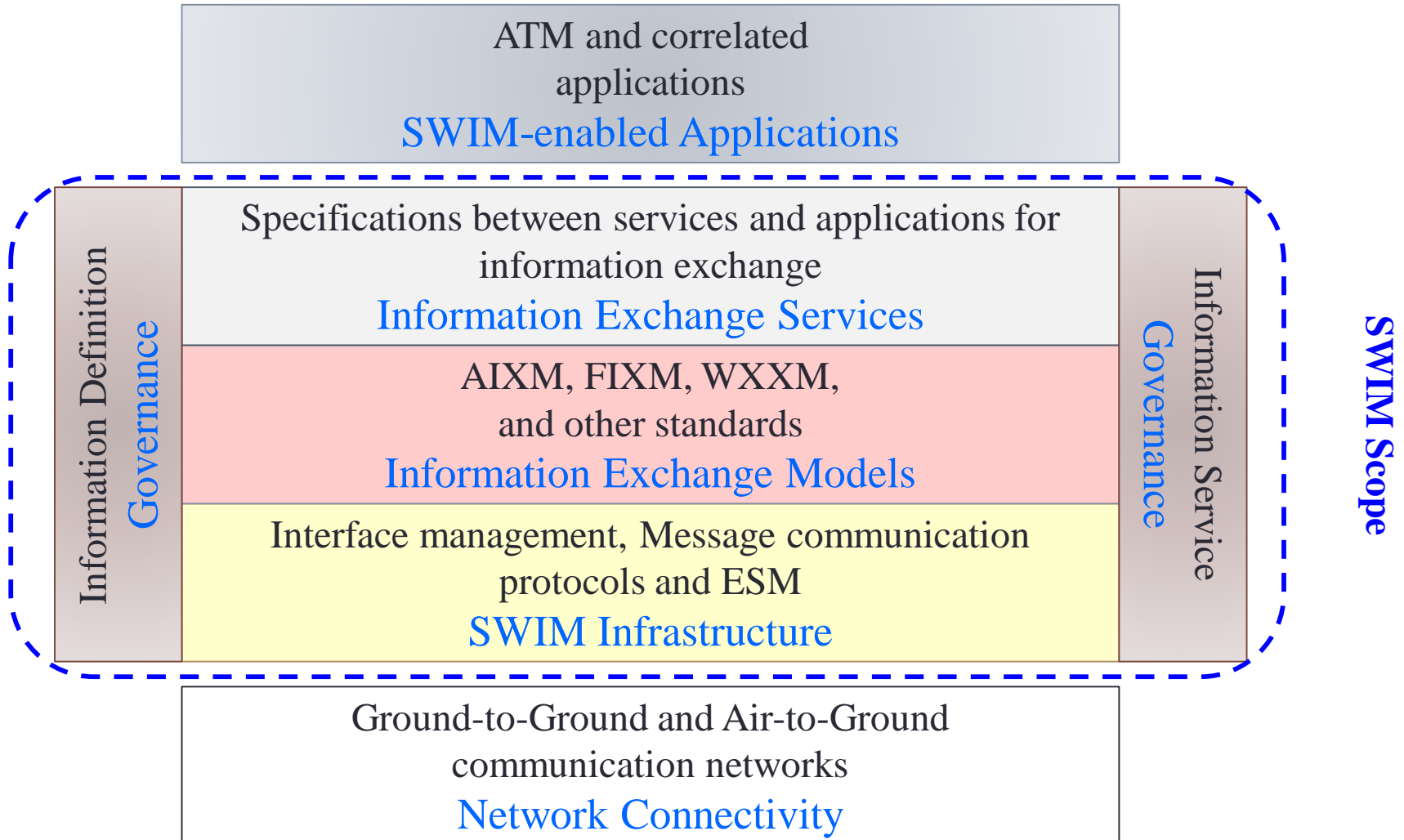
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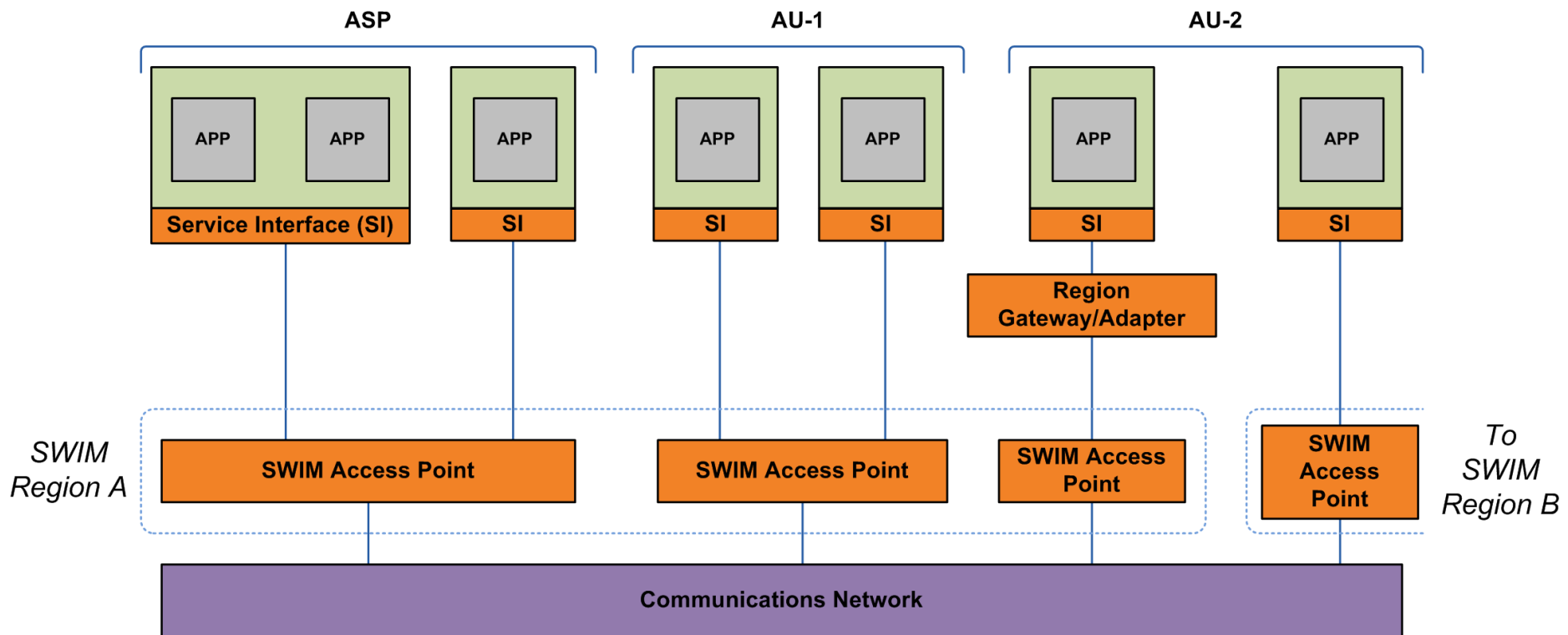
# SWIMの概念

- **SWIM Framework**



# SWIMの概念

- SWIM Concept Architecture





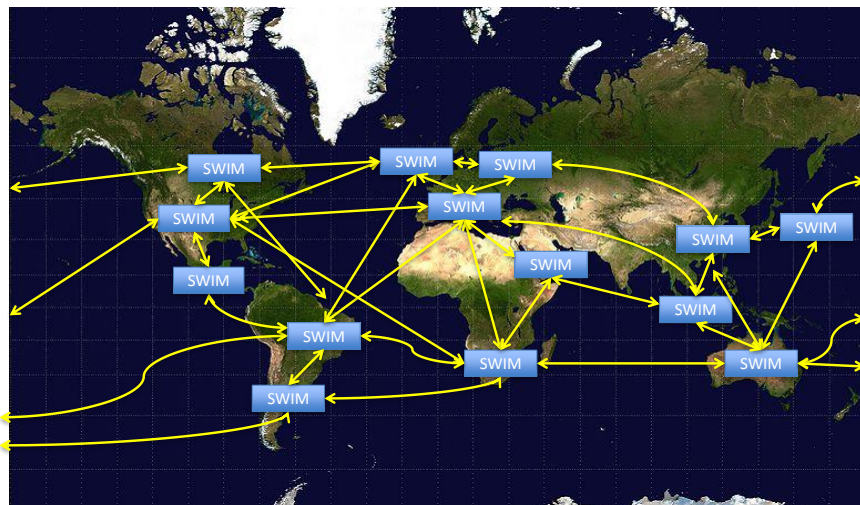
# Agenda

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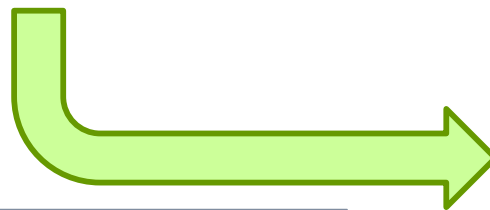
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# Mini Global Demonstration

- 概要



Point-to-Point SWIM



Seamless Interoperability and Harmonization

Enhanced Efficiency



Mini Global SWIM

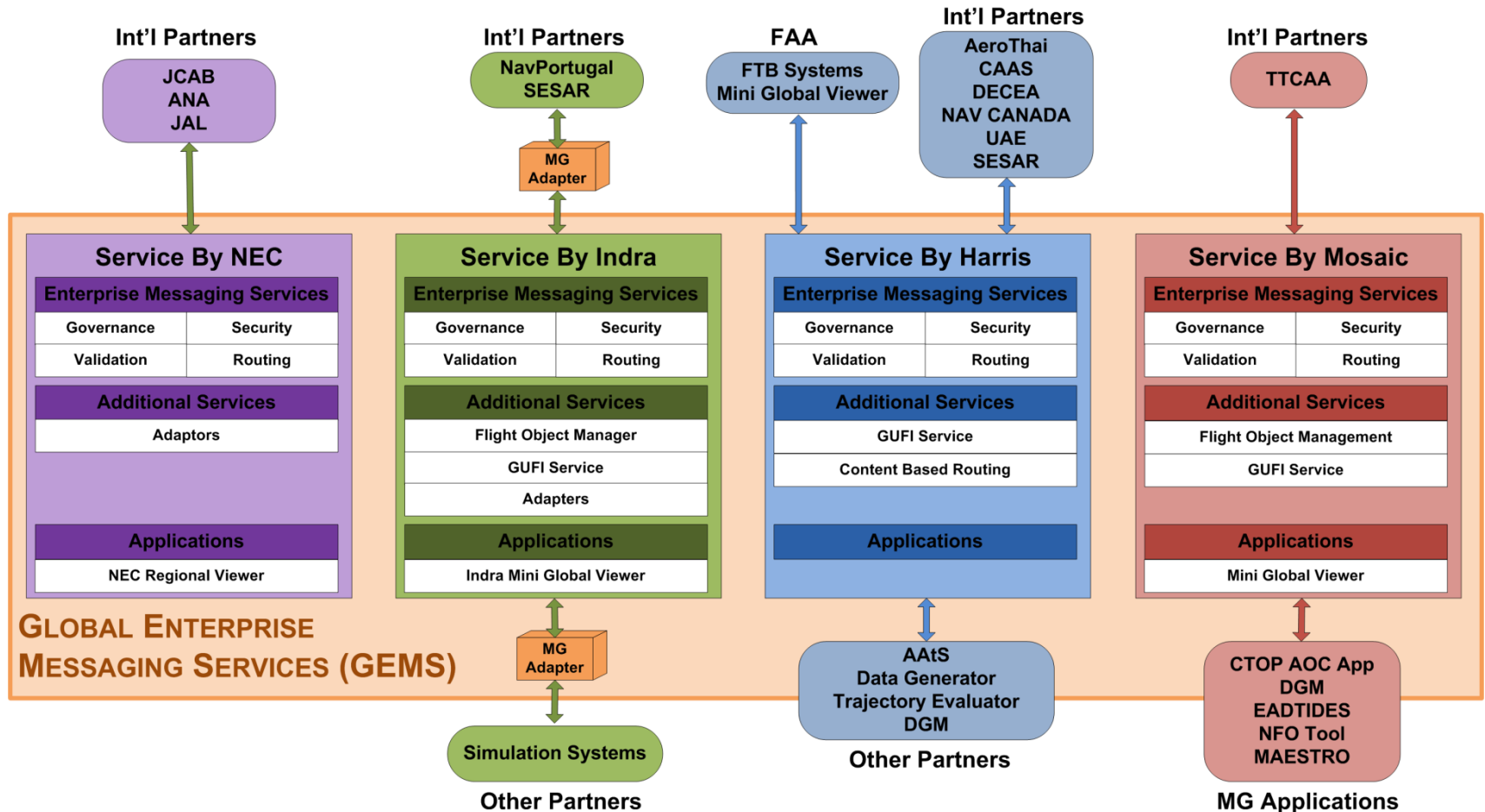


# Mini Global Demonstration

	Mini Global I	Mini Global II
Overview	<p>SWIM Region A</p> <p>SWIM Region B</p> <p>Legend: <span style="color: green;">■</span> = SWIM node, <span style="color: blue;">■</span> = EMS</p>	<p>Global SWIM</p> <p>Common Messaging</p> <ul style="list-style-type: none"> <li>Request/Reply</li> <li>Publish/Subscribe</li> <li>Open Standards</li> </ul>
Platform	<b>Global Enterprise Messaging Service (GEMS)</b>	
Service Provider	Harris and Indra	Harris, Mosaic, Indra and NEC
Message Format	FIXM 2.0 (飛行情報交換モデル) AIXM 5.1 (航空情報交換モデル) WXXM 1.1 (気象情報交換モデル)	FIXM 3.0.1 (4DT Package 1.0) AIXM 5.1 iWXXM 1.0 (ICAO WXXM)
Messaging Protocol	Within Region: JMS (Java Messaging Service), SOAP (Simple Object Access Protocol) Between Regions: SOAP	Within Region: AMQP, JMS, SOAP Between Regions: AMQP (Advanced Messaging Queuing Protocol), SOAP

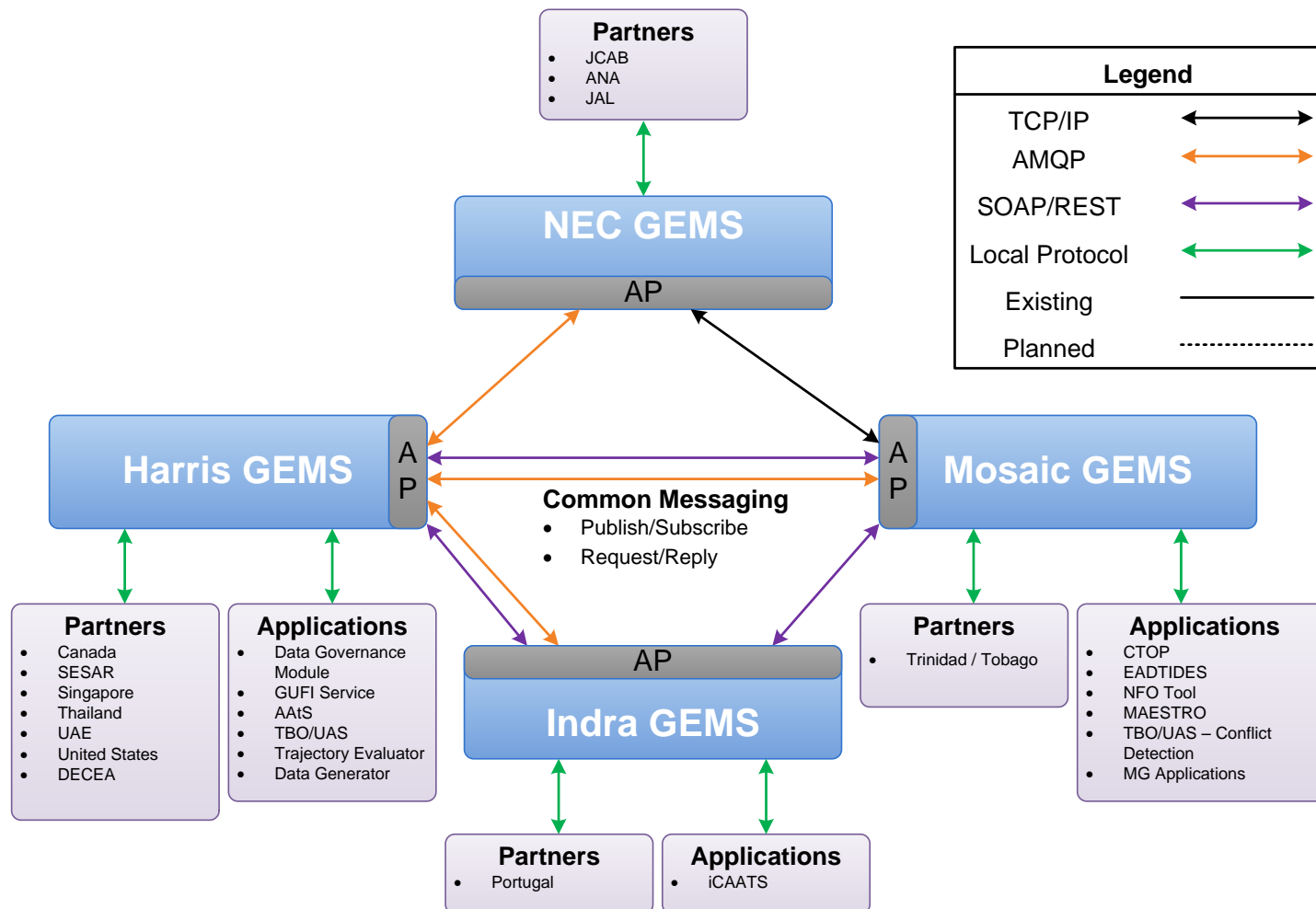
# Mini Global Demonstration

## GEMSの構造



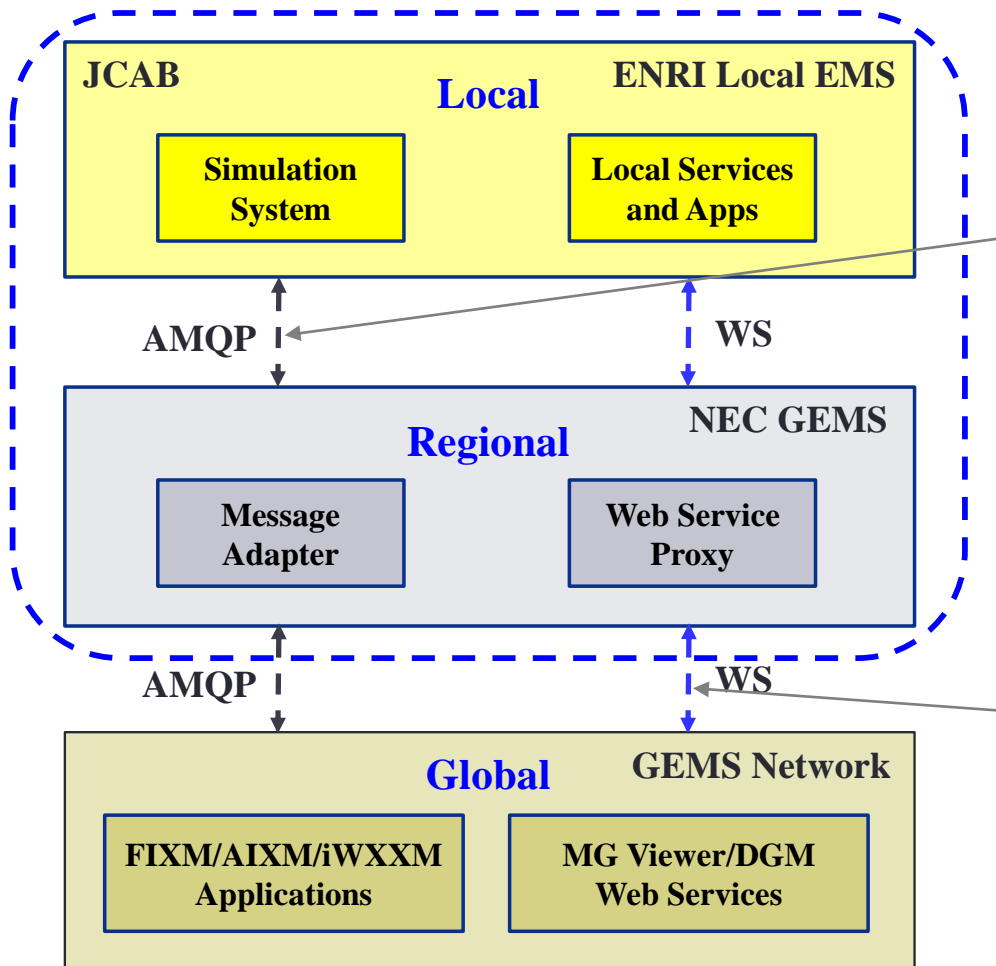
# Mini Global Demonstration

## • GEMSの通信方式



# Mini Global Demonstration

## • GEMSのガバナンスとセキュリティ



### - Publish / Subscribe

- > Secure VPN connection
- > EMS authenticates
- > Authorized message queue
- > User based message filtering
- > Receive subscribed information

### - Request / Reply

- > Secure VPN connection
- > EMS authenticates
- > Authorized web service endpoint
- > Receive authorized information

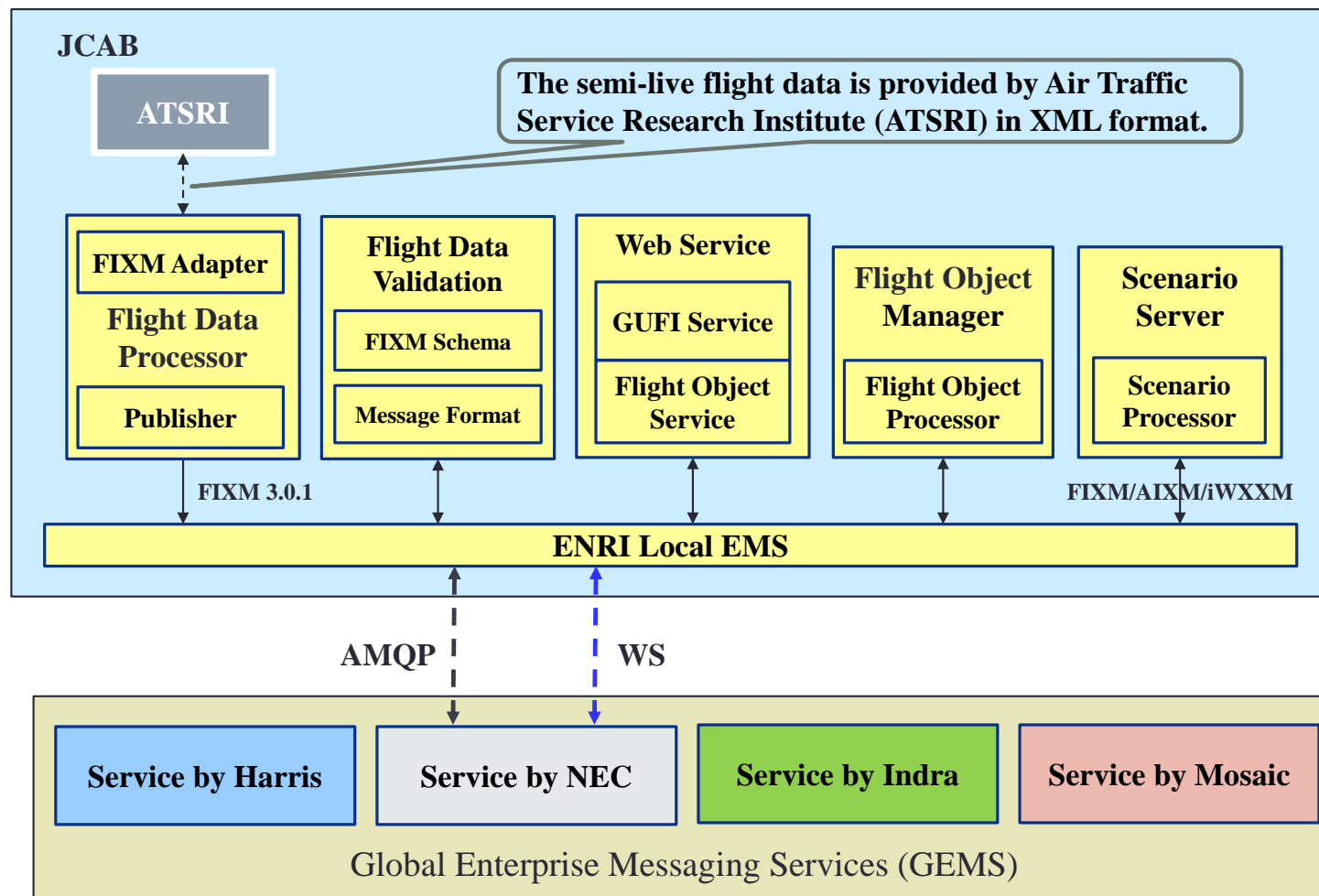
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# 実験システムとシナリオ

- ENRI Local EMS





# 実験システムとシナリオ

## • Services and Applications

WELCOME TO ELECTRONIC NAVIGATION RESEARCH INSTITUTE

Aircraft Details: Message Type: ANA77A Search

Message Headers:
 

- Time: 2016-04-07T23:48:11.509Z
- Gulf: e1e986b3-3d22-443c-b7fc-c9ab5809b2e9
- ACID: ANA77A
- Source: FAA
- System: FOXS
- Message: ROUTE
- Category: FIXM\_OBJECT\_UPDATE
- Category Version: FIXM\_3\_0
- Airline: ANA
- Departure Country: RJ
- Departure Airport: RJAA
- Arrival Country: K
- Arrival Airport: PTGH
- Flight Duration: PT9H11M00S
- Initial Flight Rule: FR
- Route Text: CUPHD Y808 ALLEN Y812 SCORE OT11 AVB1 OBT11 LEFKM083F360 41N160E 44N170E 46N180E 47N170W M083F360 48N180W 47N150W 44N140W 40N130W DCT DACEMND489F350 DCT PAINT DCT PRCT AVE 5400E
- Requested Altitude: 38000.0

Received Messages: Total Results: 201

Message Type	Message
FPL	CAAS_OUT:1460072485294,SEB_IN:1460072485715,SEB_OUT:1460072485748,SEB_IN:1460072487164,SEB_OUT:146
CHG	CAAS_OUT:1460072573826,SEB_IN:1460072574216,SEB_OUT:1460072574229,SEB_IN:1460072574233,SEB_OUT:146
DEP	CAAS_OUT:1460072633858,SEB_IN:1460072633996,SEB_OUT:1460072634015,SEB_IN:1460072634138,SEB_OUT:146
TRACK	CAAS_OUT:1460072636032,SEB_IN:1460072636041,SEB_OUT:1460072636041,SEB_IN:1460072636195,SEB_OUT:146
TRACK	CAAS_OUT:1460072659815,SEB_IN:1460072659815,SEB_OUT:1460072659815,SEB_IN:1460072659815,SEB_OUT:146
TRACK	CAAS_OUT:1460072678934,SEB_IN:1460072678934,SEB_OUT:1460072678934,SEB_IN:1460072678934,SEB_OUT:146
TRACK	CAAS_OUT:1460072698950,SEB_IN:1460072698950,SEB_OUT:1460072698950,SEB_IN:1460072698950,SEB_OUT:146
ROUTE	JCAB_OUT:1460072889828,SEB_IN:1460072889828,SEB_OUT:1460072889828,SEB_IN:1460072889828,SEB_OUT:146
ARR	JCAB_OUT:1460072889828,SEB_IN:1460072889828,SEB_OUT:1460072889828,SEB_IN:1460072889828,SEB_OUT:146
DEPARTURE	JCAB_OUT:1460072889828,SEB_IN:1460072889828,SEB_OUT:1460072889828,SEB_IN:1460072889828,SEB_OUT:146
FLIGHT_OBJECT	JCAB_OUT:1460072889828,SEB_IN:1460072889828,SEB_OUT:1460072889828,SEB_IN:1460072889828,SEB_OUT:146
ARR	FDXS_IN:1460072893122,FDXS_OUT:1460072893367,SEB_OUT:1460072893491,SEB_IN:1460072893596,SEB_OUT:14
SDSS_EXTENSION	FDXS_IN:1460072893122,FDXS_OUT:1460072893367,SEB_OUT:1460072893491,SEB_IN:1460072893596,SEB_OUT:14
FLIGHT_OBJECT	FDXS_IN:1460072893122,FDXS_OUT:1460072893367,SEB_OUT:1460072893491,SEB_IN:1460072893596,SEB_OUT:14
ARR	FDXS_IN:1460072893143,FDXS_OUT:1460072893496,SEB_OUT:1460072893630,SEB_IN:1460072893836,SEB_OUT:14
FLIGHT_OBJECT	FDXS_IN:1460072893143,FDXS_OUT:1460072893496,SEB_OUT:1460072893630,SEB_IN:1460072893836,SEB_OUT:14
DEPARTURE	JCAB_OUT:1460073024598,SEB_IN:1460073024697,SEB_OUT:1460073024697,SEB_IN:1460073024697,SEB_OUT:146
FLIGHT_OBJECT	JCAB_OUT:1460073024598,SEB_IN:1460073024697,SEB_OUT:1460073024697,SEB_IN:1460073024697,SEB_OUT:146
TRACK	JCAB_OUT:1460073067021,SEB_IN:1460073067132,SEB_OUT:1460073067132,SEB_IN:1460073068892,FDXS_IN:1460

## - Fight Object Manager

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

## - Scenario Server

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

AMQP Subscriber Host: 172.16.19.12 Port: 5672

Type Name: ENR-C

Username: admin Password: admin

Stop Subscribe Clear Flight Object Trace Message

Message Number: 1004

```

<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<flight xmlns="urn:ietf:params:xml:ns:fixm" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="urn:ietf:params:xml:ns:fixm:2016-03-09/fixm-2016-03-09.xsd">
  <id>e1e986b3-3d22-443c-b7fc-c9ab5809b2e9</id>
  <source>FAA</source>
  <system>FOXS</system>
  <message>ROUTE</message>
  <category>FIXM_OBJECT_UPDATE</category>
  <categoryVersion>FIXM_3_0</categoryVersion>
  <airline>ANA</airline>
  <departureCountry>RJ</departureCountry>
  <departureAirport>RJAA</departureAirport>
  <arrivalCountry>K</arrivalCountry>
  <arrivalAirport>PTGH</arrivalAirport>
  <flightDuration>PT9H11M00S</flightDuration>
  <initialFlightRule>FR</initialFlightRule>
  <routeText>CUPHD Y808 ALLEN Y812 SCORE OT11 AVB1 OBT11 LEFKM083F360 41N160E 44N170E 46N180E 47N170W M083F360 48N180W 47N150W 44N140W 40N130W DCT DACEMND489F350 DCT PAINT DCT PRCT AVE 5400E</routeText>
  <requestedAltitude>38000.0</requestedAltitude>
</flight>
  
```

AMQP Subscriber Host: 172.16.19.11 Port: 5672

Type Name: JCAB TEST

Username: admin Password: admin

Message Interval (ms): 1000

Start Publish

Map showing flight paths over Japan with a data popup for ANA77A (2016/04/08 22:12:00) with coordinates 35.375, 142.243 and altitude 28000 feet.

# 実験システムとシナリオ

## Services and Applications

AirCraft ID	Message Type	Gulf	Source	Time Stamp	Validation	Report
ANA77A	ARR	e1e868b3-3d22-44dc-b7fc-c9ab5809b2e9	FAA	2016-04-08T01:37:25.507Z	Invalid	
ANA77C	TRACK	e5ff089b-633f-41f0-be2e-2fc175e4f353	FAA	2016-04-08T01:37:24.930Z	Success	
ANA77C	SDSS_EXTENSION	e5ff089b-633f-41f0-be2e-2fc175e4f353	FAA	2016-04-08T01:37:25.504Z	Invalid	
ANA77C	TRACK	e5ff089b-633f-41f0-be2e-2fc175e4f353	FAA	2016-04-08T01:37:23.931Z	Success	
ANA77C	TRACK	e5ff089b-633f-41f0-be2e-2fc175e4f353	FAA	2016-04-08T01:37:21.930Z	Success	
ANA77C	TRACK	e5ff089b-633f-41f0-be2e-2fc175e4f353	FAA	2016-04-08T01:37:22.929Z	Success	
ANA77C	TRACK	e5ff089b-633f-41f0-be2e-2fc175e4f353	FAA	2016-04-08T01:37:19.929Z	Success	
ANA77C	TRACK	e5ff089b-633f-41f0-be2e-2fc175e4f353	FAA	2016-04-08T01:37:20.930Z	Success	
ANA77C	TRACK	e5ff089b-633f-41f0-be2e-2fc175e4f353	FAA	2016-04-08T01:37:17.929Z	Success	
ANA77C	TRACK	e5ff089b-633f-41f0-be2e-2fc175e4f353	FAA	2016-04-08T01:37:18.930Z	Success	
ANA77C	TRACK	e5ff089b-633f-41f0-be2e-2fc175e4f353	FAA	2016-04-08T01:37:15.930Z	Success	
ANA77C	TRACK	e5ff089b-633f-41f0-be2e-2fc175e4f353	FAA	2016-04-08T01:37:16.931Z	Success	
ANA77C	TRACK	e5ff089b-633f-41f0-be2e-2fc175e4f353	FAA	2016-04-08T01:37:13.930Z	Success	
ANA77C	TRACK	e5ff089b-633f-41f0-be2e-2fc175e4f353	FAA	2016-04-08T01:37:14.928Z	Success	
ANA77C	TRACK	e5ff089b-633f-41f0-be2e-2fc175e4f353	FAA	2016-04-08T01:37:12.927Z	Success	
ANA77C	TRACK	e5ff089b-633f-41f0-be2e-2fc175e4f353	FAA	2016-04-08T01:37:10.927Z	Success	
ANA77C	TRACK	e5ff089b-633f-41f0-be2e-2fc175e4f353	FAA	2016-04-08T01:37:11.927Z	Success	
ANA77C	TRACK	e5ff089b-633f-41f0-be2e-2fc175e4f353	FAA	2016-04-08T01:37:08.927Z	Success	
ANA77C	TRACK	e5ff089b-633f-41f0-be2e-2fc175e4f353	FAA	2016-04-08T01:37:09.929Z	Success	
ANA77C	TRACK	e5ff089b-633f-41f0-be2e-2fc175e4f353	FAA	2016-04-08T01:37:06.927Z	Success	

```

1 <?xml version="1.0" encoding="UTF-8"?>
2 <fx:Flight centre="ESE" flightFilter="" flightType="NON_SCHEDULED"
3 remark="" source="TRIM" system="TRIM"
4 timeStamp="2016-03-18T15:28:05.781Z"
5 xmlns:fa="http://www.fixm.aero/ext/fix/3.0"
6 xmlns:fb="http://www.fixm.aero/fix/3.0"
7 xmlns:ff="http://www.fixm.aero/foundation/3.0"
8 xmlns:fx="http://www.fixm.aero/flight/3.0"
9 xmlns:sdas="http://www.fixm.aero/ext/sdas/3.0"
10 xmlns:xe="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>I8K</fa:meterReferencePointName>
14 <fa:meterReferencePointType>ROMA3</fa:meterReferencePointType>
15 <fa:scheduleMeterCrossingTime>2016-03-18T16:34:00.000</fa:scheduleMeterCrossingTime>
16 <fa:meterFixDelayTimeMa>374000</fa:meterFixDelayTimeMa>
17 <fa:freezeFlightIndicator>true</fa:freezeFlightIndicator>
18 <fa:locationIdentifier>S46</fa:locationIdentifier>
19 <fa:source>I51</fa:source>
20 </fa:meteringData>
21 <fa:meteringData>
22 <fa:meterReferencePointName>HWGAT</fa:meterReferencePointName>
23 <fa:meterReferencePointType>METER_FIX</fa:meterReferencePointType>
24 <fa:scheduleMeterCrossingTime>2016-03-18T16:24:24.000</fa:scheduleMeterCrossingTime>
25 <fa:meterFixDelayTimeMa>3487000</fa:meterFixDelayTimeMa>
26 <fa:freezeFlightIndicator>true</fa:freezeFlightIndicator>
27 <fa:locationIdentifier>S46</fa:locationIdentifier>
28 <fa:source>I51</fa:source>
29 </fa:meteringData>
30 </fx:extensions>
31 <fx:gulf codeSpace="urn:uuid:229460be-bde0-41d0-bd4b-0d3a8f8c337d">fx.gulf</fx:gulf>
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

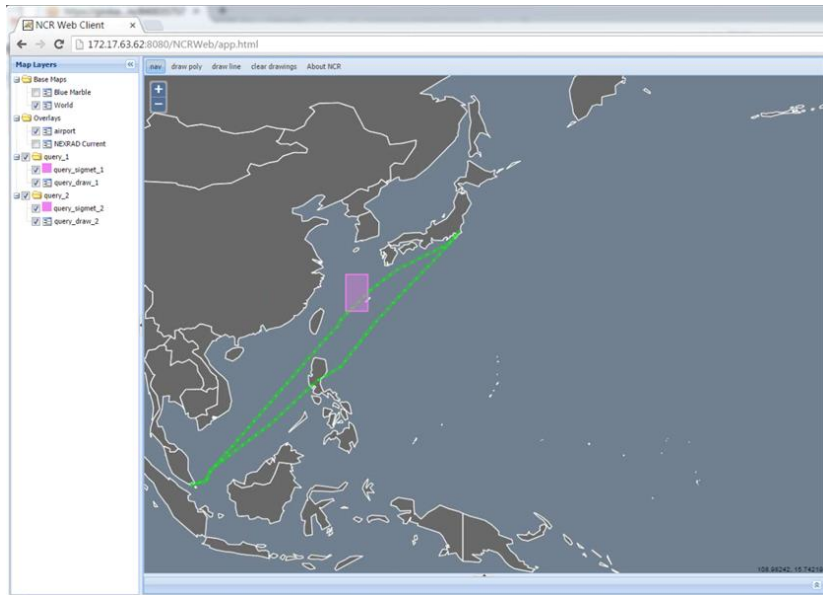
## - Flight Data Validation

- > FIXM schema validation
- > Message format validation



# 実験システムとシナリオ

- **Trans-Pacific Operations: Part I SIN-NRT**



1. CAAS publishes FPL of ANA77A for Part 1
2. JCAB issues SIGMET of turbulence
3. CAAS publishes CHG of ANA77A
- 4-5. CAAS publishes DEP and TRACKS
6. JCAB publishes TRACKS

The screenshot shows a flight information table overlaid on a map of the Pacific region. The table lists flight details for ANA77A and related flights.

GUPI	Acid ↑	Msg Type	Orig	Dest	Status	Est Out	Act Out	Est Off	Ctrl Off	Pred Off	Act Off	Est On	Act On	Route
ad4082d3-7831-...	ANA77A	DEP	WSSS	RJAA		01/01:30								
376d00bf-9328-...	ANA77B	FLIGHT_OBJECT	RJAA	KLAX		31/23:08					31/23:13			
95ac74b9-7758-...	ANA77C	FLIGHT_OBJECT	RJAA	KLAX		31/23:08					31/23:13			
5ef5e483-9a15-...	ANA77D	FLIGHT_OBJECT	RJAA	KLAX		31/23:08					31/23:13			

# 実験システムとシナリオ

## • Trans-Pacific Operations: Part 2 NRT-LAX

7. JCAB publishes FPL of ANA77A for Part 2

8. JCAB publishes ARR of ANA77A for Part 1

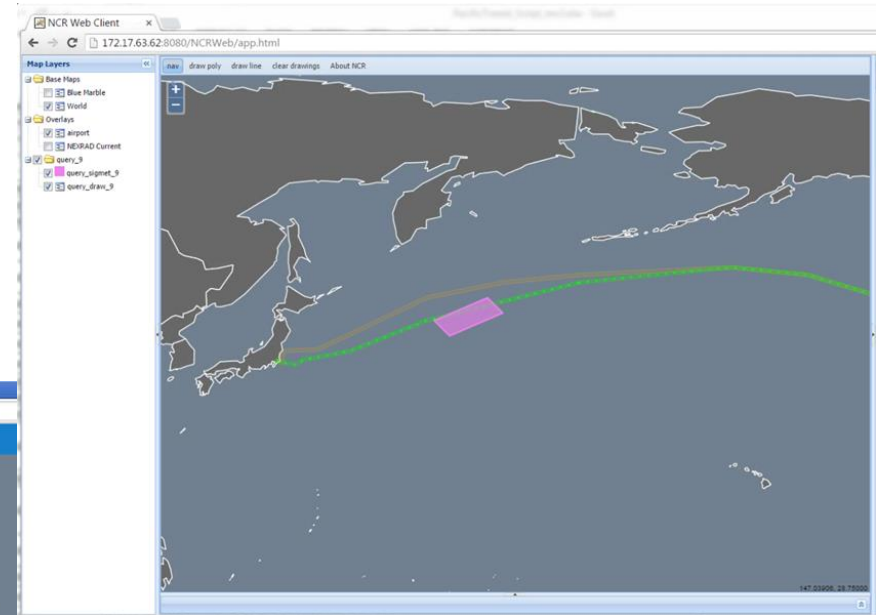
9-10. JCAB publishes DEP and TRACK

11. JCAB issues updated SIGMET

12. JCAB publishes revised FPL

Mosaic ATM Viewer screenshot showing flight information for ANA77A. The interface includes a map of the Pacific region and a table of flight data.

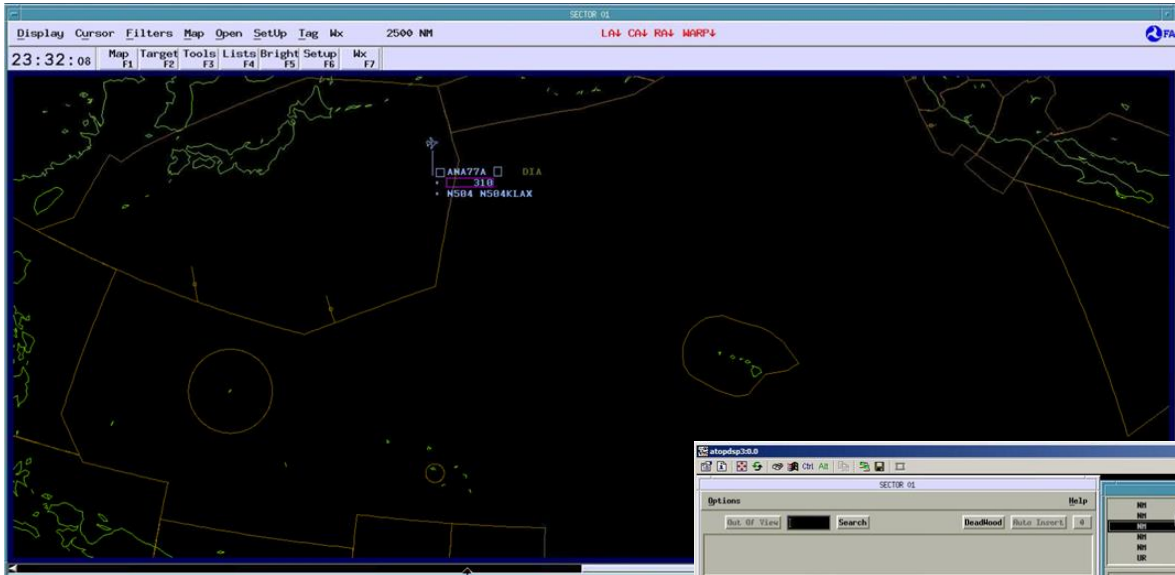
GUFI	Aid	Msg Type	Orig	Dest	Status	Est Out	Act Out	Est Off	Ctrl Off	Pred Off	Act Off	Est On	Act On	Route
ad4082d3-7831-...	ANA77A	ARR	WSSS	RJAA	COMPL...	31/13:30							31/19:58	
e1e868b3-3d22-...	ANA77A	FLIGHT_OBJECT	RJAA	KLAX	FILED	31/21:30					31/21:40			CUPID Y808 ONO
376d00bf-9328-...	ANA77B	FLIGHT_OBJECT	RJAA	KLAX		31/23:08					31/23:13			
95ac74b9-7758-...	ANA77C	FLIGHT_OBJECT	RJAA	KLAX		31/23:08					31/23:13			
5ef5e483-9a15-...	ANA77D	FLIGHT_OBJECT	RJAA	KLAX		31/23:08					31/23:13			





# 実験システムとシナリオ

## • Trans-Pacific Operations: Boundary Coordination



### Boundary Coordination:

13-1. JCAB publishes ABI and CPL

13-2. FAA issues CDN with a change to the boundary crossing altitude

13-3. JCAB publishes ACP

**Options**

Sub. Of View	Search	DeadMood	Auto Tower1
B744	310	40N 6649N 46N 47N 48N 47N 46N	4000 10
NS04	310	16334E 179E 1694 1694 1564 1400	2100 10
NS04	310	2340 0013 0103 0240 0329 0404	1000 10
		40N DRCKER PRINT	
		1504 0504 0544 0555	

**AIRCRAFT MESSAGES**

MM	POS	MM077A	23:38:04
MM	CDN	MM077A	23:35:04
MM	CDN	MM077A	23:35:04
MM	CPL	MM077A	23:35:46
MM	CPL	MM077A	23:31:18
MM	TXT	MM077A	23:38:08

**SECTOR QUEUE**

MM	SYS	CESS77	23:35:03
MM	TXT	MM077A	23:38:08
MM	CPL	MM077A	23:31:18
MM	CDN	MM077A	23:35:04

**ERROR QUEUE**

TXT	CESS77	23:35:42
MM	CESS77	23:36:47
TXT	CESS77	23:38:15
TXT	CESS77	23:36:47

**SECTOR QUEUE**

MM	SYS	CESS77	23:35:03
MM	TXT	MM077A	23:38:08
MM	CPL	MM077A	23:31:18
MM	CDN	MM077A	23:35:04

**Message Content:**

```

Origin.....: OHTI2023>
DestLineLoc: OCS23000>.
(ACP-00077A/02777-0.000-01.00)

Acid: MM077A
Message Type:
Date from:
Date to:
Time from:
Time to:
  
```

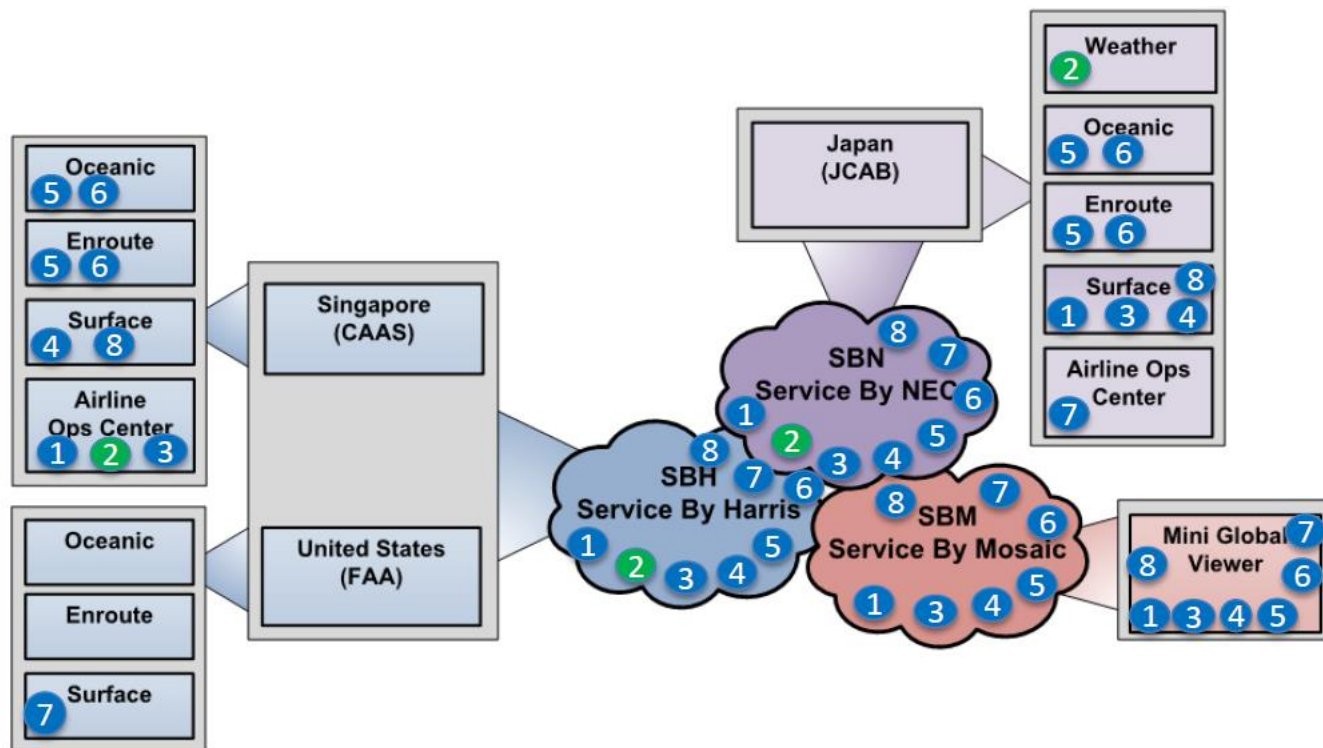
**Message Content:**

```

FPCT-1-FREE_F00001_INF : FPCT-1-C000_001_SEQ : (MM077A): Initial
Coordination is required with I113 : ((CPK-00077A/02777-IN
-107640-000/0101))
-R-000-04401604E/22409 310
-NS04-014 CXP'D TIME UNLIM DTIS AN00P DTIS NULM/0003350 400104E
400179E 470110E 400110H 4701500 4001400 4001500 DCT DRCKER/00003350
DCT POINT DCT POINT DCT HVE SOME
-1-0X
-0)
  
```

# 実験システムとシナリオ

- Governance: Information Management



- ① CAAS Flight Plan    ③ Change Message    ⑤ CAAS Tracks    ⑦ JCAB Flight Plan
- ② SIGMET(s)        ④ DEP Message        ⑥ JCAB Tracks    ⑧ ARR Message

# Agenda

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1. 背景
2. SWIMの概念
3. Mini Global Demonstration
4. 実験システムとシナリオ
5. 分析評価
6. まとめ



# 分析評価

## • Benefits and Lessons Learned

### Benefits

- ✓ 様々な情報共有
  - 予測能力の向上
  - シームレス運航の実現
- ✓ GUFIIによる飛行情報の管理
  - Flight Object管理の実現
  - グローバル運航管理の向上
- ✓ EMS-to-EMS構造
  - 情報セキュリティの向上
  - 接続性の向上

### Lessons Learned

- ✓ 飛行情報(FIXM)
  - 拡張スキーマ(必要?)
  - データ検証の多様性
- ✓ メッセージ交換
  - 異種システム間の同期
  - Flight Objectの統一定義
- ✓ GEMS提供者
  - 情報セキュリティの保証
  - ガバナンスの一貫性

# 分析評価

## 構成要素の分析評価

構成要素 性能要件	Networkインフラ		Messagingインフラ					
	Web Service + IP Network	EMS + IP Network	Publish / Subscribe			Request / Reply		
			AMQP	JMS	DDS	SOAP	REST	WFS
Performance	1	2	2	2	3	2	2	2
Interoperability	3	2	3	2	3	3	3	3
Fault Tolerance	3	2	2	2	3	2	3	2
Maintainability	2	3	3	3	2	3	3	2
Security	2	3	3	2	1	2	1	2

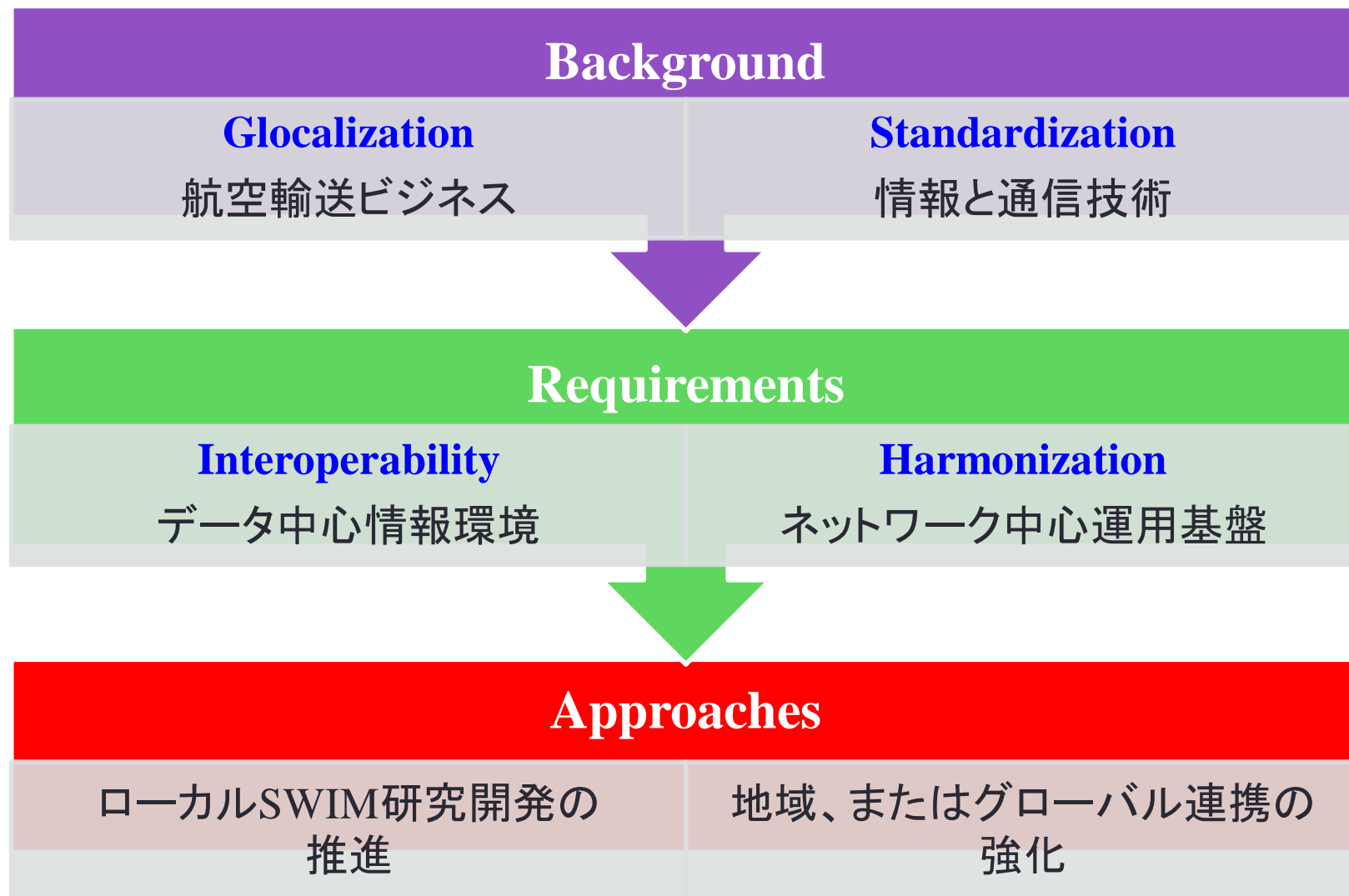
評価基準： 3は十分な性能を持つ機能を提供している、2は使用目的によっては制限がある、1は性能の保証が考慮されていない項目である。

# Agenda

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# まとめ



# ご清聴ありがとうございます



# Appendix: Acronyms and Terminology

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Term	Definition
AIXM	Aeronautical Information Exchange Model
AMQP	Advanced Messaging Queuing Protocol
DDS	Data Distribution Service
EMS	Enterprise Messaging Service
FIXM	Flight Information Exchange Model
GEMS	Global Enterprise Messaging Service
GUFID	Globally Unique Flight Identifier
ICAO	International Civil Aviation Organization
iWXXM	ICAO Weather Information Exchange Model
JMS	Java Messaging Service
REST	Representational State Transfer
SOA	Service Oriented Architecture
SOAP	Simple Object Access Protocol
VPN	Virtual Private Network
WFS	Web Feature Service
XML	Extensible Markup Language