NCOIC Interoperability Framework (NIF™) and NCOIC Patterns Overview

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Approved for Public Release
NCOIC-NIF™ Overview

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**About NIF™**

- **Customer Goals**
- **Missions to Achieve Goals**
- **Mission Needs**
- **Solutions to Needs**
  1. Analysis of Alternatives
  2. Requirements Derivation
  3. Requirements Validation
  4. Design Synthesis
  5. Design Verification
  6. Deployment
  7. Support
  8. Upgrade/Disposal
- **Resulting Services**
- **End-to-End Quality of Service**

**NIF™**
- Provides enabling guidance for net-ready solutions
- Overarching framework
- Specialized frameworks
- Pattern template

**NIF™**
- NCOIC Interoperability Framework
- Building Blocks (BB)
- Net Centric Analysis Tool (NCAT™)

**Modeling/simulation**

**Test/evaluation**

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Why Is a NIF™ Needed?

- Most attempts at common architectures and common standards have failed to achieve interoperable systems

- The NIF™ is different because…
  - Recommends standards plus guidance flexible enough to be used in multiple architectures
  - Derived by consensus across industry – not dictated by a single organization
  - Closer to Internet model (IETF methodology in the W3C) than a prescriptive policy-based approach for a department or ministry of defense
Standards Alone Are Not Sufficient—Need Guidance

- Often the “BEST” Standard depends on the Mission
  - Real-World Condition! Often no “One Size Fits All”
  - Requires Guidance to select Consistent Standards by Class of Missions: very hard to do! (but a key goal of the NIF™)
Guidance re: Mission

- Usually no one Standard can be general enough to meet all needs of all domains, as the SCOPE Model demonstrates.

*Examples of SCOPE dimensions, actual dimensions are more comprehensive.

Different Standards because Different Mission Domains have Different Needs!
Guidance re: Level of NCO

- What is the appropriate level of NetCentricity for a given operational context? May impact selection of Standards!

Which is the “Best” Standard for this hypothetical operational context?

This example is time-based; many other perspectives!

Notional Cost (or Risk)

Notional Performance

Today’s Range of required performance

Future Range of required performance

Standard “A”
For Technology X

Standard “B”
For Technology X

Notional Cost (or Risk)

Notional Performance

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“Bad” Standard, or “Bad” System Implementations?

- Real-World Condition!
- In a System-of-Systems, cannot force systems to not use highly-desirable features when operating independently
- Requires Guidance to operate in 100% Interoperability Regions
- Can only recommend use of 100% Interoperability Regions when Systems need to Interoperate
Guidance re: Versions

- Is Everyone Running the Same Version of a Standard?
  - Real-World Condition!
  - In a System-of-Systems, cannot force Legacy systems to update to newest standard
  - Requires Guidance to operate in 100% Interoperability Regions
  - Can only recommend use of 100% Interoperability Regions when Systems need to Interoperate
Guidance re: Standards Interpretations

Interpretation “A” of Standard
Interpretation “B” of Standard
GUIDED Interpretation of Standard

Does Everyone Understand the Standard the Same Way?
- Real-World Condition! (Not necessarily a bad Standard)
- Requires Guidance to achieve goal of common understanding
  - Different Languages; different Cultural backgrounds
  - Same Standard applied in different Operational Domains
  - Same Standard implemented by designers with different levels of experience, different technical disciplines, different company rules
Interdependency of Standards

Standards are Interdependent!

- Standards for a layer of Interoperability often dependent on standards for lower layers

Layers of Interoperability

- Physical Interoperability
- Connectivity & Network Interop.
- Data/Object Model Interoperability
- Semantic/Information Interoperability
- Aligned Procedures
- Aligned Operations
- Harmonized Strategy/Doctrines
- Political or Business Objectives

C2 Application Standard
- COI Standard
- COP Standard
- KM Standard

Information Services
- Web Services Standard
- Pub / Sub Standard

Network Transport
- IPv6 Standard
- Radio Standard
- LAN Standard

Semantics/Information Interoperability

assists customers in obtaining interoperable solutions
Guidance must be CLEAR and Straightforward!
The Value of the NIF™ Approach

- Addresses the problems listed on prior pages
  - Focus is on Net-Centric / Net-Enabled aspects
- Encourages users to use a common terminology and approach to achieving the guidelines
  - Consistent terminology and repeatable patterns of solutions
- Includes lessons learned from domain experts to keep future users from repeating common mistakes
  - Addresses root causes of interoperability failures
- Integrates guidance across critical specialties
  - The “Specialized Frameworks” e.g., Information Assurance, Services, Semantics, Mobility, etc.
- Includes guidance for verification that the standards and guidance have been “properly” followed
- Designed to support all stages of the system life cycle
  - Acquisition, initial design, upgrade design, training
Intended Users of the NIF™

- Oriented toward “Architects” (System, Enterprise, SoS) as well as Design Engineers
  - Useful for general industry and governments, not just NCOIC members

- How does the NIF™ help the intended users?
  - Acquisition community
    - Generating better Request For Proposals / Tenders
    - Evaluating proposals from a common perspective
  - Industry
    - Expands available markets (example: the Internet)
    - Points architects in the right direction for interoperability
    - Establishes infrastructure that allows a company to focus on value added enhancements rather than basic environment
The NIF™ Process in Four Documents

**Requirements**
- **NIF™ Scope and Problem Statement Deliverable (NSPS)**
  - Defines the Scope of the NIF™
  - Defines the Interoperability Problem Space
  - Defines top level requirements for interoperability

**Solution & Guide**
- **NIF™ Solution Description (NSD)**
  - Reference Manual (NSD-RM) including Overarching Information (meta)model
  - User’s Guide (NSD-UG) with general user oriented NIF™ guidelines & rules for architecting, including Fully Documented Example

**Rationale**
- **NIF™ Approach and Rationale (NAR)**
  - Examines alternatives for a particular solution space
  - Defines criteria for interoperability and net-centricity
  - Makes recommendations for a solution set based on the criteria
The Process in Action

NCOIC Customer

NCOIC Focus: Net-Centric Interoperability

Operational Subject Matter Expert

Enterprise/System Architect

Technical Subject Matter Expert

Operational Analysis

Architectural Analysis

Technical Analysis

NCO Requirements

Overarching Architecture Specs

Technology Guidance

Integrated Project Teams (IPTs) SCOPE Model

IPTs, NIF™ OverArching Framework

IPTs, Specialized Frameworks

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Operational Analysis

NCOIC Customer

Enterprise Context, Organization, Assets & Missions

Operational SME

SCOPE dimensions
NCO Scenarios & Use Cases
NCO Capabilities & KPPs
NCO Views and Patterns

IPTs, SCOPE

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Architectural Analysis

NCOIC Customer

Operational Description

Enterprise/System Architect

“Generalization”

OverArching Architecture Description

IPTs using NIF™ OverArching Framework artifacts

NCOIC focus

Architecture Standards

Customer

Operational Description

NetCentric Services, Principles, Tenets, Architecture Patterns, Architecture Standards and Technology Forecasts, Risks

Capability Patterns

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Technical Analysis

IPTs and Specialized Frameworks (SF) using NIF™+SF artifacts

Technical SME

“Specialization”

Technical Analysis

OverArching Architecture Description

Technical Services Principles, Tenets Technical Standards & Forecasts

Technical Patterns

NCOIC Customer

NCOIC focus

Technical Standards

assists customers in obtaining interoperable solutions
Framework, Process, and Patterns

- The Overarching Framework contains:
  - Concepts: necessary knowledge definitions, dictionaries, ontologies, information models, etc.
  - Processes: Top-down, Bottom-up, & Middle-out
  - Principles: overall requirements, goals, tenets, and best practices that foster net-centricity
  - A construct for developing guidance for solving Operational and Technical problems for a given context

- The latter is a **template** for NCOIC Patterns
  - These Patterns are not contained in the NIF™
  - Patterns are stored in an online Repository
  - Patterns provide guidance for creating systems with the desired net-centric capabilities and mitigate specific net-centric interoperability problems

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Basis for Patterns

- Christopher Alexander, Civil Engineering Architect
  - Described architecture patterns for civil engineering
- “Design Patterns: Elements of Reusable Object-Oriented Software”
  - Book by Erich Gamma, Richard Helm, Ralph Johnson, and John M. Vlissides (the Gang of Four)
- Successful pattern stories:
  - J2EE & Microsoft .NET Patterns (software)
  - DIACAP-compliant Security Patterns (secure design)
- Key foundation for NCOIC Patterns:
  - Systems Architecture Patterns (Cloutier & Verma)
Characteristics of a Systems Architecture Pattern

- A Systems Architecture Pattern is a high-level structure, appropriate for the major components of a system. It expresses the relationship between:
  - The Context
  - A Problem
  - A Solution

- A Systems Architecture Pattern Documents:
  - Attributes
  - Usage Guidance

- Patterns are time-proven in solving problems similar in nature to the problem under consideration

*Extracted from “Applying the Concept of Patterns to Systems Architecture” by Robert J. Cloutier and Dinesh Verma, Stevens Institute of Technology, Systems Engineering DOI 10.1002/sys*
Finding a PATTERN of Net-Centricity amongst all of the apparent conflict & noise

Subject Matter Experts often independently arrive at similar solutions (a painful process!)
Three Major Categories of NCOIC Patterns

- **Operational (or Domain) Patterns**
  - Top level approaches to addressing domain or Customer Capability needs
    - Identifies associated Capability Patterns
    - Example: Sense & Respond Logistics Total Asset Visibility

- **Capability (or Composite or Application) Patterns**
  - One or more for each of the areas identified above
  - Describe an approach to achieving a particular capability need in the context of the domain
    - Identifies associated Technical Patterns
    - Example: Legacy Systems Integration

- **Technical Patterns**
  - Specific approaches to solving a given technical need identified in the Capability Patterns
    - Example: Web Services
Pattern Relationships

**NOTIONAL EXAMPLE**

OPERATIONAL DOMAIN “A”

OPERATIONAL DOMAIN “B”

Composite Pattern

CAPABILITY PATTERN 1

CAPABILITY PATTERN 2

CAPABILITY PATTERN 3

CAPABILITY PATTERN 4

TECHNICAL PATTERN “A”

TECHNICAL PATTERN “B”

TECHNICAL PATTERN “C”

TECHNICAL PATTERN “D”

TECHNICAL PATTERN “E”

TECHNICAL PATTERN “F”

TECHNICAL PATTERN “G”

*NIF™ v1 Global Attribute*
Anatomy of a NCOIC Pattern

- Captures domain knowledge from Subject Matter Experts (SMEs)
- Not just about Standards
  - Includes mature solutions to a given domain problem
- Includes best standards to apply to a problem
  - Goes beyond the standards to include practical guidance as to how to implement the standards
  - Guidance oriented toward obtaining consistent results
- Flexible/Extensible solutions to a genre of problems
  - Not a specific recipe for a solution to a specific problem
An NCOIC Pattern also contains:

- Identity
- Purpose (context and applicable scenarios)
- Description
  - Architectural implementation, interfaces, applicability, known uses, maturity metrics, etc.
  - Relationships to other required/associated patterns
- Verification
  - Showing that the Pattern complies with NIF™ (and Specialized Framework) guidance
- Conformance
  - How to verify conformance of Building Block components to the Pattern
- Tailoring
  - Guidance of how to apply/adjust to various domains
Relationship of the NIF™ to Other NCOIC Tools

Customer Goals → Missions to Achieve Goals → Mission Needs → Solutions to Needs → Resulting Services

1. Analysis of Alternatives
2. Requirements Derivation
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NIF™
NCOIC Interoperability Framework

BB
Building Blocks

NCAT™
Net Centric Analysis Tool

SCAPE Model
NCO Initiatives Database

Modeling/simulation
Test/evaluation

Assists customers in obtaining interoperable solutions
Relationship of the NIF™ to Other NCOIC Activities

- **Relationship of the NIF™ to:**
  - NCOIC Integrated Project Teams (IPTs)
    - Provides process guidance for IPT development and update of NCOIC Patterns
  - NCOIC Functional Teams (FTs)
    - Provides process guidance for FT development and update of Technical Patterns
  - External Standards-setting bodies
    - Potentially identifies gaps in existing Standards and desirable enhancements to existing and new Standards
    - Note: the NCOIC is **not** a standards-setting body!

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NIF™ Summary

Break through the Technical Maze

Reach the Reward of Interoperable Systems
NCOIC Goal