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SWIM Evolution Strategy

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Foreword

The purpose of this document is to present a strategy for System Wide Information Management (SWIM) evolution that will facilitate the transition from initial capabilities to the Next Generation Air Transportation System (NextGen). The evolution strategy provides a framework than can be used to begin planning future segments of SWIM. Our approach is to develop and describe dimensions of SWIM evolution. These dimensions consist of the SWIM Environment, Communities of Interest (COIs), Net-enabled Services and Data, National Airspace System (NAS) Service Access, and Information Technology (IT) Infrastructure and Core Services. Examples of how SWIM can evolve in each dimension are included in the paper and are rooted in related activities at the Joint Program Development Office (JPDO), other government agencies, and commercial industry. Also included in the paper are SWIM maturity and utility models. These models can form the basis for measuring and evaluating progress towards achieving long term goals and objectives.

The evolution examples included in this paper provide a point of departure for Segment 2 planning activities in fiscal year 2008. CAASD will continue to work with the FAA on instantiating an effective evolution strategy to SWIM capabilities that will enable the accomplishment of NextGen objectives.

The material in this product was presented to SWIM program personnel in September of 2007.

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Foreword

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Organization

- **SWIM Evolution Strategy Overview**
  - **Approach and philosophy**
- **Dimensions of SWIM Evolution**
  - **Organizational and technical characteristics**
- **Evolution Strategy Examples**
  - **From present-day to future vision**
- **Summary**

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Organization

This briefing begins with an overview of the approach and philosophy used to determine a SWIM evolution strategy. In many ways, SWIM fits the definition of a net-centric enterprise [1,2] and it is possible that SWIM will continually evolve over time, perhaps never reaching a definitive end-state. Five dimensions of SWIM evolution are identified in this presentation to characterize the complex development environment of SWIM.

Each of the dimensions of SWIM evolution is introduced along with a description of concepts that may be used to further strategic planning of SWIM evolution. SWIM evolution examples are then presented that offer ideas for shaping the future of SWIM. The presentation concludes with a summary of the major elements presented herein.

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SWIM Evolution Strategy Overview

- **Identifies certain dimensions in which SWIM can evolve**
  - **Organizational**
  - **Technical**
- **Does not attempt to predict or identify specific outcomes**
  - **Allows for creativity and innovation of Communities of Interest (COIs) and NAS users to develop new solutions**

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SWIM Evolution Strategy Overview

This SWIM evolution strategy addresses certain dimensions of a net-centric enterprise along organizational and technical paths [3]. Other dimensions not directly addressed in this strategy, but dealt with separately in other MITRE products [4,5], address the issues of architecture and governance.

The approach taken in developing the evolution strategy for SWIM was to concentrate on providing frameworks, methods and processes that will allow the FAA to create and innovate solutions to challenges that may not have been foreseen at this time. For this reason, we do not attempt to define precisely where SWIM should evolve at specific points in time. Instead, we offer examples of how SWIM might evolve towards a future supporting net-centric operations in the NAS.

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Dimensions of SWIM Evolution

- **SWIM Environment**
  - **Stakeholders with interest in SWIM**
- **COIs**
  - **Defining, starting, and closing COIs**
- **Net-Enabled Services and Data**
  - **Business Processes and Data Modeling**
- **NAS Service Access**
  - **Service and Data Visibility, Accessibility**
- **Information Technology (IT) Infrastructure & Core Services**
  - **Planning, management, and operation of IT infrastructure**
  - **Networking, security, service and system management, etc.**

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Dimensions of SWIM Evolution

In this briefing, we examine two organizational dimensions. The first is called the SWIM Environment. The SWIM Environment includes all the stakeholders, including users, that influence and shape SWIM. There are different ways in which the stakeholders relate to one another and these relationships can evolve over time. The second dimension refers to the SWIM Communities of Interest (COIs) and describes ways in which COIs may be formed, operated, and disbanded depending on how broadly a given COI is defined.

We also examine three technical dimensions. Basic to SWIM are its constituent net-enabled services. Early net-enabled services tend to focus on data exchange. As net-enabled operations mature, services should evolve to encompass important business processes that can reduce duplication within the enterprise and bring about higher levels of interoperability. NAS Service Access is another important concept of a net-centric enterprise, allowing for discovery of services and data. Underlying net-centric operations is an IT infrastructure that supports the net-enabled technology.

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Dimension: SWIM Environment

- **Identifies roles for the many stakeholders involved with net-enabling the NAS**
  - **SWIM Program Office (PO), Operational Evolution Partnership (OEP), NextGen, COIs, Lines of Business (LOBs), external aviation community**
- **SWIM becomes the net-enabled solution for OEP and NextGen concepts**
- **Two possible paths identified for evolution of the SWIM Environment**
  - **Controlled**
    - **Methodical approach for developing SWIM technology in the NAS through the SWIM PO**
  - **Organic**
    - **Takes advantage of loosely-coupled nature of SWIM technology to allow ad-hoc participation by LOBs**

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Dimension: SWIM Environment

The SWIM Environment consists of many stakeholders. The set of stakeholders include the Operational Evolution Partnership (OEP) and NextGen. Other stakeholders include the Lines of Business (LOBs), external organizations and COI leadership. It is important to shape an evolution of the SWIM Environment such that SWIM becomes the solution for implementing net-enabled services derived from OEP initiatives and NextGen concepts.

Defining the manner in which these interoperate will be key to the future evolution of SWIM. One path in which the stakeholders can operate is called a Controlled SWIM Environment. The Controlled SWIM Environment is basically a top-down approach, whereby the SWIM PO primarily manages net-centric development efforts. A second possible path follows a combination of top-down and bottom-up approaches, whereby the SWIM PO guides development of net-centric solutions throughout the FAA and allows LOB programs, and even external partners, to participate in the SWIM Environment asynchronously with SWIM PO initiated acquisitions.

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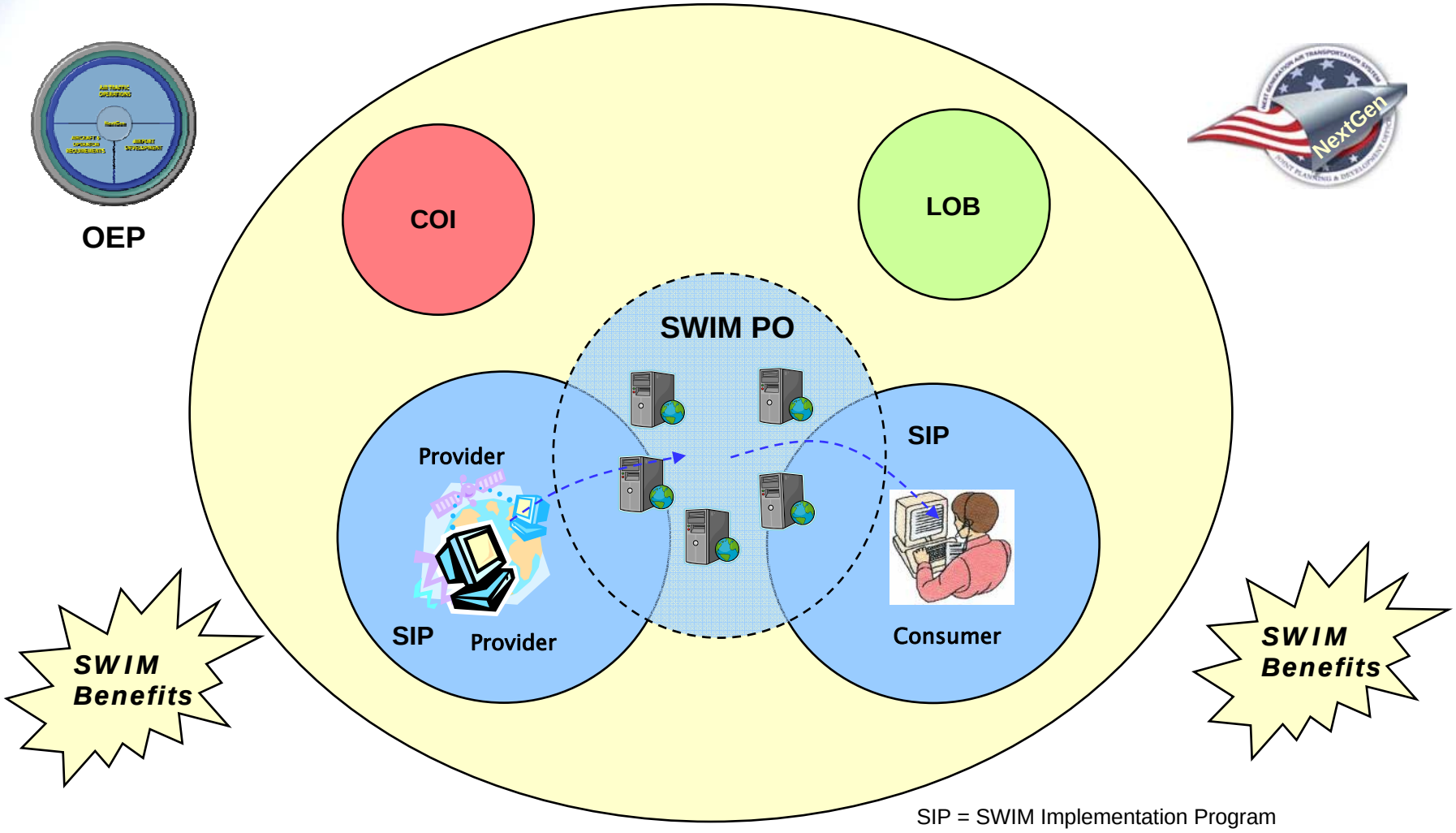
Notional SWIM Environment



SIP = SWIM Implementation Program

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Notional SWIM Environment

This chart provides a context for the stakeholders operating in the SWIM Environment. SWIM is portrayed as a net-enabled infrastructure with participating net-enabled service providers and consumers identified as SWIM Implementing Programs (SIPs). The SIPs are managed by the LOBs and develop specific net-enabled operational capabilities identified by the COIs. Also, within the SWIM Environment are the NextGen and OEP programs that can influence the shape of the SWIM Environment.

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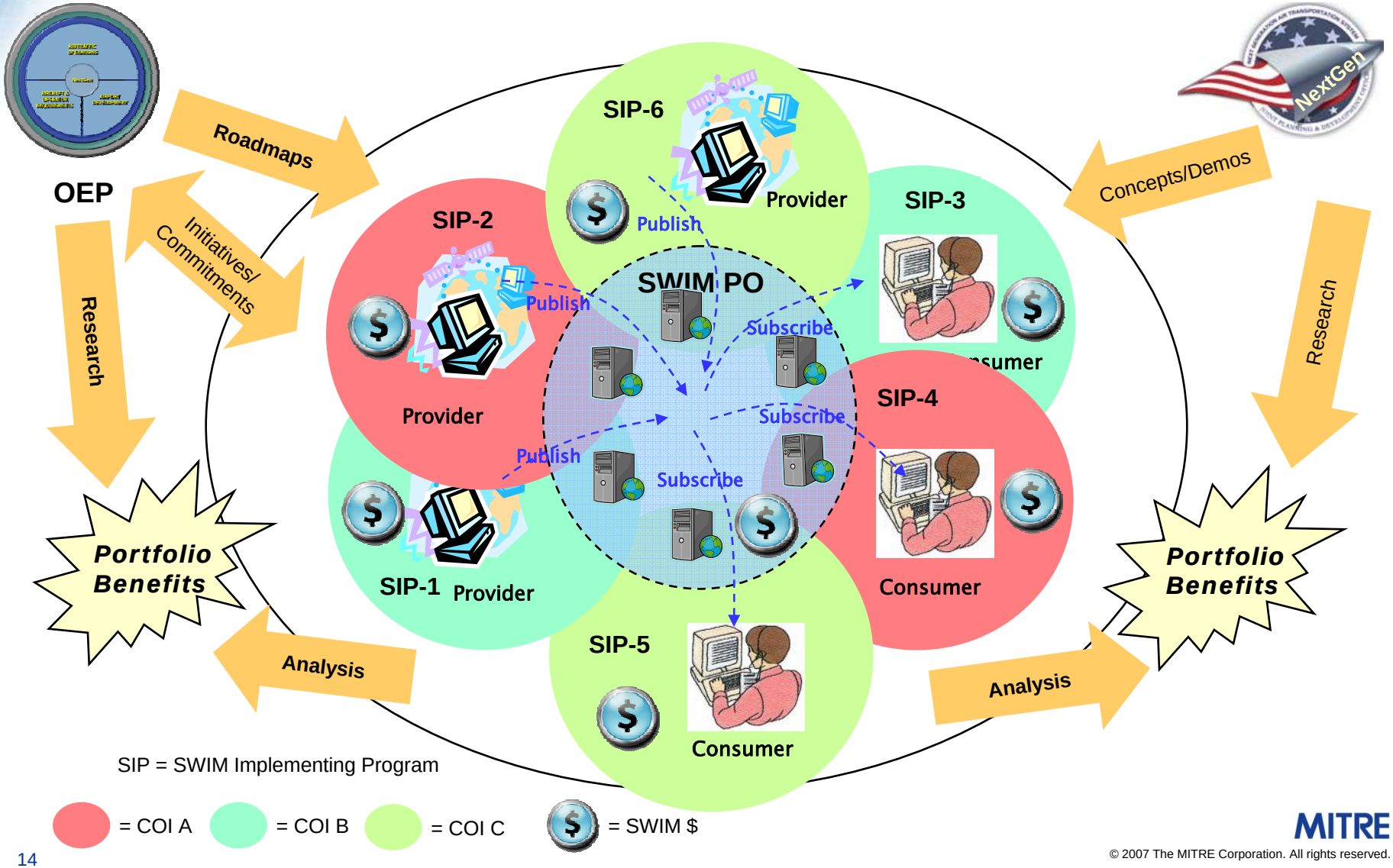
Controlled SWIM Environment



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Controlled SWIM Environment

The Controlled SWIM Environment is comprised of SWIM Core Services and net-enabled services developed by SIPs as coordinated through the COIs. The SWIM PO implements SWIM Core Services and provides funding for SIPs.

The agency, through the OEP and using NextGen concepts, coordinates initiatives and commitments with SIPs, as facilitated by SWIM and the COIs, to shape the SWIM Environment.

Also, the OEP and NextGen organizations promote basic research to develop the portfolio of benefits for future net-centric concepts. Benefits defined by these organizations, with inputs based on SIP analysis, contribute to the formal FAA acquisition process.

All net-enabled capabilities are implemented in a top-down manner, with funding from the SWIM PO, and procured through SWIM related acquisitions.

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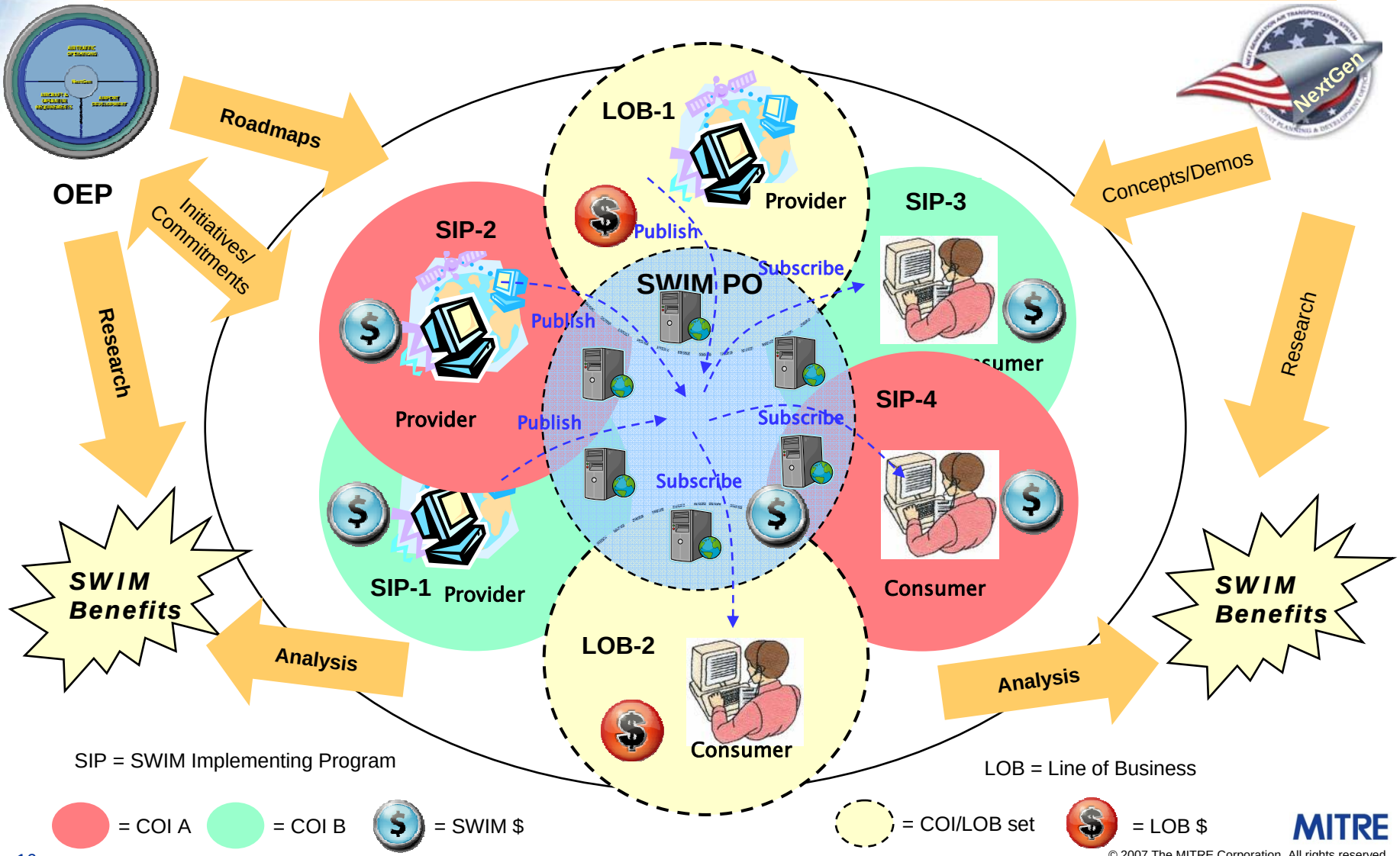
Organic SWIM Environment



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Organic SWIM Environment

The Organic SWIM Environment is comprised of the same stakeholders as those in the controlled environment, but additionally allows for a bottom-up approach for net-enabled LOB acquisitions with LOB funding. The SWIM PO would still implement SWIM Core Services and, as in the controlled environment, provide funding to the SIPs. The LOB programs would become part of the SWIM Environment using LOB funding to develop services according to SWIM guidance and policy.

The agency, through the OEP and using NextGen concepts, coordinates initiatives and commitments with the LOBs and the SIPs, as facilitated by SWIM and the COIs, to shape the SWIM Environment.

Also, the OEP and NextGen organizations promote basic research to develop the portfolio of benefits for future net-centric concepts. Benefits defined by these organizations, with inputs based on SIP and LOB analysis, contribute to the formal FAA acquisition process.

Net-enabled capability in the organic environment is implemented with some mixture of top-down and bottom-up approaches. The top-down approach provides SIPs with funding from the SWIM PO and procured through SWIM related acquisitions. LOB initiated acquisition and development can occur asynchronously with SWIM funded acquisitions and development.

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Dimension: COIs

- **Provides a process for identifying, establishing and disbanding future COI for the NAS**
  - **Guidelines for COI lifecycle**
  - **Definition of proper scope**
- **Formation of COI can be applied in many ways**
  - **Generalized or Focused**
    - **"NAS Information" or "NOTAMs"**
  - **Controlled or Organic**
    - **SWIM PO chartered or Ad-hoc**
- **Process based on DoD NCES training material and lessons learned**
  - **Identify information sharing problem and related COI**
  - **Form COI and addressing sharing information problem**
  - **Assess COI**

NOTAMs = Notice(s) to Airmen

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Dimension: COIs

In Segment 1, the SWIM program has identified three COIs: flight and flow (FF), weather, and aeronautical information management (AIM). Each COI has varying levels of activity and formalized governance. There are also existing “de facto” COIs (which may be subsets or intersections of these larger, broader COIs). An example is the effort to modernize the NOTAM system to improve access to and usability of NOTAMs, including making them readable by automation. A SWIM COI evolution strategy might consider formalizing COI governance processes, not to constrain or burden COI innovation, but to ensure that COIs are cognizant of, and coordinate with, related efforts. A COI lifecycle model, which the FAA could tailor, is presented on the next slide.

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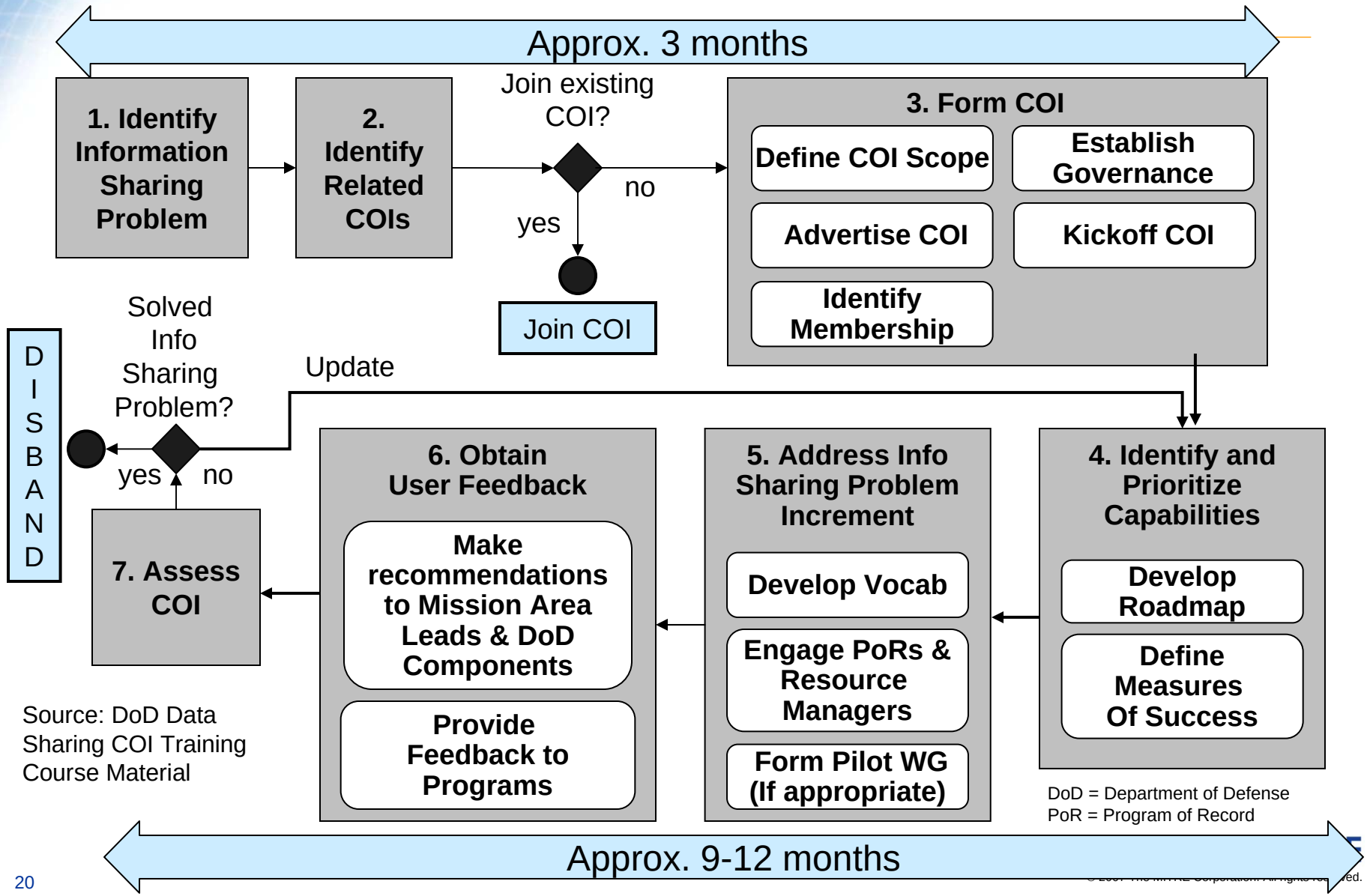
DOD Model for Establishing a COI



Source: DoD Data Sharing COI Training Course Material

DoD = Department of Defense
PoR = Program of Record

DOD Model for Establishing a COI

This diagram shows a DoD model for a COI lifecycle. The SWIM program may find it advantageous to develop and publish guidelines for the establishment, operation, and sunset of a COI. These guidelines can be used by existing, de facto, or potential COIs to help them organize and function more effectively, and to develop outputs that are compatible with evolving the SWIM environment. The model can be tailored to fit the FAA and SWIM program, but includes several key elements:

- Timelines for establishing the COI and completing the COI work
- Identification of the specific problem to be solved and whether a new COI needs to be established
- Identification of activities, products, and decision points
- A defined “sunset” for the COI activity

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Dimension: Net-Enabled Services and Data

- Services mature and evolve in content and capability over time
  - Initially, services may address data-exchange
    - Special Use Airspace (SUA)
    - Flight Plans
  - In the future, the power of Net-enabled operations is delivered by services that address core "business" processes
    - Complete Flight Plan processing for consumers
- Core data schema enable information sharing across the enterprise
  - Core schema describes "when, where, what" for all participants
  - Extensible by COIs, services, and systems as needed
  - Strives for a minimal set of terms
  - Agreed to by aviation/air transportation community
  - Uses appropriate open and Federal standards

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Dimension: Net-Enabled Services and Data

The NextGen vision includes several “business process” services, described as Shared Situational Awareness Services. These include weather information, surveillance, flight plan filing and flight data management, Aeronautical Information Services, and others. These services include fusing, processing, and computing data to provide consistent results to all authorized users. SWIM evolution should address the path from current data exchanges to provisioning of shared services to enable better decision making and performance-based operations.

A schema for universally-shared “core” data should be developed to facilitate more agile information sharing. It should not be overly prescribed but instead focus on the essential “when, where, and what” from an enterprise perspective. This provides a foundation to which COIs can link their work and from which they can specify more specialized data sharing. Such a schema, or its basis, may already exist based on logical data schemas developed within the FAA. Vocabularies have been developed within the FAA and are also being developed for NextGen. Core data may be shared across domains, such as between FAA and Homeland Security and Defense entities.

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Implementing Business Processes

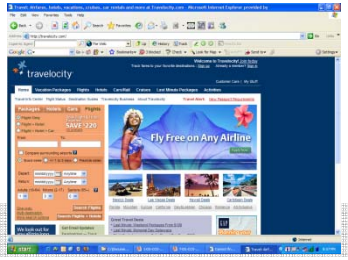
time

Analog

User

- Many phone calls
- Many iterations
- Time consuming

Digital Immigrants



e.g., Travelocity.com

- Fast
- Data available on the web
- Price comparisons for best value

Digital Native

- Book online
- eTicket
- Online check in
- Mobile alerts

- Web accessible data allows **increased** capability & agility
- Requires **TRUST** in services, data, & security
- Business processes **transformed**; If you don't migrate
  - **Producer/Owner**: Gets <u>left behind</u> – goes out of business
  - **Consumer**: <u>Pays more</u> & has fewer options

Source: DoD Data Sharing COI Training Course Material

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Implementing Business Processes

An important aspect of net-centric operations is the idea of improved business processes. Historically, the constraints imposed by NAS data communications architecture best supported separate systems working independently over pre-defined interfaces. With net-centric operations, business processes can be distributed more easily across the enterprise, resulting in reduced duplication. Net-centric operations will require higher levels of operational trust among systems that were previously independent. Operations that do not transform to a net-centric paradigm may be left behind or may pay more for less functionality.

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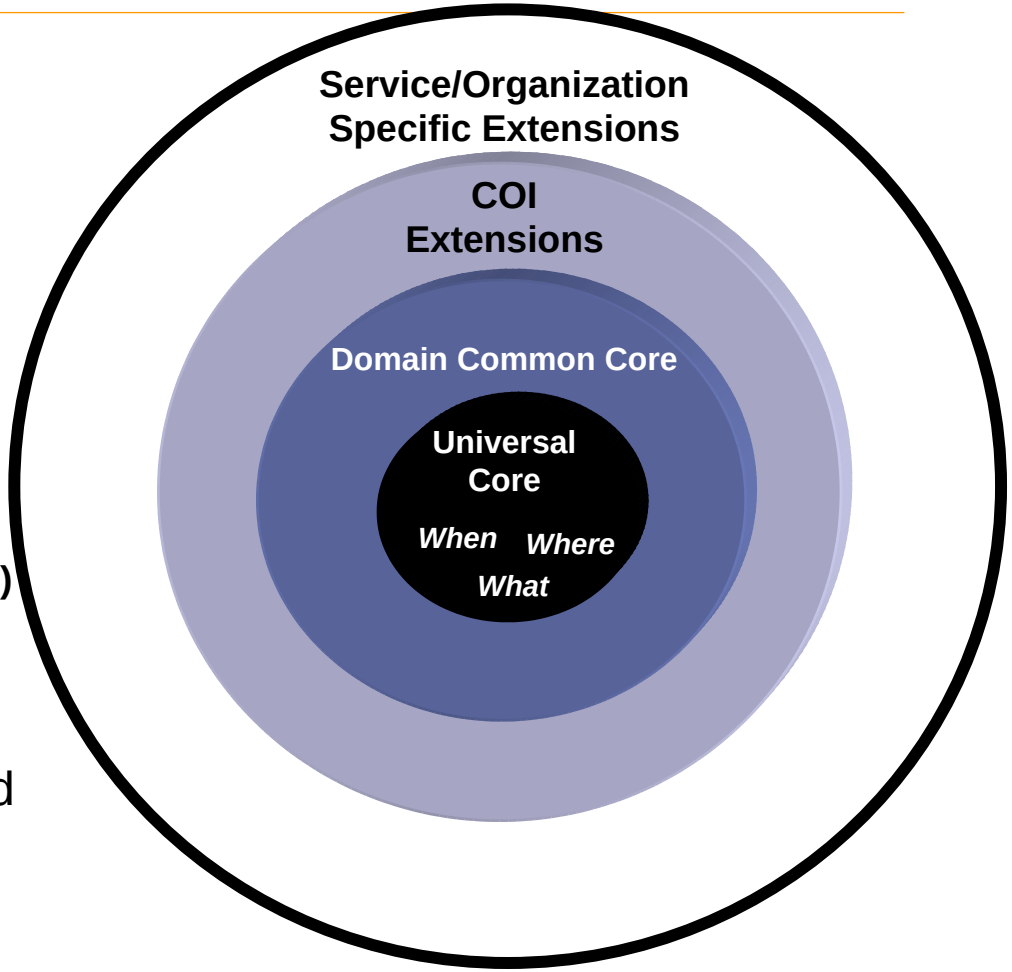
Universal Core Schema

- Universal core data schema to enable information sharing
  - Describes "when, where, what"
  - Includes minimal set of terms
  - Agreed to by aviation/air transportation industry
  - Uses appropriate open and Federal standards
    - **Geography Markup Language (GML)**
    - **Intelligence Community – Information Security Markings (IC-ISM XML schema)**
  - Extensible by COIs, services, and systems as needed



OGC = Open Geospatial Consortium
XML = eXtensible Markup Language

Increased Agility and Interoperability

Source: Based on DoD Data Sharing COI Training Course Material

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Universal Core Schema

There are many differences in terms, syntax, and semantics for data to be shared among the many aviation stakeholders. Services developed by SWIM will require an XML schema that describes the acceptable format of the data to be exchanged. Coordination of the schema within the COI, and across other COIs, would facilitate interoperability and extensibility. SWIM or the COI may need to coordinate with enterprise-wide users throughout the government to facilitate interoperability among all stakeholders.

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Dimension: NAS Service Access

- **NAS Service Access is a key function of a net-enabled enterprise**
  - **Provides for discovery of services within the enterprise**
- **Evolution of a NAS Service Access capability makes:**
  - **Data Visible: *Where is the data?***
  - **Data Understandable: *What does the data mean?***
  - **Data Accessible: *How do I get the data?***
  - **Services Visible: *Where are the services?***
  - **Services Understandable: *What will the services do?***
  - **Services Accessible: *How can I subscribe to a service?***

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Dimension: NAS Service Access

NAS Service Access evolution is critical to meeting the NextGen and mid-term visions. SWIM Segment 1 service access is fairly limited, essentially defined as point-to-point interchanges. To achieve more universal access to and effective use of data and services, the DoD has defined several strategies to make data and services visible, understandable, and accessible. These strategies may be applicable to SWIM. With more reliance on automation to perform computation-intensive tasks and to support decision-making, data and services need to be unambiguously defined and transparently available, while restricting access to sensitive, safety-critical, or classified information.

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Enterprise Services to Support Evolution[1]

Strategy	NCES [2]	FAA
Data Visible	• **Federated Search** – Content discovery across the Enterprise	TBD
	• **DoD Discovery Metadata Specification (DDMS)** – Discovery metadata to advertise information holdings	TBD
Data Understandable	• **Metadata Registry** – Electronic marketplace for structural metadata components	• **Metadata Registry** – FAA Data Registry (FDR) in place – Weather Data Registry (TBD)
Services Visible	• **Service Registry** – Catalog of services available for development time discovery	• **Service Registry** – Catalog of services available for development time discovery in Segment 1
Services Accessible	• **Service Registry** – Service endpoints for runtime location transparency	TBD
Data Accessible	• **Security Services** – Authenticate via PKI Certificate – Authorize via attribute based access control	TBD

[1]DoD COI Training Material

[2] NetCentric Enterprise Services

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Enterprise Services to Support Evolution

This figure shows how various DoD data sharing strategies are enabled by enterprise core services. For each data sharing strategy shown in the first column, a corresponding NCES capability is shown in the second column. The FAA has some existing or planned services that can be leveraged to support these strategies; those currently known are shown in the third column. The Services Visible strategy is realized in NCES and FAA by the creation of a Service Registry available to developers. Undertaking an assessment of existing capabilities could help the FAA to develop approaches for delivering future enterprise services that make data more visible, discoverable, and usable. As an example of such a future enterprise service, the FAA may wish to pursue a “run-time” service registry to complement the “design-time” registry planned for Segment 1.

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Dimension: IT Infrastructure and Core Services

- **The IT Infrastructure provides the underlying technology that supports a net-enabled enterprise**
  - **Intrusion Detection and Response**
  - **Identity and Certificate Management**
  - **Naming and Addressing**
  - **WAN Security**
- **Core Services provide application middleware that supports the net-enabled enterprise**
  - **Messaging**
  - **Interface Management**
  - **Enterprise Service Management**
  - **Service Security**

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Dimension: IT Infrastructure and Core Services

The Information Technology (IT) Infrastructure functions include the networking and security capabilities and services that SWIM needs to make use of to support higher level SWIM Services. The IT Infrastructure functions that are not specific to SWIM are outside the scope of this study.

SWIM Core Services isolate IT concerns from business concerns, allowing developers to focus on applying service oriented architecture (SOA) principles to developing application layer capability. It also promotes re-use of existing services. The next charts provide additional detail on IT Infrastructure and Core Services from the perspective of the SWIM Functional Architecture.

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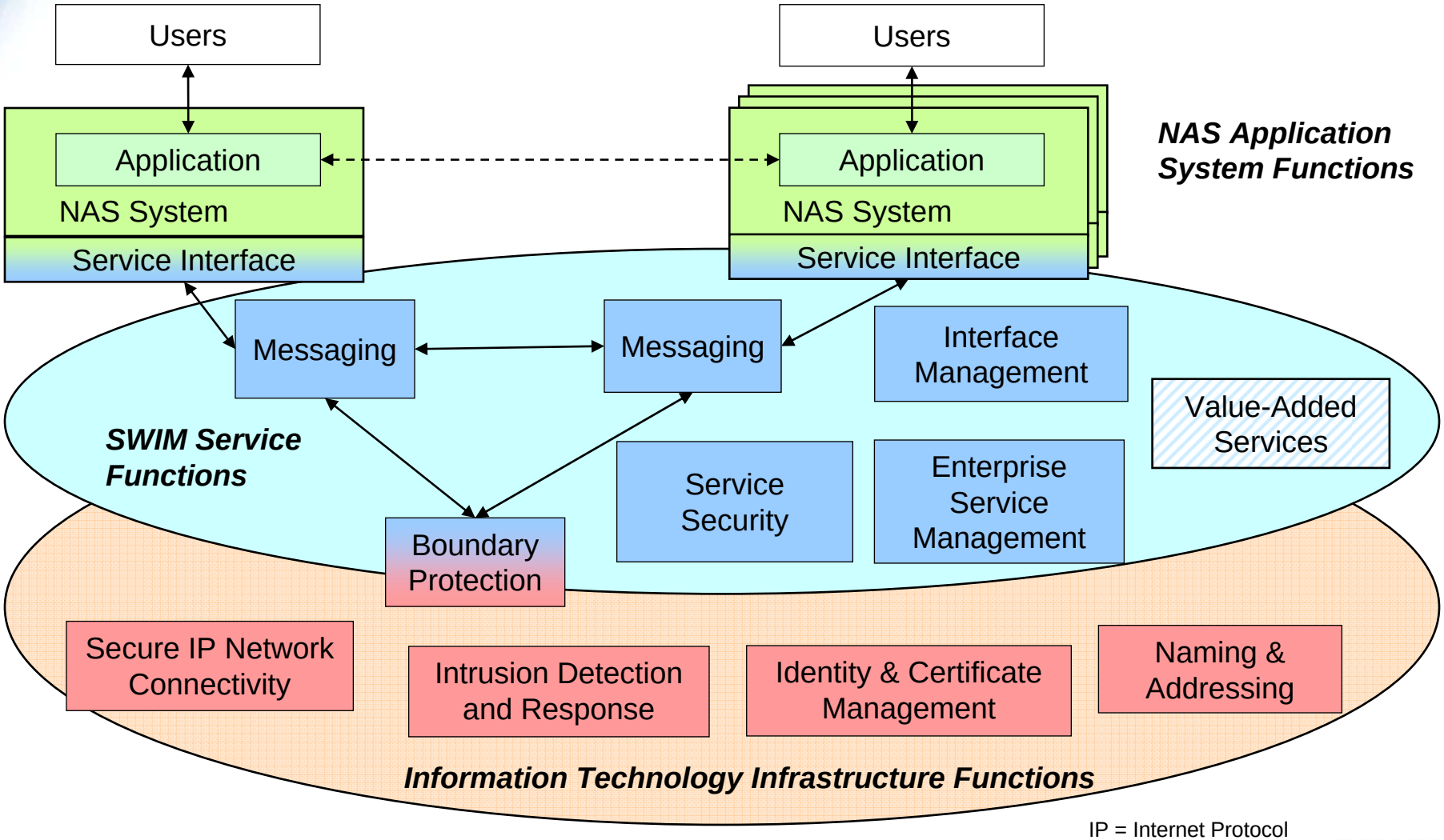
SWIM Functional Architecture



IP = Internet Protocol

Source: SWIM Strawman Architecture, V. Prabhu, D. Thomson, MITRE/CAASD, MTR060193, January 2007

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SWIM Functional Architecture

The SWIM Functional Architecture shows how the IT Infrastructure and the SWIM Core Services layers interoperate. The IT infrastructure provides necessary capabilities, such as basic IP connectivity and naming and addressing, upon which SWIM Core Services depend. Naming and addressing provides the means for systems to identify each other using the Universal Resource Locator (URL) protocol that matches a user defined host name with a specific IP address. Other IT infrastructure capabilities are related to security at the Wide Area Network (WAN) layer and include boundary protection, intrusion detection of unauthorized network activity, as well as response procedures when such activity is observed.

Above the IT infrastructure layer are the SWIM service functions that are implemented by SWIM Core Services. The Messaging capability provides services to application layer communication that use the underlying IP network for transport. Interface Management deals with the integration of legacy application layer communication technology and provides a bridge to allow legacy applications to interoperate with net-enabled applications. Application layer communication also has its own unique security challenges for which SWIM Core Services can assist by providing access authorization and authentication prior to initiating services. See [4] for a complete description of SWIM architecture.

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Evolution Strategy Examples

	Segment 1	Potential Evolution Path
SWIM Environment	Controlled: SWIM Program	Organic: SWIM Environment
COIs	FF, Wx, AIM	Expanded Set of COI
Net-Enabled Services & Data	Data Exchange	Business Processes
	Specialized Data Formats	Interoperable Schema
NAS Service Access	Data Visibility	Service Accessibility
IT Infrastructure & Core Services	Federated/ Distributed	Consolidated

AIM = Aeronautical Information Management
FF = Flow Flight
Wx = Weather

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Evolution Strategy Examples

This chart summarizes the five dimensions of SWIM Evolution addressed by the evolution strategy. Each dimension is depicted as a continuum starting with the present-day and potentially moving towards the vision articulated for NextGen. These dimensions are summarized as follows:

SWIM Environment – The SWIM services are "controlled" in that the SWIM PO is the focal point for service creation, funding, implementation, and management. In an "organic" SWIM environment, authorized users can access quality information in a timely manner by complying with SWIM standards and use of SWIM-compliant interfaces.

COIs – Evolution from current COIs to other areas, such as surveillance, safety, security, and NAS infrastructure management. The COIs facilitate net-enabled operations across the entire air transportation enterprise. Established lifecycle processes for COIs provide guidance for existing, de facto, and new COIs.

Net-Enabled Services and Data – Evolution to standards-based universal and common schemas that can be extended by COIs. Evolution from current emphasis on data exchanges, e.g., flight plan data, to the inclusion of business processes, e.g., flight plan expansion/constraint checking.

NAS Service Access – Evolution from Segment 1 predefined "point-to-point" data exchange services, to providing services that are more widely available to any authorized user who can access and use the service. Evolution from the current limited data visibility to flexible, discoverable services reflecting a highly mature service environment.

IT Infrastructure and Core Services – The implementation of these services will initially be federated across the NAS, but may become more consolidated over time.

The following charts provide additional detail, including specific examples of how SWIM may evolve in each of these five dimensions.

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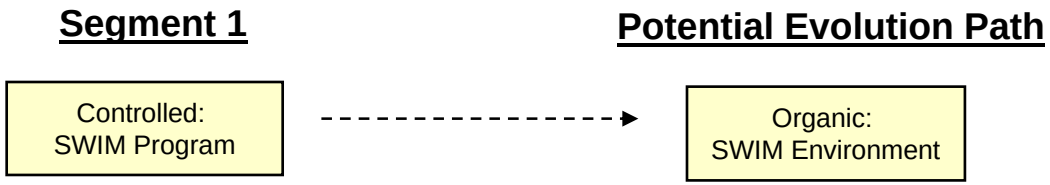
Evolution Strategy: SWIM Environment



- **Develop plans to encourage evolution towards an organic SWIM environment**
  - **Identify planning activities within FAA and the aviation community to use SWIM technology**
  - **Identify acquisition processes that could invoke SWIM standards and governance policies**
- **Identify organization roles to guide the development of the SWIM Environment**
  - **Manage the portfolio of all related acquisitions**
- **Establish roles and means to measure progress of SWIM Evolution**
  - **SWIM Maturity: Based on concepts of a Capability Maturity Model as applied to net-enabled enterprises**
  - **SWIM Utility: Based on concepts of Systems Engineering as applied to net-enabled operations**

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Evolution Strategy: SWIM Environment

The FAA may wish to pursue strategies and planning that encourage formation of an Organic SWIM Environment. An Organic SWIM Environment would allow innovation and creativity throughout the agency with the use of both SWIM and LOB funds and acquisitions.

Regardless of whether the SWIM Environment is Controlled or Organic, the agency could consider a means to manage the portfolio of system acquisitions necessary for the fielding of net-enabled services. This effort should also include coordination of research to support a benefits case across the portfolio. Many systems may be involved with enabling a particular net-centric service, either as producers or consumers. Some of the system acquisitions may fall outside of the SWIM Environment, but may be required to realize full benefits [6].

To address the difficulty of managing net-enabled enterprises, two methods have been identified for tracking progress and providing guidance. The notion of a maturity model is prevalent in the industry and has been used to quantify the progress of net-centric technology [7,8,9]. As a complement to maturity models, the notion of SWIM Utility is proposed to quantify the progress of net-centric operations. SWIM Utility is a concept originated by MITRE/CAASD to address the evaluation and evolution of net-enabled operations and is based on a systems engineering approach [10].

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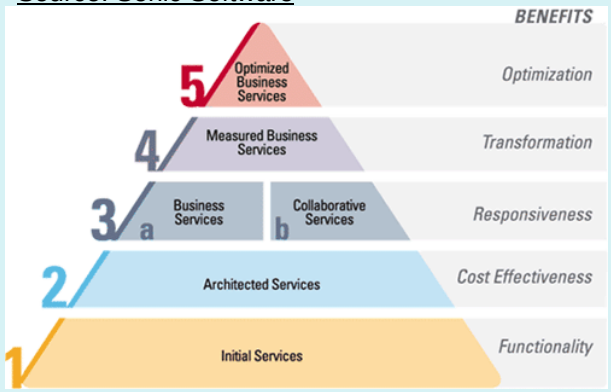
SWIM Maturity

Example SOA Maturity Models

Source: Sonic Software



Source: Gartner Group

I Introduction
II Spreading
III Exploitation
IV Plateau

Source: CMMI

SOA Maturity Levels CMMI Maturity Levels
Level 1 – Initial Services -> Initial
Level 2 – Architected Services -> Managed
Level 3 – Business & Collaborative Services -> Defined
Level 4 – Measured Business Services -> Quantitatively Managed
Level 5 – Optimized Business Services -> Optimizing

Source: IBM

- Silo (data integration)
- Integrated (application integration)
- Componentized (functional integration)
- Simple services (process integration)
- Composite services (supply-chain integration)
- Virtualized services (virtual infrastructure)
- Dynamically reconfigurable services (eco-system integration)

CMMI = Capability Maturity Model Integration
SOA = Service Oriented Architecture

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SWIM Maturity

Maturity models have been used to describe software development for some time. Maturity models for net-enabled systems are emerging from industry and can help benchmark adoption of net-centric design principles.

The maturity model offered by Sonic Software closely follows the Capability Maturity Model Integration (CMMI) structure and defines five levels of maturity. Level 1 is characterized by standards definition and a set of initial services using XML and SOAP technology with a focus on integrating legacy applications. Level 2 continues by introducing additional technology related to Universal Description Discovery and Integration (UDDI) and Web Services (WS-*) standards to support an underlying net-enabled architecture that enables fundamental capabilities, such as reliable messaging and performance management. Levels 3-5 begin to introduce services that align with business processes. At each stage, successive capabilities are introduced until an optimized business process maturity is achieved.

Other perspectives on maturity emphasize the progress an organization makes towards integrating business processes and de-coupling interfaces across the enterprise. IBM offers a maturity model describing seven stages that measures the amount of flexibility within an organization. Level 1 starts with unshared stove-piped “silos” of data. Levels 2 and 3 deal with the integration offered by Enterprise Architecture Integration (EAI) and message oriented middleware as fore-runners to SOA technology. Formal introduction of SOA technology begins at Level 4 and increases until an organization has a dynamically re-configurable architecture composed of services at run-time using externalized policy descriptions, management and monitoring (Levels 5-7).

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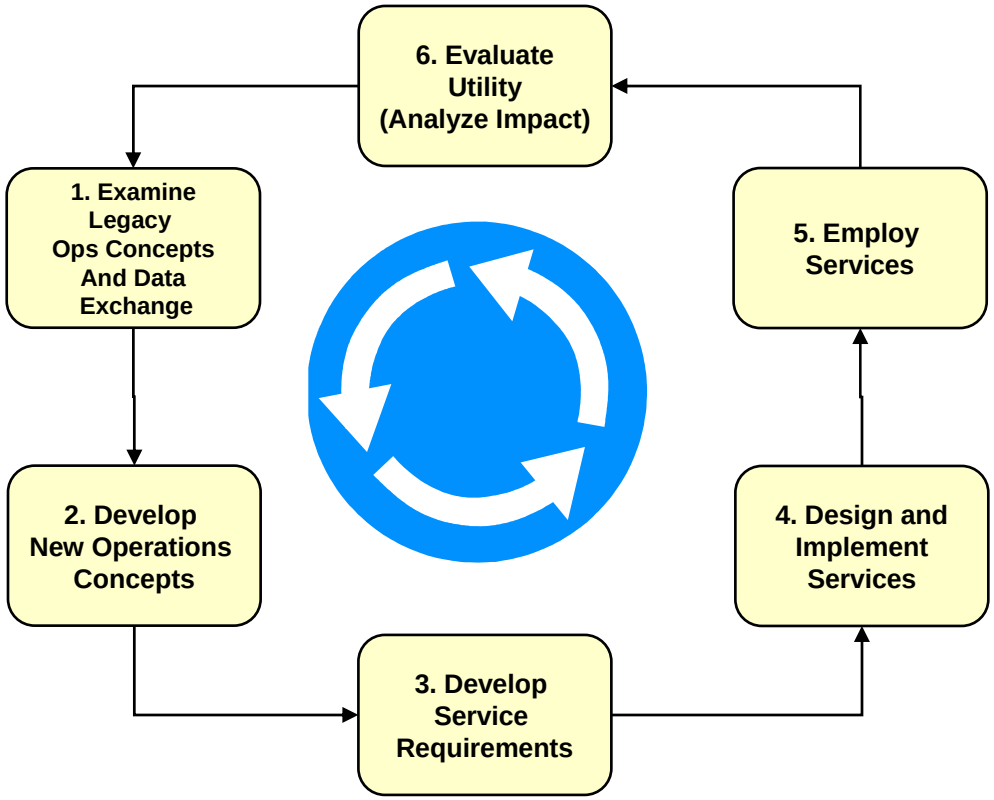
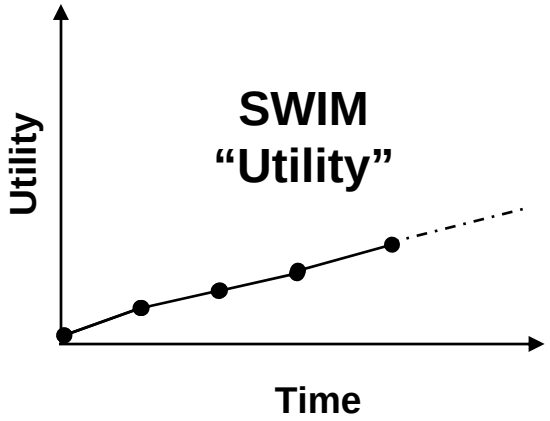
SWIM Utility



Service Lifecycle



- Develop a means to measure utility
- Iterate through the Service Lifecycle
- Increase SWIM utility

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SWIM Utility

Organizations implementing net-enabled systems and infrastructure are increasingly being seen as enterprises that require specialized systems engineering tools. While maturity models may provide an organization with some general guidelines, SWIM will likely require more detailed tools to measure how effectively SWIM advances certain OEP initiatives and NextGen concepts for net-centric operations. CAASD had developed the notion of SWIM Utility to provide a means to measure progress towards these goals. The concept is based on principles of systems engineering and covers a cycle from concept design through development and, finally, to validation. Step 1 examines existing or future operational concepts and methods of data exchange. In Step 2, new concepts for future services are defined. Requirements are developed in Step 3 and services developed in Step 4. After initial deployment of services in Step 5, validation occurs in the final step as we measure overall SWIM utility as compared to new or revised operational concepts. Validation is an important step that evaluates the deployed services in relation to the concepts examined in Step 1, and a subjective measure of completeness is made. The cycle is repeated as needed and at the conclusion of each cycle SWIM utility is measured.

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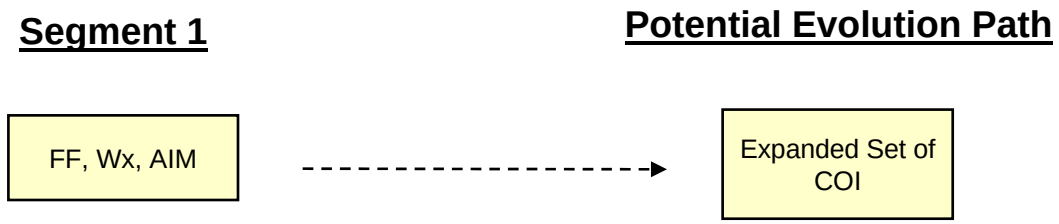
Evolution Strategy: COIs



- **Encourage COIs to address services for specific exchanges of data or specific business processes**
- **Establish policies to allow ad-hoc creation of COIs to foster creativity and innovation in the NAS**
- **Define engagement strategy for existing de facto COIs**
- **Encourage COIs to include both non-FAA and non-NAS organizations**

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Evolution Strategy: COIs

One possible evolution strategy might include the formation of additional COIs. The new communities could be implemented either as standalone COIs, or as a sub-groups under existing COIs, such as Flow-Flight or AIM.

Also, in keeping with an evolution strategy that promotes an organic SWIM environment, policies and procedures could be implemented to define how COIs could form within the LOBs and engage with existing COIs. These polices and procedures could also define how existing COIs could identify “ad-hoc” COIs and coordinate efforts across the aviation community.

Regardless of how COIs are formed, active non-FAA and non-NAS participation within COIs would facilitate the extension net-centric concepts to the larger federal and private sector arenas.

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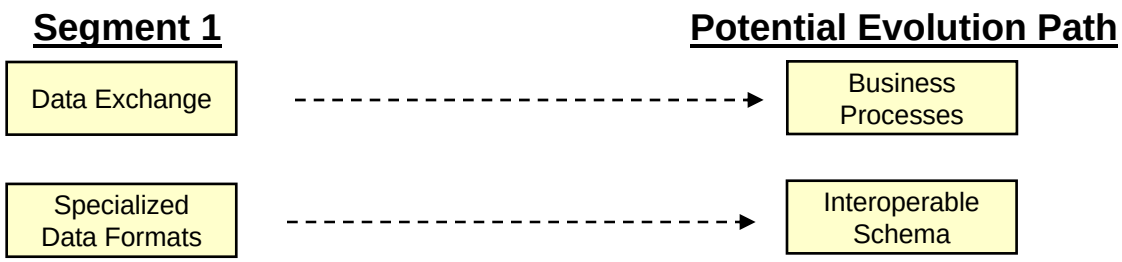
Evolution Strategy: Net-Enabled Services and Data



- **Examine OEP solution sets and capabilities when determining and defining net-enabled services, for example:**
  - **Collaborative ATM**
    - **Trajectory flight data management, flight plan constraint evaluation, on-demand NAS Information (NOTAMs)**
  - **High Density Airports**
    - **Surface traffic management**
  - **Reduce Weather Impact**
    - **Integration of weather data, near-real-time dissemination of weather data**
- **Identify roles and responsibilities for creating interoperable NAS schema**

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Evolution Strategy: Net-Enabled Services and Data

A possible source of ideas for new net-enabled services and data may be found in OEP and NextGen concepts. The OEP is designed to align FAA capabilities and initiatives with concepts developed by NextGen.

The OEP has identified specific solutions sets and associated capabilities that address net-enabled operations. COIs may examine the solution sets for applicable concepts on which to focus their developmental efforts.

All net-enabled services will require consistent and interoperable data schema to facilitate data exchange. It is recommended that the COIs coordinate their schema development to avoid a multiplicity of data formats and standards.

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Evolution Strategy: NAS Service Access

- **Work with stakeholders to implement complete NAS Service Access capabilities**
- **Consider implementation of metadata cataloging**
- **Implement run-time discovery to support virtual access to NAS services**

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Evolution Strategy: NAS Service Access

SWIM Segment 1 focuses on a very important first step for achieving net-centric operations, making data visible, as well as accessible, via SWIM-defined interchanges, as opposed to traditional system-system data interchanges. Moving forward from this precedent, there are several areas where SWIM can engage with stakeholders to enhance data sharing and service accessibility. Migration from pre-defined, pair-wise data exchange to more loosely-coupled services would provide the opportunity for enhanced service discovery by authorized users, including unanticipated users.

Evolution along this dimension requires a robust technical and organizational data sharing infrastructure which ensures that data available from SWIM services is understandable and trusted. In addition, services providing data, and possibly business processes, need to be discoverable and accessible both at design time and possibly at run-time. To achieve this, descriptive information (i.e., metadata) about data and services needs to be managed within catalogs or registries. For data sharing, metadata catalogs provide the user with an understanding of what a particular element or aggregation of data means. For service access, metadata catalogs provide the user with descriptions of, and pointers to, SWIM services. These catalogs enable automated discovery of, and transparent access to, SWIM services in the runtime environment, a capability that is key to creating a flexible, scalable, and responsive NextGen system. Standards for metadata catalogs or registries include International Standards Organization (ISO) 11179 and those available from the Organization for the Advancement of Structured Information Standards (OASIS).

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Evolution Strategy: IT Infrastructure and Core Services

- **One possible evolution path:**
  - **Develop or acquire consolidated, managed IT services for the NAS**
  - **Engage affected stakeholders that plan IP-based communications**
  - **Continue development of SWIM Core Services supporting NAS net-enabled operations**

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Evolution Strategy: IT Infrastructure and Core Services

Net-centric technology assumes a mature and modern IT infrastructure. Without such an infrastructure, net-enabled operations cannot function. Roles and responsibilities could be identified to deliver each of the functional elements of the IT infrastructure and this infrastructure could then evolve in parallel with SWIM.

The evolution of SWIM Service Functions (i.e., core services) could take a similar path as the IT infrastructure. In early segments of SWIM, it will be important to distinguish between the roles of the participating SIPs and the SWIM PO. As the deployment of net-enabled services increases, the SWIM PO might consider taking a larger role in providing Service Functions to the participating SIPs to alleviate them from the responsibility of having to provide specialized application layer communication functions.

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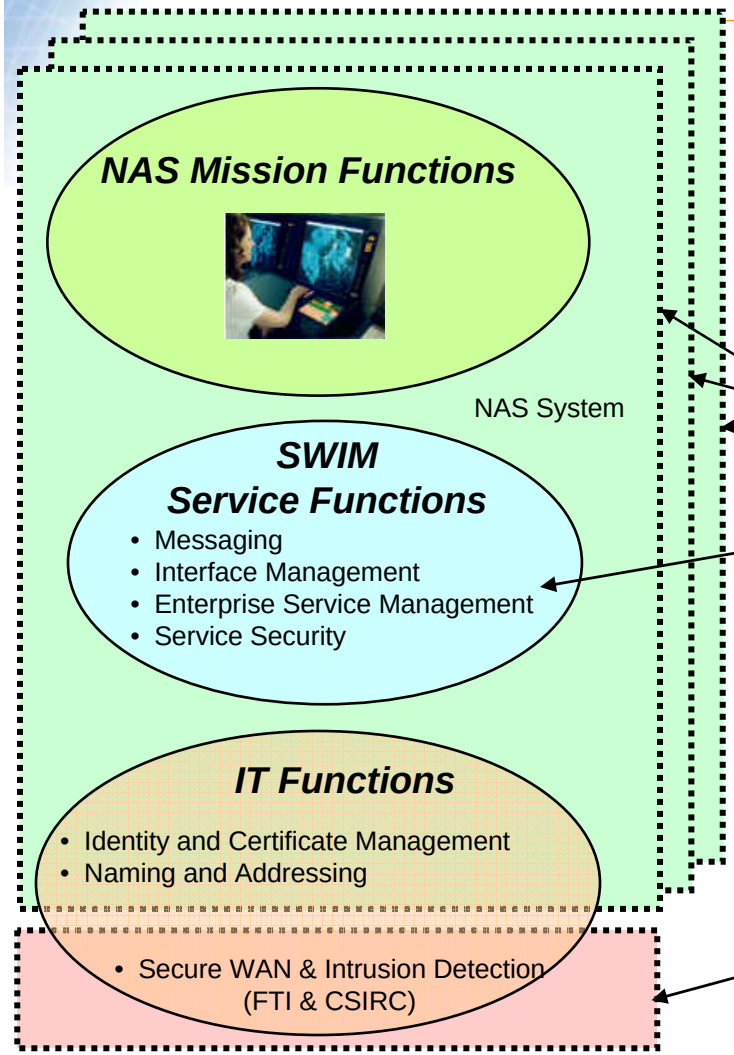
IT Infrastructure and Core Services Evolution (1 of 3)



Functions implemented, operated and maintained by each NAS system owner/operator

- ***Standardized off-the-shelf software suite for SWIM service functions to promote interoperability***

Functions implemented, operated, and maintained by an infrastructure service provider

SWIM Segment 1

CSIRC = Computer Security Incident Response Capability
FTI = FAA Telecommunications Infrastructure

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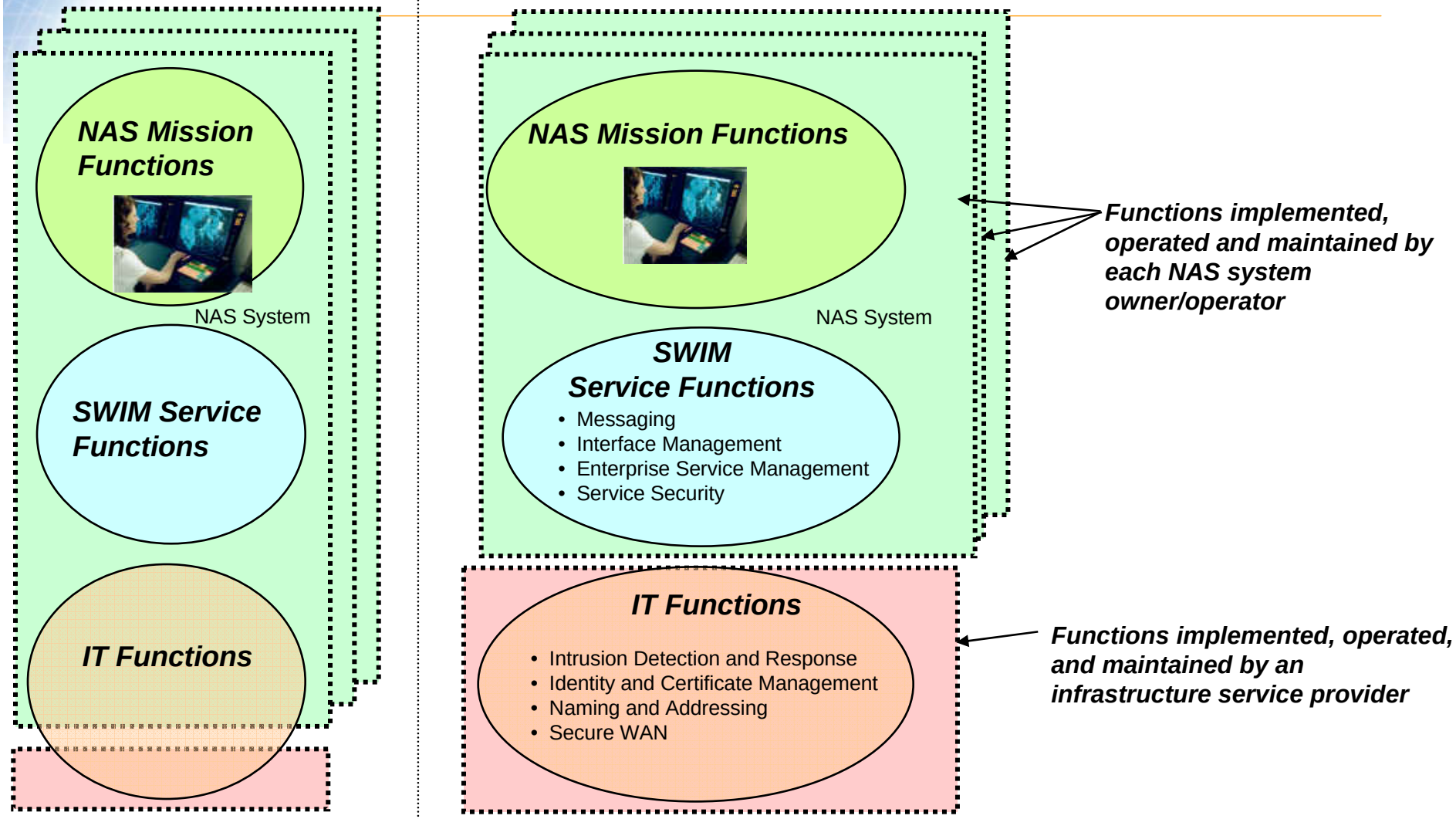
IT Infrastructure and Core Services Evolution (2 of 3)



SWIM Segment 1

SWIM Segment N Timeframe

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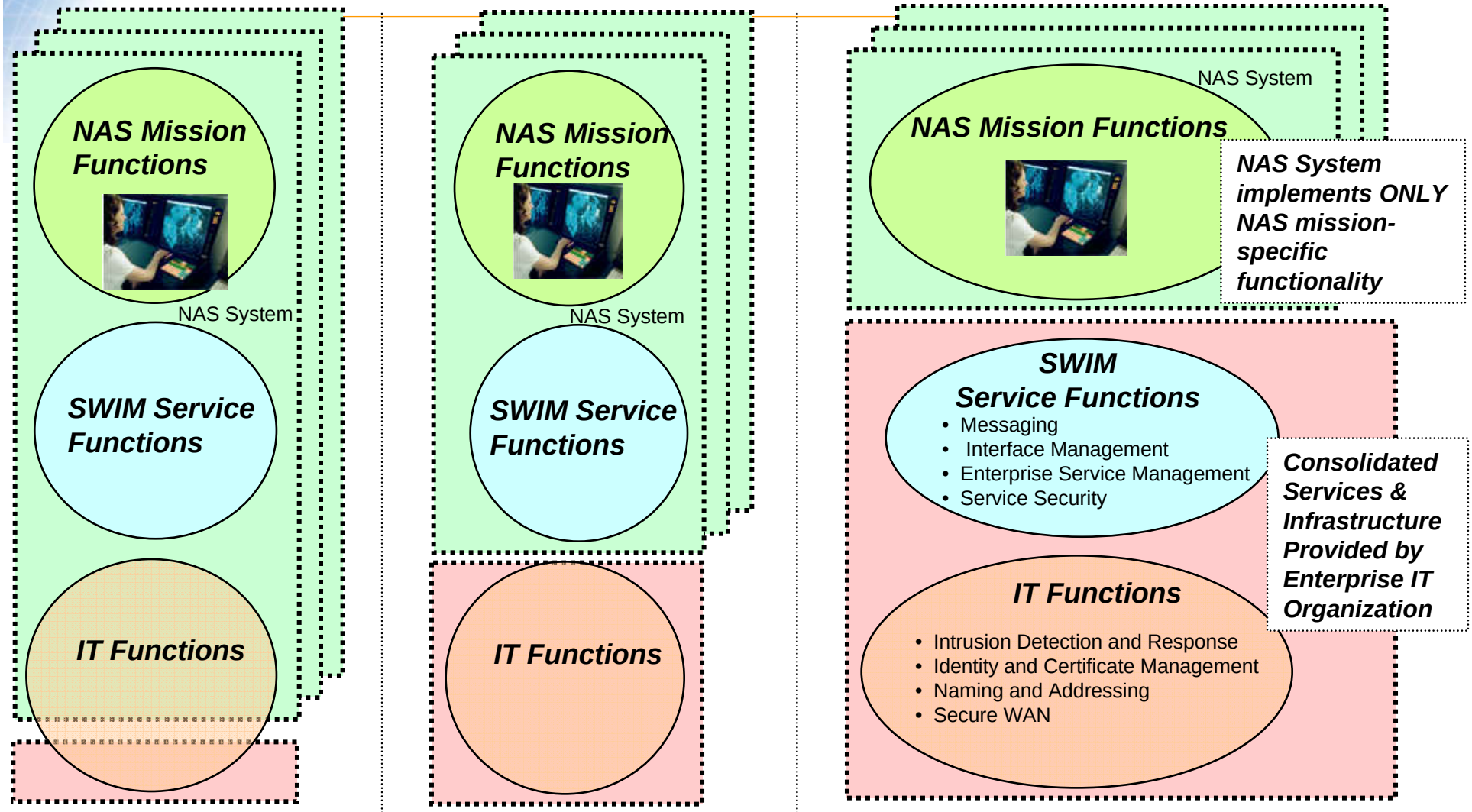
IT Infrastructure and Core Services Evolution (3 of 3)



SWIM Segment 1

SWIM Segment N Timeframe

Future Evolution

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IT Infrastructure and Core Services Evolution

These three charts depict a notional re-allocation of core services and IT infrastructure over time from the federated approach to a more consolidated architecture.

NAS Application System Functions provide the mission-specific functionality that supports the operation of the NAS. Examples include air traffic control automation systems, flow management systems, and network and systems management systems. In the near-term, NAS application systems exchange information and interact with one another in order to perform the necessary mission-specific functionality to support NAS Users. This interaction is carried out by means of services that NAS application systems provide to one another [3].

As shown progressively in slides 2 and 3 of these charts, migration of some functionality (initially instantiated by NAS application systems) to an enterprise IT organization could take place in later SWIM segments. The specific functions included, and the pace of migration, would be dictated by the requirements of the COIs and SIPs. Eventually, SWIM Service and IT Functions might merge into capabilities managed by an enterprise IT organization. The details of how and when such a migration would take place need to be considered.

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Summary

- Five dimensions for SWIM evolution have been identified
- An evolution strategy is proposed that keeps SWIM on a path towards a long-range vision of net-centric operations
- The evolution strategy also addresses the need to assess SWIM maturity and utility over time

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Summary

This briefing presented an evolution strategy for SWIM. Five dimensions for SWIM evolution were identified: SWIM Environment, COIs, Net-Enabled Services and Data, NAS Service Access, and IT Infrastructure and Core Services. The evolution strategy is based on moving SWIM towards the vision of supporting net-centric operations enabling a scalable, responsive and flexible future air transportation system. While moving towards this vision, there is a need to assess SWIM services maturity in supporting optimized FAA business processes and evaluating SWIM utility in meeting concepts and goals as described by NextGen and OEP.

The development of processes for the evolution of organizational dimensions (SWIM Environment and COIs) may benefit from referring to the SWIM governance strategy developed by CAASD [5]. Process development for the evolution of technical dimensions may also benefit as well. The governance strategy document contains considerable detail on processes, roles, and responsibilities for SWIM Segment 1 and beyond.

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Glossary

Enterprise – A complex, highly integrated collection of systems comprised of processes, organizations, information and supporting technologies, with multifaceted interdependencies and interrelationships across their boundaries [2].

Net-Centric – Participating as a part of a continuously evolving, complex community of people, devices, information and services interconnected by a loosely-coupled communications network to achieve optimal benefit of resources and better synchronization of events and their consequences [1].

Net-Enabled – a) To make something net-centric; b) To make something capable of communicating on a network.

Portfolio Management – The application of systematic management to large classes of items managed by a net-centric enterprise. Examples of IT portfolios would be planned initiatives, projects, and ongoing IT services (such as application support). The promise of IT portfolio management is the quantification of previously mysterious IT efforts, enabling measurement and objective evaluation of investment scenarios [6].

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Acronyms

AIM	Aeronautical Information Management
CAASD	Center for Advanced Aviation System Development
CMMI	Capability Maturity Model Integration
COI	community of interest
CSIRC	Computer Security Incident Response Capability
DDMS	DoD Discovery Metadata Specification
DoD	Department of Defense
EAI	Enterprise Architecture Integration
FAA	Federal Aviation Administration
FDR	FAA Data Registry
FF	Flow Flight
FTI	FAA Telecommunications Infrastructure
GML	Geography Markup Language
IC-ISM	Intelligence Community Information Security Marking
IP	Internet Protocol
ISO	International Standards Organization
IT	Information Technology
JPDO	Joint Program Development Office
LOB	Line of Business

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Acronyms (concluded)

NAS	National Airspace System
NCES	NetCentric Enterprise Services
NextGen	Next Generation Air Transportation System
NOTAM	Notice(s) to Airmen
OASIS	Organization for the Advancement of Structured Information Standards
OEP	Operational Evolution Partnership
OGC	Open Geospatial Consortium
PO	Program Office
PoR	Program of Record
SIPs	SWIM Implementing Programs
SOA	Service Oriented Architecture
SUA	Special Use Airspace
SWIM	System Wide Information Management
UDDI	Universal Description Discovery and Integration
URL	Universal Resource Locator
WAN	Wide Area Network
WS	Web Services
Wx	Weather
XML	eXtensible Markup Language

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