International Civil Aviation Organization

The Tenth Meeting of System Wide Information Management Task Force (SWIM TF/10) and Second Working Session of SIPG

Bangkok, Thailand, 20 – 30May 2025

Agenda Item 5: Updates on the assigned tasks by task leads/contributors, including progress report and issues

b) SWIM Infrastructure

APPROACH TO GLOBAL API GATEWAY FOR WEB SERVICES

(Presented by SIPG, presenter ROK)

SUMMARY

This paper introduces de-facto API Gateway topologies commonly used in the ICT industry—particularly in cloud computing environments, where various heterogeneous systems interact—and proposes an approach for implementing a regional API Gateway as a counterpart to GEMS, in order to support the Request/Reply Message Exchange Pattern (MEP) within the APAC SWIM architecture.

1. INTRODUCTION

1.1 The SWIM Implementation Pioneer Ad-hoc Group (SIPG) is working towards building a prototype of regional SWIM architecture. Currently, most efforts are focused on GEMS, which supports a messaging service using the Publish/Subscribe message exchange pattern.

1.2 SWIM Implementation (Doc 10203) also defines the Request/Reply MEP, which corresponds to web service-style interactions. And, at the 9th APAC SWIM TF, WP/16 - *"Proposed Business Functionality of APAC Common SWIM Information Services"* identified some global SWIM services based on the Request/Reply MEP.

1.3 However, from a regional perspective, most demonstrations and implementation efforts have been centered around the Pub/Sub MEP, and therefore, efforts on implementing the Request/Reply MEP also should be conducted

1.4 In SWIM TF/10 WP/0X - "Methods for Implementing FF-ICE Services Using Request/Reply Message Exchange Pattern," an explanation has already been provided as to why HTTP (REST) API-based web services should be considered as the approach for implementing the Request/Reply MEP in the APAC region. Therefore, other methods to implement the Request/Reply MEP and implementation cases from other regions should be referenced in advance through the WP/0X.

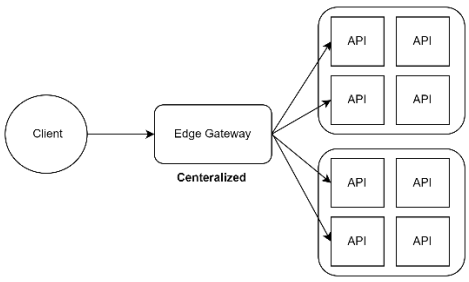
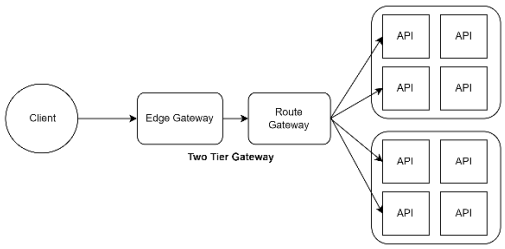
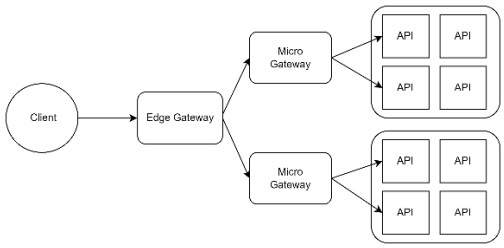
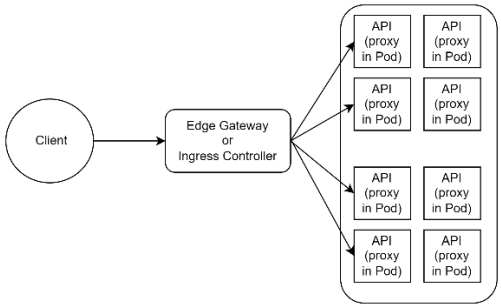
1.5 To implement this in the APAC region, a medium corresponding to GEMS for message delivery is required, which is generally referred to as an API Gateway (API GW) in the ICT industry. Therefore, this document introduces several API Gateway topologies commonly used in the ICT industry, particularly in microservices architectures and cloud environments, and proposes an approach for implementing a regional API Gateway as a complementary element to the messaging service GEMS within the APAC SWIM architecture.

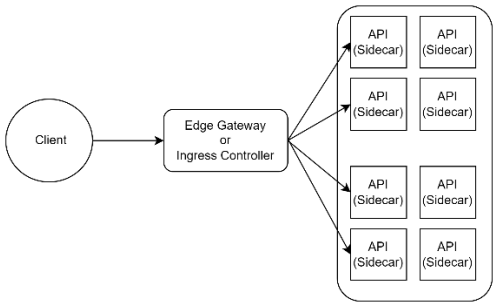
2. DISCUSSION

2.1 An API Gateway is a proxy gateway that routes service requests from endpoints to appropriate backend services based on user-defined routing configurations. It then delivers the processed response back to the requesting endpoint.

API GW Deployment Cases Commonly Used in the ICT Industry

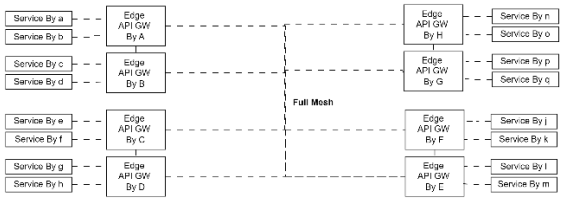
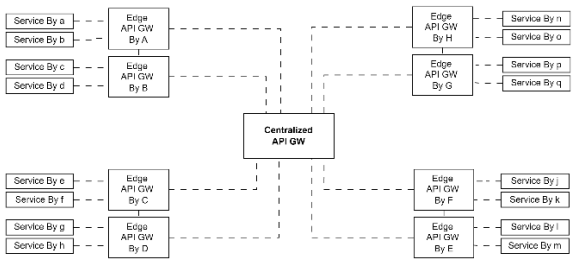
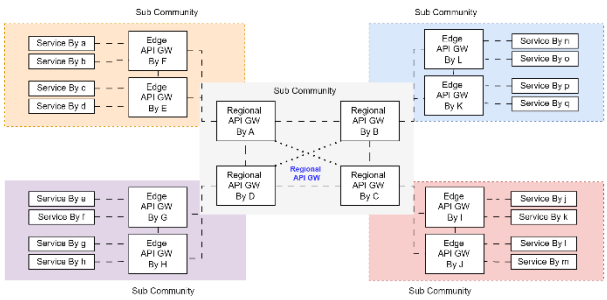
2.2 This section introduces several API Gateway deployment patterns that are commonly used in the ICT industry as shown in the table below. Approaches that map these cases to the context of APAC SWIM architecture for request/reply message exchange pattern is described in the following section.

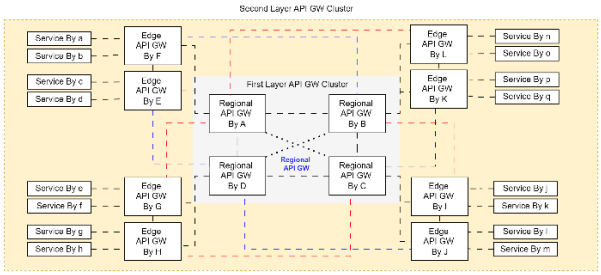
Deployment Case	Diagram	Description
Edge Gateway		This API GW pattern is a common API GW pattern similar to an ADC (Application Delivery Controller) Suitable Use Case - Monolithic Application - Centralized Management Unsuitable Use Case - MSA - High Change Velocity
Two-Tier Gateway		This API GW pattern is designed for distributed and small-scale services, and supports the separation of roles. Suitable Use Case - MSA - Independent Scaling Unsuitable Use Case - Distributed Control
Micro Gateway		This API Gateway pattern is built on a two-tiered architecture, where one gateway handles external traffic (e.g., client requests), while a separate internal gateway manages service-to-service communication and operational traffic. Suitable Use Case - MSA Unsuitable Use Case - Tightly Regulated System - Low Change Velocity
Per-Pod Gateway		This API GW pattern extends the micro-gateway pattern by introducing a per-pod proxy gateway, which allows each service instance to manage its own inbound and outbound traffic independently. Suitable Use Case - MSA Unsuitable Use Case - Small-Scale Systems - Single-Service Environment

Deployment Case	Diagram	Description
Sidecar Gateway and Service Mesh		This approach extends the micro-gateway pattern by deploying sidecar gateways alongside each microservice, enabling each service instance to independently manage both inbound and outbound traffic. Suitable Use Case - MSA Unsuitable Use Case - Small-Scale Systems - Single-Service Environment

Approach of API GW Deployment in the APAC SWIM Architecture

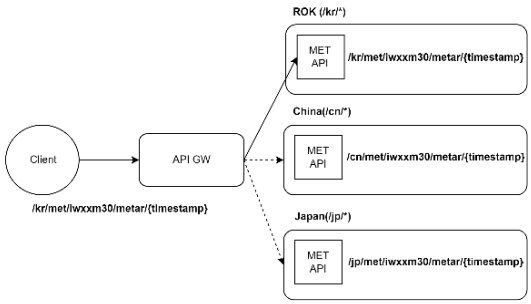
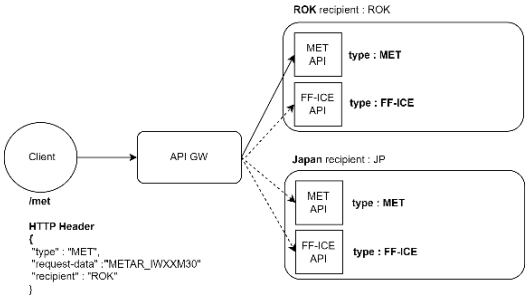
2.3 As mentioned in Section 2.1, API GW commonly used in the ICT industry is primarily designed for a single enterprise which has many different backend services, and thus cannot be directly applied to the APAC SWIM context. Therefore, this paper considers an approach for applying such patterns to the APAC SWIM architecture, particularly from the perspective of end-to-end message delivery guarantee as shown in the table below:

Approach	Figure	Description
Decentralized Approach		Same as Decentralized Approach of EMS interconnectivity architecture presented in WP05, SWIM/TF8 A service interacts with its own Edge GW, and the Edge GW directly forwards the request to another Edge GW Pros - Simple Architecture Cons - Complex Transaction (i.e., P2P)
Centralized Approach		Same as Centralized Approach of EMS interconnectivity architecture presented in WP05, SWIM/TF8 API GW acts as a single-entry point for all services and clients between member states Pros - Simplified Communication Cons - Centralized API GW is SPOF
Hierarchical Architecture		Same as Hierarchy Approach of EMS interconnectivity architecture presented in WP05, SWIM/TF8 Edge GW interacts with Regional GW, which handle routing within sub-community or forward requests to other sub-community Pros - Scalability, Fault Isolation Cons - Regional API GW is SPOF

Architecture	Figure	Description
Two-layer Hierarchical Architecture		Same as Modified Hierarchy Approach of EMS interconnectivity architecture presented in SP07 SIPG/WS8 Two-layer hierarchical API GW architecture with a clustered regional layer <u>Pros</u> - Optimized for HA, scalability <u>Cons</u> - Policy Sync, - Management Complexity

<u>Approach of Message Routing Using API GW in the APAC SWIM Architecture</u>

2.4 Regardless of API GW deployment models mentioned in Section 2.3, the Request-Reply message exchange pattern also ought to guarantee end-to-end message delivery between the requester and the responder. To support this, the following message routing patterns could be considered.

Method	Diagram	Description
Path-Based Routing		Client requests are routed based on URL, which may be identified by the region (e.g., /kr/). API GW uses the path to determine the appropriate destination to forward the request to. <u>Pros</u> - Simplicity, Clarity <u>Cons</u> - Limited flexibility - Hardcoded Route (tightly coupled)
Content-Based Routing		Client sends a generic request (e.g., to /met) and includes routing information in the **HTTP headers or payload**. API GW inspects the content to dynamically determine the appropriate destination to forward the request to. <u>Pros</u> - Highly flexible - Better separation of concerns — clients don't need to know internal routing algorithm <u>Cons</u> - Complexity to manage - Inspect the request, which requires extra computing resource

2.5 There are other message routing methods for different purposes (e.g., Policy-Based Routing, Header-Based Routing, and Failover Routing), but this paper doesn't describe them in detail as this paper is intended to provide a high-level approach to implement Request/Reply message exchange pattern.

CONCLUSION

2.6 To achieve SWIM implementation by 2030, APAC SWIM architecture also needs to consider not only the Publish/Subscribe MEP, but also the Request/Reply MEP.

2.7 Given the current emphasis on the regional SWIM prototype architecture using an Enterprise Messaging System (EMS), which the SIPG is developing in the APAC region, the primary issue is to discuss how the Request/Reply MEP should be implemented.

2.8 If HTTP (REST) API-based web service to enable Request/Reply MEP is adopted for the regional architecture, the adoption of an API GW also would be essential in a distributed and heterogeneous environment like APAC region. API GW provides a scalable and flexible mechanism to manage routing, traffic control for the Request/Reply MEP that are not covered by GEMS, which is primarily designed for Publish/Subscribe MEP.

2.9 In addition, as two-layered hierarchical architecture is under consideration for GEMS, the deployment of regional API GW should also align with this topology. Such alignment is critical to ensure consistency in routing policies, message flow, governance in the region. A misalignment between GEMS and API GW topology may lead to complexity, inefficiency, and potential fragmentation of the APAC SWIM architecture.

2.10 Therefore, this paper recommends that future implementations of the Request/Reply MEP in APAC SWIM architecture be strategically planned with API GW topology that reflect and complement the architectural direction of GEMS.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper; and

b) discuss any relevant matter as appropriate

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