Achieving Interagency Interoperability and Service Reuse: Ontologies as Mediators and Facilitators

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What is NextGen?
What is NEXTGEN?

Transforms the US National Aviation System to ensure the 2025 system meets national safety, security, mobility, efficiency, and capacity needs.


Allows for negotiated flight paths/trajectories, dynamic re-planning, incorporation of weather and other considerations in flight planning and execution, and flexible ground operations.

Makes information available to public and private sector stakeholders for improved air domain awareness and enhanced decision-making for homeland security and commercial application.
NEXTGEN Mandates

**NEXTGEN enjoys Congressional, White House and Interagency commitment and support**

  - Chartered JPDO, JPDO Board, Senior Policy Committee

- **28 Dec 07 DEPSECDEF Memo**
  - Designated AF as Lead Service for NEXTGEN

- **June 08 Interagency MOU** - align plans/programs

- **July 08 Senior Policy Committee**
  - SECAF pledged Net Centric Support-NCO Division

- **18 Nov 08 Exec Order**: Transformation of National Air Transportation System
  - SECDEF shall assist SECTRANS so that NEXTGEN meets defense needs
# What is NEXTGEN?

**NextGen Transforms...**

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NEXTGEN Information Sharing Environment (NISE)

Defining the Functional, Operational, and Technical Specification for the Net-Enabled Environment
NCO Division Mission

Facilitate the implementation of net-centric capabilities for NextGen among the partner agencies and serving the community at large.

Implementation

We do this by coordinating investment and development in network-enabled technologies, supporting proofs-of-concept, establishing a collaborative environment for test and experimentation, promoting the use of net-centric principles, coordinating the establishment of policy and standards, assisting in transition of developmental efforts to operational capabilities, and developing a functional, operational, and technical description for a NextGen Information Sharing Environment.
Net-Centric Operations (NextGen CONOPS)

Net-Centric Operations:
- Ability to store, transport, and retrieve air transportation-related information and data between providers and consumers
- A reliable, scalable, flexible, and secure interconnected enterprise network
- Incorporates infrastructure, systems, processes, and individuals

Keys to success:
- Establishment of secure solutions for FAA, DOD, DHS, and DOC information sharing
- Combination of physical infrastructure and Infrastructure Services
- Information sharing standards
- Interconnected enterprise networks
- Discoverable services and adequate metadata and supporting documentation
- Collaborative interagency environment
- Content directly supports operations

These information sharing objectives are reflected in the draft NCO CONOPS.

Source – NextGen CONOPS, v. 3.2
NextGen Information Sharing Environment (NISE)

Information Providers

- Geospatial Info
- Weather Info
- Flight Object Info
- Safety Info
- Security Info
- Intel Reports
- Sensor Data
- Airline Info
- Airport Info
- Other Info Providers

NextGen Enterprise Services (Notional)

- User Defined Operation Picture Services
- Decision Support Services
- Collaboration Services
- Track Correlation Services
- Other Services

Semantically-Enabled Core Enterprise Services

- Messaging Service
- Security Service
- Enterprise Service Management
- Semantically-Enabled Content Discovery
- Semantically-Enabled Service

Semantic Layer

Data Layer

Service Layer

Security Layer

Network Layer

Business Operations Layer

NISE Technical Profile

GOAL – To provide NextGen Stakeholders with a structural design and prototype environment within which to discover best practices and lessons learned, and identify and eliminate barriers to success before systems go into the operational

Information Consumers

- Aircraft
- Air Traffic Control Human Users, Applications, or Services
- Human Users, Applications, or Services in Aviation Operations
- Unanticipated Human Users, Applications, or Services

The Technical Profile defines a set of NextGen Service Specifications to guide future NextGen enterprise service development programs
NISE Technical Profile

Using and understanding services and information
Linking to Information Sharing Agreements, Service Level Agreements and other crucial documentation

Passing the data - Message definitions & structures

Obtaining access - Access policies / controls / permissions / CDS / firewall configurations

Discovering services and information
Ontology, Semantic Metadata Catalog, Semantic Search

Establishing the service connection - Service Bindings / Protocols

Establishing the network connection - Link layer bindings / Router configurations / protocols

Doing business with government agencies and commercial entities - Rules of engagement / interagency agreements / policies / data sharing agreements / business rules

Semantic Layer
Data Layer
Service Layer
Security Layer
Network Layer
Business Operations Layer
NextGen Enterprise Ontology
Advantages of SOA

- Promotes re-use of existing services
- Enables fast adaptation to business needs
- Facilitates the addition of new services
- Alignment of information resources to business goals
- Service discovery and understandability
- Management of multiple messaging schemas
- Composition of existing services is a manual task
- Services are often hardwired to applications (tight coupling)

Challenges to Traditional SOA

Semantic Web Services Architecture

Extending the Value of SOA

Adapting proven Semantic Web best practices to meet enterprise business needs, e.g.
- Defining community terms in a central enterprise ontology for interoperability and shared understanding
- Enabling net-centric access through a semantic web services architecture
- Utilizing semantic technology to tie it all together into a flexible and executable solution
• Actively Working on
  – Weather
  – Integrated Surveillance
• On the Horizon
  – Unmanned Aircraft System
  – Flight and Flow
• Key Deliverables
  – COI Ontology
  – Business Context (DoDAF Artifacts)
  – Other Artifacts
NextGen Semantic Technology Capabilities
Technology Capabilities Stack

Next Generation Air Transportation System
Joint Planning and Development Office

Net-Centric Operations Division

Information Exchange Services

Semantic Web Services Infrastructure
- Semantic Metadata Catalog and Portal
- Ontology Portal

Web Services and SOA Infrastructure
- SOA Service Registry
- Enterprise Service Bus

Network Infrastructure
- Network Monitoring Service
- Federated Identity Management Service
TRADITIONAL SOFTWARE APPLICATIONS
• System interfaces not standardized
• Point-to-point connections
• Limited reuse potential
• Inflexible applications tightly coupled to data
• Redundant systems

SOA
• Flexible, modular applications available as services
• Standardized interfaces
• Service registries support reuse

Semantics
• Utilizes existing SOA registry capabilities
• Supports cross-agency information exchanges
• Facilitates collaboration
• Intelligent search for improved discoverability
• Takes full advantage of semantic relationships

Automated Service Orchestration
• Run-time composition
• Dynamic Binding
Accessing Artifacts through User Interface

JPDO User Interface Layer

Semantic Metadata Portal

Ontology Portal

Web Services Layer

Semantic Metadata Catalog

Artifact Catalog

Transformation Rules (XSLT)
Message Schema (XSD)
Service Description (WSDL)
Business Process Analysis (OV-2)
Information Exchange Description (OV-3)
Operational Activity Model (OV-5b)
Systems Communications Description (SV-2)
Requirements Document (SV-4)
Business Rules Service Constraints
Architectural Impact Report
COI Ontology (RDF/OWL)

Color Key:
- Semantic
- External

Next Generation Air Transportation System
Joint Planning and Development Office

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Based on Linked Data Architecture

A set of best practices for connecting and publishing data on the Web
Semantic Metadata Catalog and Portal Architecture
Semantic Metadata Catalog Roadmap

Phase I
- Traditional Search
- Semantic Search

Phase II
- Form Based Queries
- Service Matching (Similarity / Interoperability)
- Faceted Browsing

Phase III
- Dynamic Binding of Services
- On-Demand Service Composition

Design Time
- Run Time