

Federal Aviation Administration



Enterprise Messaging Services

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1.0 Purpose

This paper provides an overview of the FAA's existing Enterprise Messaging capabilities in terms of the architecture, concept of operations, and the associated challenges as implemented today under the FAA Telecommunications Infrastructure (FTI) contract. The FAA is considering various procurement strategies for the follow-on FTI-2 program. Included in the portfolio of services currently provided under the FTI contract are the Enterprise Messaging Services which are required by the System Wide Information Management (SWIM) program. These services and associated infrastructure are currently available in all three domains of the FAA Enterprise – NAS Operations, Mission Support, and Research and Development (R&D). The FAA is seeking to gain a better understanding of technical capabilities within the commercial marketplace, assess alternative business models and operational approaches that may be beneficial to the FAA in supporting its future enterprise messaging needs.

2.0 Background

Beyond services traditionally associated with a telecommunications services contract, the FTI contract is scoped to provide enhanced data services, such as the service-oriented architecture (SOA) messaging services required by the FAA's SWIM program. These services were initially established in the NAS Operations Domain via the FTI-provided NAS Enterprise Messaging Service (NEMS) infrastructure. This enterprise messaging infrastructure provides messaging functions that support the “publish once, consume many” concept of operations fundamental to SOA messaging services. Similar messaging infrastructure has also been implemented in the Mission Support and R&D Domains.

The FAA enterprise messaging infrastructure is a commercial-off-the-shelf (COTS) SOA implementation at the application layer (Layer 7) that leverages the Internet Protocol (IP) network to provide ubiquitous messaging access to users on the network. As such, users across the FAA's enterprise can request, acquire, and access enterprise messaging services in a similar manner as they acquire any other FTI services. Enterprise Messaging Services are also available to external producers and consumers via the NAS Enterprise Security Gateway (NESG), part of the FAA's boundary protection infrastructure. The FAA's SWIM program and enterprise messaging infrastructure provide a “utility” that supports governance, security, service management, standardization, and policy management across the agency.

3.0 Description of Current Environment

3.1 FAA Enterprise Messaging Services Architecture

FAA Enterprise Messaging Services support producers and consumers of aviation information across the FAA enterprise and the sharing of data products with aviation

partners outside the FAA. Each user has varying requirements for access, reliability, maintainability and availability. Enterprise messaging functionality required to support these users is referred to as SWIM “Core Services” which are implemented in the enterprise messaging architecture. These Core Services include: Interface Management, Messaging, System Security, and Enterprise Service Management.

Interface management enables data service producers to publish information about a given product or service. Each user is provided documentation and other tools to expedite the process of “on-ramping” to the FAA Enterprise Services Bus (ESB). The on-ramping process includes configuring and enabling a connection between a user (i.e. a producer and/or consumer) and the enterprise messaging infrastructure. Interface Management enables enterprise governance and policy enforcement through standard messaging service interfaces for access to a given information product/service.

Messaging provides an information exchange mechanism that moves information products and services between the ESB and a producer or consumer. The FAA has deployed a decentralized messaging infrastructure in which IT equipment supporting SWIM Core Services are installed in FAA facilities. Enterprise messaging servers, hosted and interconnected over FTI IP networks, exchange information products/services between SWIM users via three messaging patterns: publish/subscribe messaging, request/reply web services, and dynamic subscriptions.

Enterprise messaging Core Services include Enterprise Service Monitoring (ESM) and System Security, respectively. Monitoring and control functions for managing failure modes, service degradation, service level agreements, and quality of service are provided by the ESM function. A tiered architecture is used for the implementation of the ESM function to forward service impacting alarms and alerts to a centralized management infrastructure. Alarms that are service-affecting are forwarded to the FAA facilities. System Security employs a similar architecture and has been extended to support boundary protection via gateways between the FAA domains and interactions with external users. FAA boundary protection has been further enhanced to support bi-directional messaging interfaces using a request/reply web service and dynamic subscription message patterns.

3.2 Operational Approach

The process for acquiring information begins with physical connectivity. There are mature processes under FTI for internal and external users to gain access to these services. For external users, these processes have been modified to accommodate SOA messaging requirements. Once physically connected, users access the FAA’s NAS Service Registry and Repository (NSRR) to display information services (typically used to publish information on web services), or the Product Catalog (for information products

used for publish/subscribe messaging). These tools point to the authoritative source for the various information products/services and provide early discovery of information sharing. Only SWIM-compliant products are registered in the NSRR and Product Catalog. Proper registration includes adding service meta-data (detailed information about the given information product/service), syntax, semantics, schemas, service artifacts (i.e., examples, etc.), and related service level agreements (SLAs). The NSRR is operated and maintained by the SWIM Program independently of enterprise messaging services provided under FTI.

Data and information providers, referred to as “producers,” receive a Service Approval that represents their initial authorization to provide a SWIM-compliant service. Upon final approval, the producer on-ramps their information products/services to the FAA enterprise over the messaging infrastructure. As service acceptance is achieved, the information is made available to authorized consumers.

These processes enable the FAA to establish enterprise wide governance structure. Access rules, information usage, authoritative source, and SOA/data standards are centrally managed by the FAA. The enterprise messaging infrastructure arbitrates and enforces enterprise policy and establishes a loosely coupled relationship between information provider and consumer.

The enterprise messaging infrastructure enables the exchange of data products and information services between providers and consumers as enabled by the ESB. Delivered as an “infrastructure-as-a-service”, the FAA orders the enterprise messaging infrastructure in advance of demand. System level capabilities include run-time subscriptions, message reliability (QoS), mediation and security services were ordered to enable core capabilities for general availability to SWIM users. SWIM user services are structured such that producers and consumers can order either “basic services” (publish/subscribe messaging services or web services) or “enhanced services” which include more advanced capabilities including mediation, service level agreements, and dynamic subscriptions, as needed.

As producers publish their products/services, the SWIM ESB is configured (as part of the Basic User service for on-ramping) to automatically route information to all consumers anywhere the data is needed. These processes apply to internal and external consumers. Integration with the FAA’s boundary protection services provides a secure information exchange interface for external producers and consumers. Enterprise messaging infrastructure is deployed across the FAA Enterprise including the Administrative domain and the Research & Development (R&D) domain. The on-ramping process includes consumer development within the R&D environment that

enables users to develop and test their interfaces while reducing technical and integration risk as they move into the NAS Operations environment.

Enterprise Service Management and Security are centrally managed and leverage FTI contractor and FAA operational assets through the FTI-provided Network Operations Control Center (NOCC) and the NEMCs. SWIM services are monitored, tracked and managed from these facilities using a proactive monitoring approach for fault, performance and security functions. Trouble tickets are generated in various service degradation or failure modes and prioritized in accordance with FAA policy. Events are tracked and system level service agreements (SLAs) are reported, then provided to users who have ordered this enhanced service. SWIM security follows the same process for the tracking and management of security events. In addition to the FTI and FAA monitoring infrastructure, the FAA has further integrated security elements into the Department of Transportation's (DOT's) Cyber Security Management Center (CSMC) as part of the DOT's cyber security initiative.

All enterprise messaging infrastructure assets, including software, hardware, and other configuration items that support Messaging, System Security, and Enterprise Service Management are contractor owned, operated and maintained. NEMC and CSMC assets are FAA owned, operated and maintained by the SWIM Program, independently of the SWIM services provided in FTI.

4.0 FAA Critical Challenges

A central challenge for the FAA is to determine whether the manner in which the enterprise messaging infrastructure, and associated SWIM services, should be acquired under FTI-2 as they are currently under the FTI contract or, alternatively, under a different architectural, operational, and procurement model. Among the considerations in this trade space is an understanding of how a post-FTI SWIM model will position the resulting messaging capabilities to meet the FAA NextGen operational future needs. SWIM will see future challenges in the following: 1) Evolving FAA to an integrated enterprise; 2) Evolution of user demand (i.e., data integrity, cyber security, etc.) and implications to infrastructure; and 3) Role of data standards and interoperability.

A key challenge is to evolve business processes and technology to deliver SWIM services in line with satisfying user demand. Processes now exist that define how information providers and consumers register, request, provision and manage information products/services. Future implementations of Enterprise Messaging services should consider mechanisms that influence business processes and shape user behavior. Additionally, technological advances like virtualization, cloud computing and other enterprise technologies (i.e., real time information sharing, etc.) must be accounted for. Establishing SWIM standards, consistency in infrastructure deployment, interface

development, and configuration management processes were key drivers in establishing architectural requirements. As “enterprise services”, these will have to evolve to continue driving user behavior in compliance with FAA policy.

Another significant challenge is that in the FTI-2 timeframe, it is expected the messaging infrastructure will have to support safety critical services. NAS systems will also have greater interdependency between internal and external systems. System performance, data integrity and verification and cyber security represent a critical challenge for SWIM. Initiatives like On-Demand NAS Information, Performance-Based Operations, and Collaborative Air Traffic Management (CATM) among others, will introduce the need for new business services, putting greater demand for information management and the underlying infrastructure. NextGen promises to create an environment that drives innovation and greater demand on infrastructure, and, as such, the messaging infrastructure will have to support these applications.

Evolving data standards are still another challenge ahead for the FAA. These data standards will impact each of the various SWIM Core Services, including services like mediation and orchestration to process messages compliant to these new standards. The development of aviation data standards for data exchange is an on-going collaboration with global stakeholders and will continue to evolve with various air traffic modernization initiatives (i.e., NextGen in the US, Europe’s SESAR, Brazil’s SIRIUS, Japan’s CARAT, etc.). Data standards use common data structures (i.e., XML) to further abstract information from the underlying applications, increasing both flexibility and agility, while potentially increasing message size and/or processing requirements. Improvements in data standards and information models will establish new uses for information, driving greater demand on infrastructure. It is believed these standards will have implications to the size of messages being exchanged over the SWIM infrastructure and between NAS stakeholders, in addition to introducing potential vulnerabilities associated with the associated schemas. Data standardization efforts are coordinated by the Open Geospatial Consortium (OGC) and have initially targeted aeronautical (AIXM), flight (FIXM) and weather (WXXM) information, and will certainly require changes by the FAA.

5.0 Questions

1. Are there examples of communications infrastructure, either currently deployed or otherwise offered to users, that integrates messaging services into the Wide Area Network (WAN) infrastructure?
2. As users and information products are added to the enterprise messaging infrastructure, user demand will become more dynamic and difficult to predict. What considerations and potential technical solutions could help manage messaging resources?

3. SWIM is integrated with the NESG - a critical part of the FAA's border protection architecture - to securely share information with external users through DOT allocated Internet Access Points (IAPs). What are some best practices around information level security and its role in enterprise information exchange?
4. Cyber security presents significant challenges to the emerging FAA enterprise. What specific considerations should the Government give to role of security as it pertains to Enterprise Messaging services?
5. The SWIM architecture is comprised of two components: (1) messaging, which is de-centralized to optimize message routing; (2) security and enterprise service management, which is centralized to support consolidation of key monitoring and control functions (e.g., governance). What technology innovations are envisioned that might have implications to the de-centralized messaging architecture approach that the FAA should consider in FTI-2? What considerations should be given to today's central management architecture for Security and Enterprise Service Management (i.e., fault, performance, configuration and security management)? Please describe any recommended alternative approaches.
6. The FAA would like feedback from industry on near-term and mid-term technology breakthroughs envisioned and their implications to enterprise messaging and information exchange.
7. What are the implications that FAA should consider on emerging technology such as virtualization, cloud, the "infrastructure-as-a-service" model, and their role in Enterprise Messaging?

Appendix A

SWIM Menu of Services

The SWIM Program, as crafted under FTI, has been established in an "infrastructure-as-a-service" model. As NEMS "nodes" are ordered, hardware, software and the cost of staging and field installation are covered for the deployment of this infrastructure. Additional services have been established to provide the funding mechanism required to ensure a robust and updated infrastructure. The features and functionality of the NEMS infrastructure are developed by the SWIM Program, tested and validated, then offered to FAA users through order able services.

The service constructs are structured into two major types: System Level Capabilities, and Individual User (Producer/Consumer) Capabilities. System Level Capabilities are the foundational services funded by the SWIM Program to establish the NEMS as a viable infrastructure to offer across the FAA Enterprise. These System Level and Individual User services have been further broken down into Basic and Enhanced. The graphic below presents the services that have been ordered for SWIM under the FTI contract.

These services are developed, tested and established for testing. These two levels of service types enable the SWIM Program to order a set of services required to establish the NEMS infrastructure (basic), and reduce user acceptance risk (enhanced). The SWIM program has them tested thoroughly to ensure they're operationally suitable to users. The table below provides some additional insight into the types of products consumed by the users, creating flexibility in the services offered. The B1 service, Run-Time Subscriptions for example, was acquired by the SWIM Program to fund. Costs covered within those line items include, software, development labor, configuration, validation and operational maintenance required to establish the Messaging Service.

System-Level Capabilities	Capabilities Available to Individual Producers / Consumers
Basic • B1: Run-time Subscription • B2: Message Reliability (QoS) • B3: Mediation • B4: Availability & Performance • B5: Security Services • B6: Web Services • B12: Dynamic Subscriptions Enhanced • B10: Producer/Consumer SLAs • B13: Global Load Balancer • B14: Local Load Balancers • B15: Advanced Mediation	Basic • U1: WS-C: Web Service - Consumer • U2: WS-P: Web Service - Producer • U3: JMS-C: JMS Subscription - Consumer • U4: JMS-P: JMS Publishing - Producer Enhanced • E1: Mediation • E2: Performance • E4: SLAs • E5: Security • E7: Reports • E8: Dynamic Subscriptions • O1: OPS Publications to R&D, FNTB