

# **SIPG Task 2 :**

**Refine the Revised APAC SWIM Hierarchical Architecture**

**Work Progress and Technical approach**

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- Background
- SIPG Task 2 Current Research Content
  - ✓ SWIM TI Interoperability Routing Mechanism
  - ✓ APAC SWIM Address Naming Pattern
  - ✓ SWIM Message Metadata Specifications
- APAC SWIM Hierarchical Architecture Test Plan and Test Status

# SWIM TI Routing

- Core Premises

- ✓ No assumption of end-to-end IP connectivity between participants
- ✓ Each system only connects to local/regional SWIM TI components
- ✓ Specifically addresses information exchange in fragmented/intermittent network environments

- Working Mechanism

- ✓ Analogous to the traditional AFTN/AMHS message overlay architecture
- ✓ Forwards based on message-level identifiers/routing metadata
- ✓ Pure technical forwarding, no parsing of message semantics or business logic
- ✓ Built-in store-and-forward mechanism to compensate for network interruptions

*from Hart, D. (2026). SWIM Connectivity and Information Exchange Approaches (IMP/4-WP/20)*

# SWIM TI Routing

Pattern	Support Status	Description
Asynchronous Messaging, Publish/Subscribe	✅ Natively Supported	Core pattern best suited for this architecture
Asynchronous Request-Reply	⚠️ Limited Support	Requires additional implementation of response routing and request correlation
Synchronous Request-Reply	❌ Not Applicable	Cannot guarantee real-time end-to-end interaction

# SWIM TI Routing

- Key Characteristics & Challenges

- ✓ Expanded TI Role: Evolves from basic technical support to the core of cross-domain connectivity
- ✓ Architectural Principle: Strictly define the scope of TI routing, prohibit business logic from sinking into the infrastructure layer
- ✓ Core Challenge: Need to preserve the information provider's access control intent at the infrastructure layer

- Applicable Scenarios

- ✓ Cross-regional/cross-domain environments without direct IP connectivity
- ✓ Areas with fragmented or unstable network infrastructure
- ✓ Transition solution for smooth evolution from traditional AFTN/AMHS to SWIM



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# SWIM TI Routing Strategy Comparison

	Business Scenario Routing	Transmission Path Routing	Granularity-Adapted Routing
Core Purpose	Bridge MEPs evolution (store-and-forward → request/reply ,pub/sub) with SWIM protocols (AMQP)	Determine optimal cross-node message delivery paths	Balance bulk distribution efficiency and customized filtering needs
Available Options	<ul style="list-style-type: none"> <li>• With recipient ID</li> <li>• Without recipient ID</li> </ul>	<ul style="list-style-type: none"> <li>• Static path routing</li> <li>• Dynamic path routing</li> </ul>	<ul style="list-style-type: none"> <li>• Coarse-grained routing</li> <li>• Fine-grained routing</li> </ul>
Key Characteristics	<ul style="list-style-type: none"> <li>• Reuses AFTN address system for compatibility</li> <li>• Flexible selection based on business needs</li> </ul>	<ul style="list-style-type: none"> <li>• Static: Low overhead, predictable, hard to adjust</li> <li>• Dynamic: Real-time adaptation, load balancing, complex troubleshooting</li> </ul>	<ul style="list-style-type: none"> <li>• Coarse: Hierarchical topics, backbone efficiency</li> <li>• Fine: Standardized metadata fields, accurate delivery</li> </ul>
Typical Use Cases	<ul style="list-style-type: none"> <li>• eFPLs (with recipient ID for precise delivery)</li> <li>• Meteorological messages/NOTAMs (without ID for broad sharing)</li> </ul>	<ul style="list-style-type: none"> <li>• Stable inter-GEMS backbone links (static)</li> <li>• Dynamic traffic load balancing (dynamic)</li> </ul>	<ul style="list-style-type: none"> <li>• Regional bulk information exchange (coarse)</li> <li>• Customized consumer access (fine)</li> </ul>

\* based on IMP/4-WP/24 Gao, H., & Fang, J. (2026). Considerations on routing mechanisms for global SWIM TI interoperability (IMP/4-WP/24)

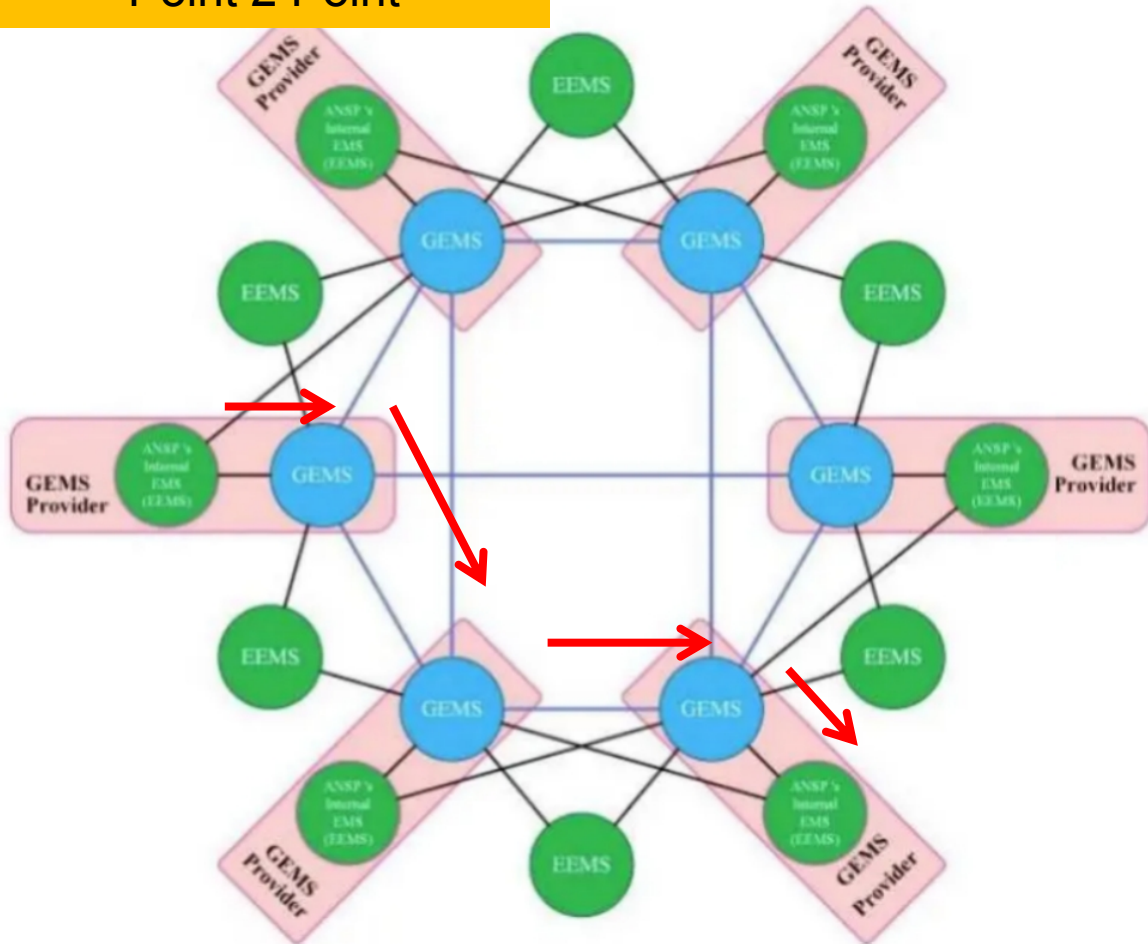
# Routing Strategy Selection Across Different Layers

interoperating parties	Function	Business Scenario Routing	Transmission Path Routing	Granularity-Adapted Routing
User<->EEMS	flexible access	explicit recipient ID& recipient-free	n/a	Fine-grained(header)
EEMS<->GMES	aggregation/disaggregation	targetEEMS sourceEEMS	?	Coarse-grained(hierarchical topics)
GEMS<->GEMS	backbone	targetEEMS sourceEEMS	?	Coarse-grained(hierarchical topics)

# SWIM TI Routing Modes

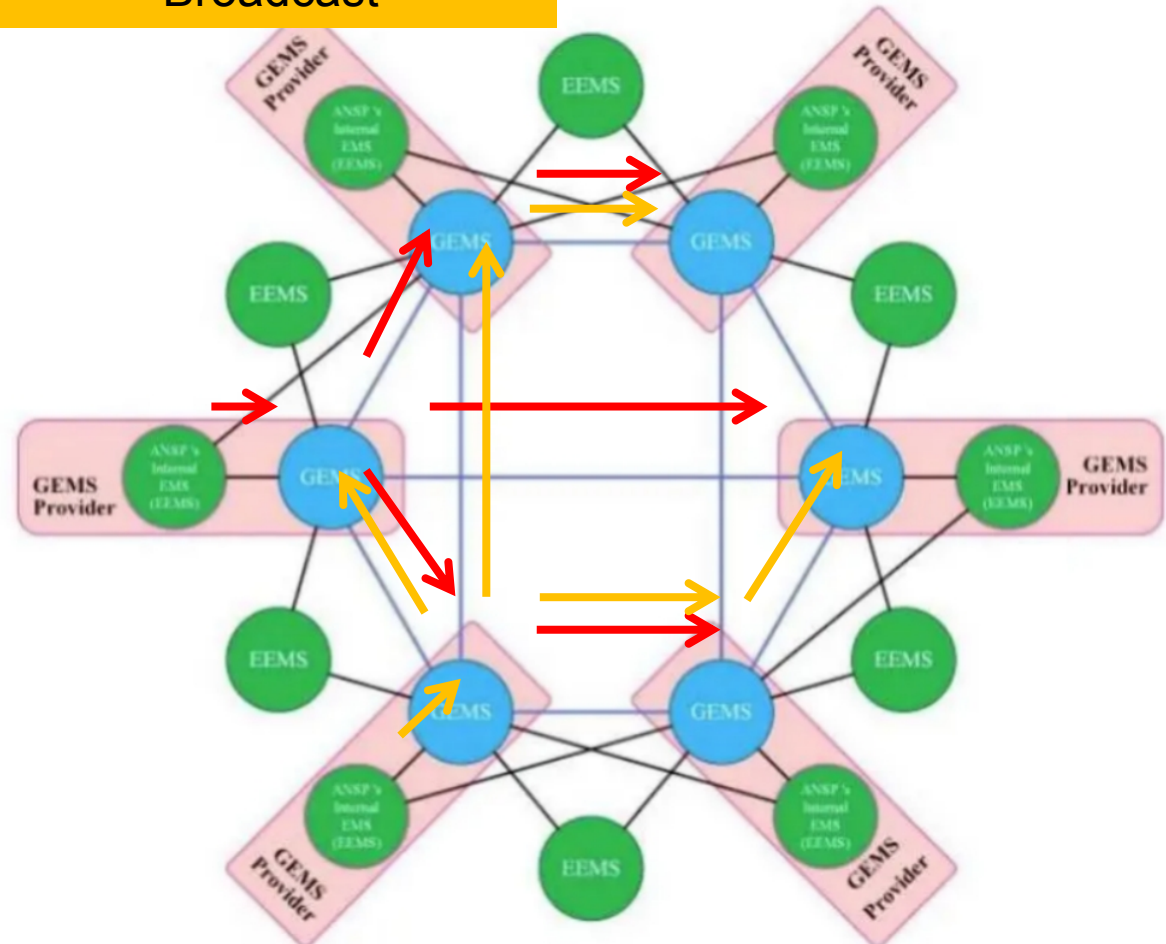
GEMS route point-to-point messages destined for the target EEMS to the downstream adjacent GEMS leading to the target EEMS.

Point 2 Point



GEMS get the broadcast information of the specific EEMS from the adjacent GEMS.

Broadcast



# MEPs mapping to SWIM TI Routing Mode

MEP	Protocols	Routing Mode	Recipient ID	Usecase
Synchronous Request/Reply	HTTP/REST	PBR		FF-ICE Filing Service
Asynchronous Request/Reply	AMQP 1.0	Point 2 Point	explicit recipient ID	FF-ICE Filing Service
One-way	AMQP 1.0	Point 2 Point	explicit recipient ID	
Publish/Subscribe	AMQP 1.0	Broadcast	recipient-free	Notam Publish Service
	AMQP 1.0	Point 2 Point	explicit recipient ID	FF-ICE Filing Service(re-evaluation process )Publish Service




# APAC SWIM Address Naming Pattern

## The topic format is:

```
amqp://{message-broker-host}:{message-broker-port}  
/{region}  
/{environment}  
/{delivery-mode}  
/{current-ems-id}  
/{upstream/downstream-ems-id}  
/{domain-name}  
/{version}  
/{domain-specificity}
```

Blue	Scope and Environment Identification
Yellow	Routing-Oriented Address Architecture
Green	Information Domain Classification



# Eurocontrol B2B Services: Environment Configuration Analysis

## Request/Reply

### PREOPS

[https://www.b2b.preops.nm.eurocontrol.int:443/B2B\\_PREOPS/gateway/spec/27.0.0](https://www.b2b.preops.nm.eurocontrol.int:443/B2B_PREOPS/gateway/spec/27.0.0)

### OPS

[https://www.b2b.nm.eurocontrol.int:443/B2B\\_OPS/gateway](https://www.b2b.nm.eurocontrol.int:443/B2B_OPS/gateway)

**Key Difference:** The test environment includes the preops subdomain, \_PREOPS context, and version path; the production environment uses the standard domain name, with \_OPS as the context and no version number path.

## AMQP Message Services

### PREOPS

<amqps://pubsub.preops.nm.eurocontrol.int:5671/15671>

### OPS

<amqps://pubsub.nm.eurocontrol.int:5671/15671>

**Key Difference:** Only the subdomain differs—the test environment uses the preops prefix; port configurations (5671/15671) remain identical across both environments.

# APAC SWIM Address Naming Pattern

## Address Description

Defines the address naming conventions, including descriptions, applicable scenarios, and other relevant details.

### Address Naming Conventions and Test Examples(CHN\_GEMS)

P2P	Conventions	/apac/<env>/point2point/to/<targeteems>/<domainname>/<domainspecific>
	Address name of chn_eems receives FFP message	/apac/test/point2point/to/chn_eems/fixm/fixm_4_3_ff_ice/filed_flight_plan
	Address name of chn_eems sends RS message	/apac/test/point2point/to/chn_eems/fixm/fixm_4_3_ff_ice/submission_response
Broadcast	Conventions	/apac/<env>/broadcast/from/<sourceeems>/<domainname>/<domainspecific>
	Address name of chn_eems broadcasts notam	/apac/test/broadcast/from/chn_eems/aixm/aixm_5_1_1/notam

# SWIM Message Metadata Specifications

AMQP Message:

header	delivery-annotations	message-annotations	properties	application-properties	application-data	footer
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Section	Mandatory Fields	Optional Fields
header	<ul style="list-style-type: none"> <li>- Message durability</li> <li>- Message TTL</li> </ul>	<ul style="list-style-type: none"> <li>- Message priority</li> </ul>
properties	<ul style="list-style-type: none"> <li>-Message-ID</li> <li>-Creation-Time</li> </ul>	
application-properties	<ul style="list-style-type: none"> <li>- Sender/receiver User (<i>Single Recipient?</i>)</li> <li>- Sender/receiver EEMS</li> <li>- Message category &amp; version</li> <li>- Message type</li> <li>- Environment</li> </ul>	<ul style="list-style-type: none"> <li>- Digital signature</li> <li>- Infomaiton Daomain Features</li> <li>- Notam/Metar basic info</li> </ul> <p>(Optional fields in the domain shall be finalized by respective expert groups. The fields adopted herein are for testing purposes only.)</p>



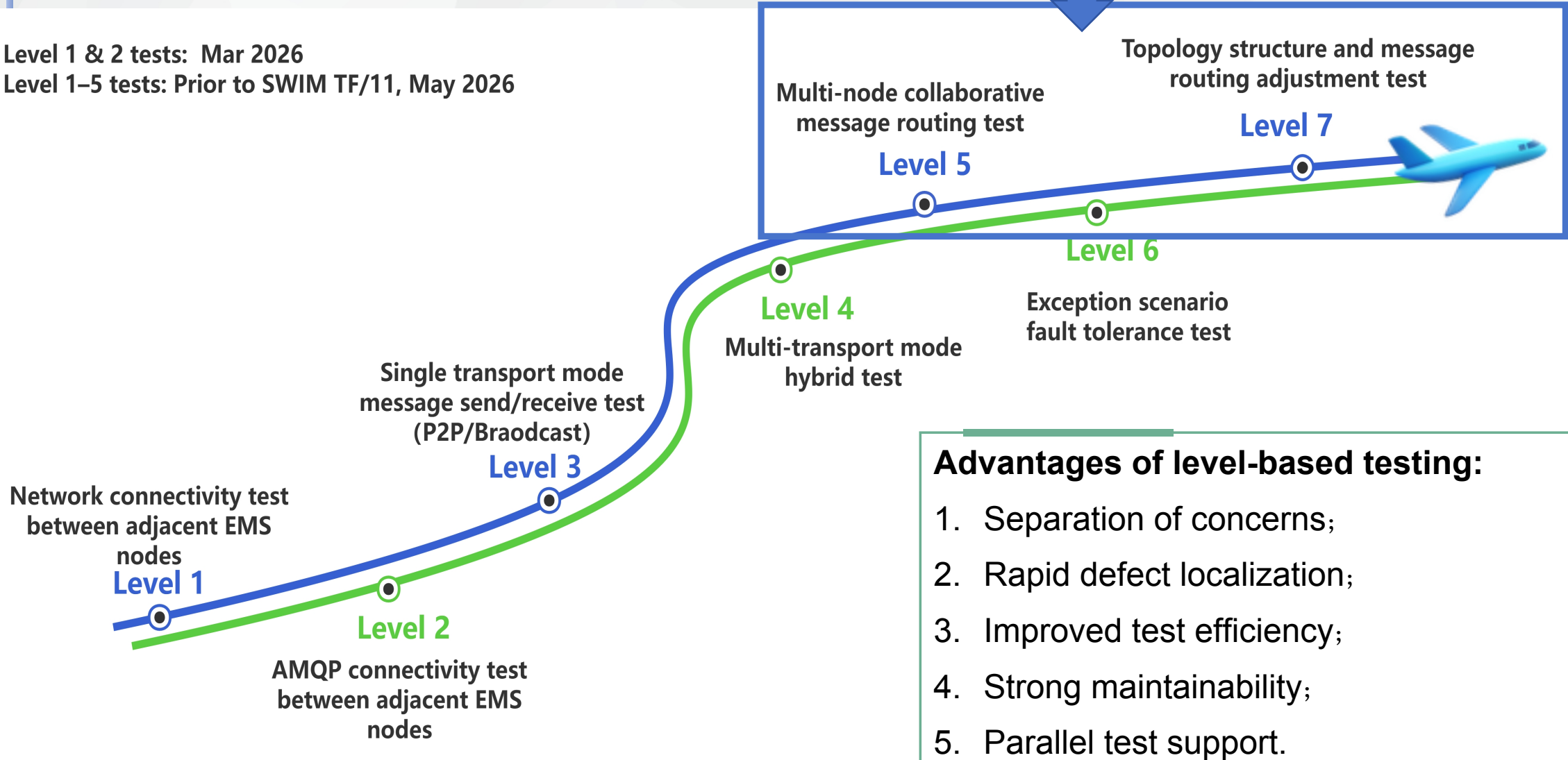
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# Task2 Test Plan

align with SIPG TASK 9/10

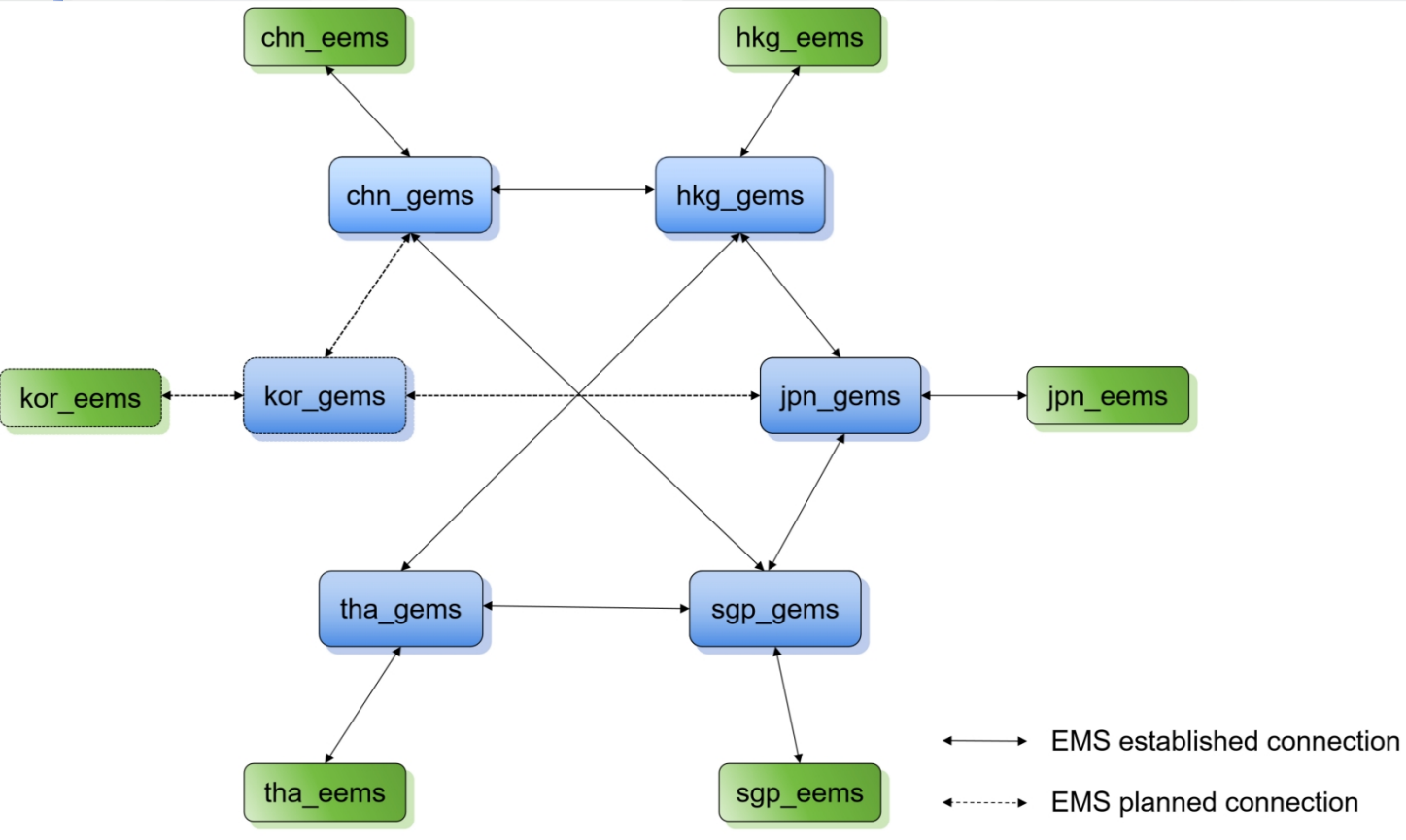
Level 1 & 2 tests: Mar 2026  
Level 1-5 tests: Prior to SWIM TF/11, May 2026



## Advantages of level-based testing:

1. Separation of concerns;
2. Rapid defect localization;
3. Improved test efficiency;
4. Strong maintainability;
5. Parallel test support.

# Task2 Test Progress



Participant connection status

Participant 1	Participant 2	Status Level1-2	AMQP Server
HKG_GEMS	CHN_GEMS	Pass	ActiveMQ Artemis - Rabbit MQ
HKG_GEMS	JPN_GEMS	Pass	ActiveMQ Artemis - /
SPG_GEMS	CHN_GEMS	Pass	- Rabbit MQ
SPG_GEMS	THA_GEMS	Pass	...
SPG_GEMS	JPN_GEMS	Pass	...
THA_GEMS	HKG_GEMS	Pass	...



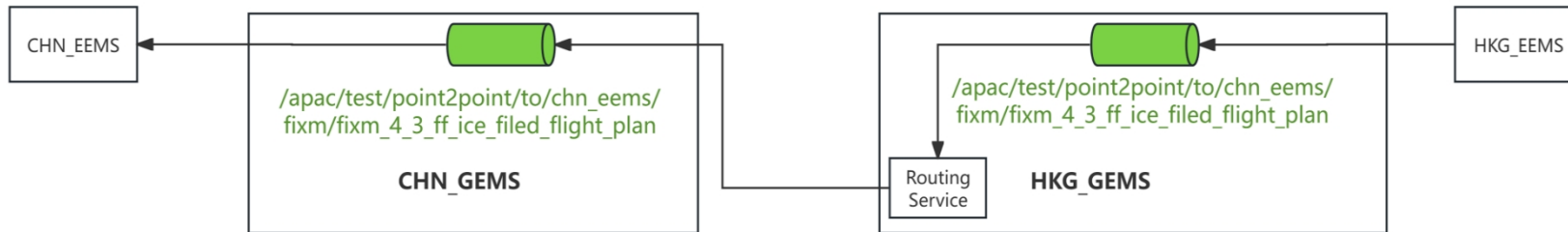
**Test progress:** 5 participants have successfully passed the Level 1 (Basic Network Connectivity) and Level 2 (Direct EMS Interconnection) tests. The Level 3 (Basic Message Transmission) testing is progressing.

# Task2 Level3 Test Case(CHN\_GEMS)

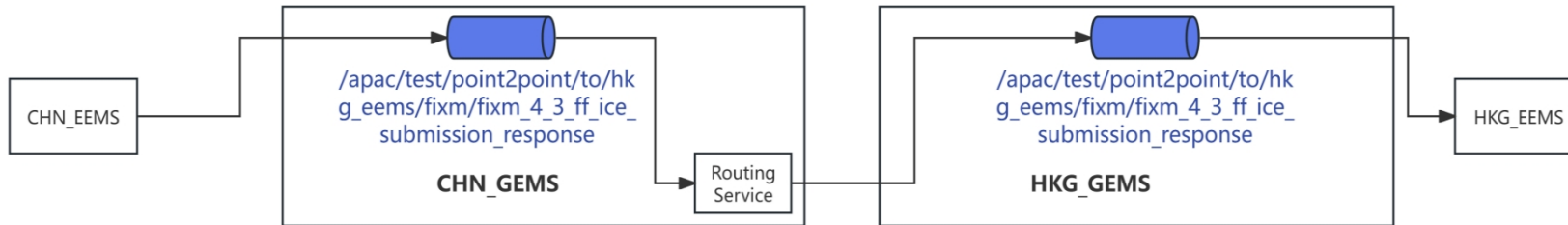
PointToPoint mode:

HKG\_EEMS sends FF-ICE Message FFP to CHN\_EEMS

Routing service: self-developed or commercial software that pulls from other GEMS or routes/pushes to other GEMS.



CHN\_EEMS sends FF-ICE Message SR to HKG\_EEMS



## Point-to-Point Mode

### Core mechanism:

1. Using the recipient ID in SWIM message and EMS routing tables to guarantees accurate message delivery.

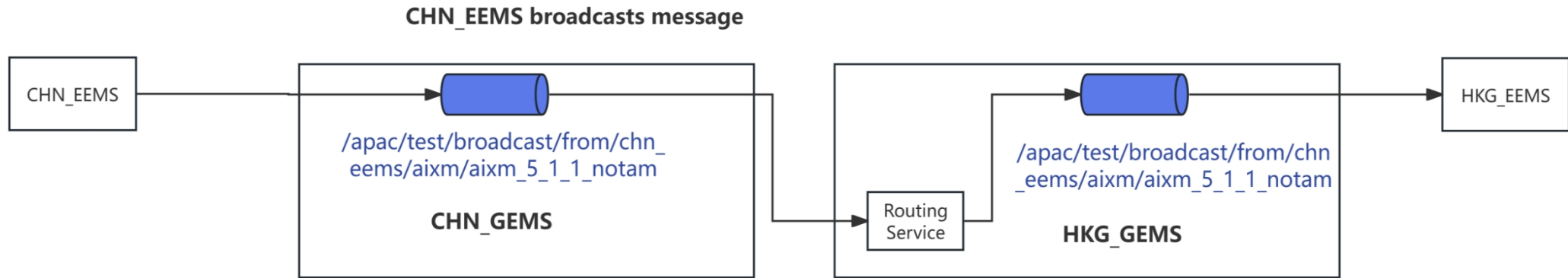
### Test Steps:

1. HKG\_EEMS sends FFP , routed via GEMS to CHN\_EEMS.
2. CHN\_EEMS sends response, routed via GEMS to HKG\_EEMS.

# Task2 Level3 Test Case(CHN\_GEMS)

**Broadcast mode:**

Routing service: self-developed or commercial software that pulls from other GEMS or routes/pushes to other GEMS.



## **Broadcast Mode Core mechanism:**

1. SWIM messages with no recipient ID may be subscribed to by downstream EMS on demand.

## **Test Steps:**

1. CHN\_EEMS publishes NOTAM messages to CHN\_GEMS;
2. The GEMS connected with CHN\_GEMS perform subscription ;



**The End**