

# **Net-Centric Implementation**

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## **Part 1: Overview**

## **Part 2: ASD(NII) Checklist Guidance**

## **Part 3: Migration Guidance**

## **Part 4: Node Design Guidance**

## **Part 5: Developers Guidance**

## **Part 6: Acquisition Guidance**

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**This document is a NESI product.**

**NESI (Net-Centric Enterprise Solutions for Interoperability) is a collaborative activity between the USN PEO for C4I and Space and the USAF Electronic Systems Center.**

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# 1 NESI implementation

## 1.1 References

- (a) DoD Directive 5000.1, *The Defense Acquisition System*, 24 November 2003.
- (b) DoD Instruction 5000.2, *Operation of the Defense Acquisition System*, 12 May 2003.
- (c) DoD Directive 8100.1, *Global Information Grid (GIG) Overarching Policy*, 21 November 2003.
- (d) DoD Directive 4630.5, *Interoperability and Supportability of Information Technology (IT) and National Security Systems (NSS)*, 05 May 2004.
- (e) DoD Instruction 4630.8, *Procedures for Interoperability and Supportability of Information Technology (IT) and National Security Systems (NSS)*, 30 June 2004.
- (f) DoD Directive 5101.7, *DoD Executive Agent for Information Technology Standards*, 21 May 2004.
- (g) *DoD Global Information Grid (GIG) Architecture, Version 2.0*, August 2003.
- (h) *DoD Joint Technical Architecture, Version 6.0*, 3 October 2003.
- (i) *DoD Net-Centric Data Strategy*, DoD Chief Information Officer, 9 May 2003.
- (j) CJCSI 3170.01D, *Joint Capabilities Integration and Development System*, 12 March 2004.
- (k) CJCSM 3170.01A, *Operation of the Joint Capabilities Integration and Development System*, 12 March 2004.
- (l) CJCSI 6212.01C, *Interoperability and Supportability of Information Technology and National Security Systems*, 20 November 2003.
- (m) *Net-Centric Operations and Warfare Reference Model (NCOW RM) V1.0*, September 2003.
- (n) *Net-Centric Checklist, V2.1.3*, Office of the Assistant Secretary of Defense for Networks and Information Integration/Department of Defense Chief Information Officer, 12 May 2004.
- (o) *A Modular Open Systems Approach (MOSA) to Acquisition, Version 2.0*, September 2004.
- (p) DoD IT Standards Registry (DISR), <http://disronline.disa.mil>.
- (q) *Net-centric Attributes List*, Office of the Assistant Secretary of Defense for Networks and Information Integration/Department of Defense Chief Information Officer, June 2004.

## 1.2 Overview

**Net-centric Enterprise Solutions for Interoperability (NESI)** is a joint effort between the U.S. Navy's Program Executive Office for C4I & Space and the U.S. Air Force's Electronic Systems Center. It provides implementation guidance which facilitates the design, development, maintenance, evolution, and use of information systems for the Net-Centric Operations and Warfare (NCOW) environment. NESI has also been provided to other Department of Defense (DoD) services and agencies for potential adoption.

The NESI Implementation guidance applies to all phases of the acquisition process as defined in references (a) and (b). NESI comprises six parts, each focusing on a specific area of guidance. *NESI Part 1: Net-centric Overview* describes each part in detail.

NESI provides guidance, best practices, and examples for developing Net-Centric software. It is aligned with the design principles of reference (o). NESI is not a replacement for references (m), (n), or (p).

The overall goal is to provide common, cross-service guidance in basic terms for the program managers and developers of net-centric solutions. The objective is not to replace or repeat existing direction, but to help translate into concrete actions the plethora of mandated and sometimes contradictory guidance on the topic of net-centric compliance and standards.

NESI subsumes two now obsolete references; in particular, the Air Force *C2 Enterprise Technical Reference Architecture (C2ERA)*<sup>1</sup> and the Navy *Reusable Applications Integration and Development Standards (RAPIDS)*.<sup>2</sup> Initial authority for NESI is per the Memorandum of Agreement between Space and Naval Warfare Systems Command (SPAWAR), Navy PEO C4I & Space and the United States Air Force Electronic Systems Center, dated 22 December 2003, Subject: Cooperation Agreement for Net-Centric Solutions for Interoperability (NESI).

In addition to references (a) through (q), Navy PEO C4I & Space has mandated a software maintenance policy<sup>3</sup> for its programs that requires the use of *NESI Part 3: Net-Centric Migration Guidance*.

NESI is intended to help programs comply with the DoD net-centric directives, instructions, and other guidance documentation (listed as references (a) through (q) above). This guidance will continue to evolve as direction and our understanding of the requirements of net-centricity evolve. NESI will be updated to reflect changes to the guiding documents and new regulations.

## 1.3 Releasability statement

This document has been cleared for public release by competent authority in accordance with DoD Directive 5230.9 and is granted Distribution Statement A: Approved for public release; distribution is unlimited. You may obtain electronic copies at <https://nesipublic.spawar.navy.mil>.

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<sup>1</sup> Air Force C2 Enterprise Technical Reference Architecture, v3.0-14, 1 December 2003.

<sup>2</sup> RAPIDS Reusable Application Integration and Development Standards, Navy PEO C4I & Space, December 2003 (DRAFT V1.5)

<sup>3</sup> Software Maintenance Policy, Department of the Navy, PEO C4I & Space, 14 June 2004.

## 1.4 Vendor neutrality

The NESI documentation sometimes refers to specific vendors and their products in the context of examples and lists. However, NESI is vendor-neutral. Mentioning a vendor or product is not intended as an endorsement, nor is a lack of mention intended as a lack of endorsement.

Code examples typically use open-source products, since NESI is built on the open-source philosophy. Since NESI accepts contributions from multiple sources, the examples also tend to reflect whatever tools the contributor was using or knew best. However, the products described are not necessarily the best choice for every circumstance. You are encouraged to analyze your specific project requirements and choose your tools accordingly. There is no need to obtain, or ask your contractors to obtain, the open-source tools that appear as examples in this guide. Similarly, any lists of products or vendors are intended only as references or starting points, and not as a list of recommended or mandated options.

## 1.5 Disclaimer

Every effort has been made to make this documentation as complete and accurate as possible. It is expected that the documentation will be updated frequently, and will not always immediately reflect the latest technology or guidance.

## 1.6 Contributions and comments

NESI is an open-source project that will involve the entire development community. Anyone is welcome to contribute comments, corrections, or relevant knowledge to the guides. To submit comments, corrections, or contributions go to the NESI public site at <http://nesipublic.spawar.navy.mil> and click on the Change Request tab, or sent an email to [nesi@hanscom.af.mil](mailto:nesi@hanscom.af.mil) or [nesi@spawar.navy.mil](mailto:nesi@spawar.navy.mil).

## 1.7 Open-source site

PEO C4I & Space is in the process of establishing an open-source site to support community involvement. Use this site for collaborative software development across distributed teams. Check the NESI public site for updates on when the collaborative development site will be available.

## 2 Introduction

The purpose of Net-Centric Warfare (NCW) is to increase combat power by effectively networking the warfighting enterprise.

Reference (n) provides direction to acquisition programs for implementing Network-Centric Warfare. The NESI implementation framework provided here complements reference (n) with more specific guidance to help you obtain approval at your milestone reviews. Developing systems in accordance with these principles will make the warfighter's life easier.

NCW involves much more than physical connectivity. The “net” in NCW emphasizes a network of connections between people in the information and cognitive domains. NCW stresses the shared information and situational awareness that accelerates command and synchronized efforts in the battlespace.<sup>4</sup> Information systems that support NCW must exchange data seamlessly and act on a compatible understanding of the data’s meaning. Specifically, they must:

- Work with each other to produce coherent information, fusing many separate facts into a common picture of the battlespace.
- Help users collaborate with each other to synchronize operations.
- Provide flexible information systems that can swiftly adapt to the information demands of a particular operational scenario. (This is necessary because we do not always know in advance what information will be needed and what user collaborations must be supported.)

Until now, most systems have not been built in a way that fulfills these requirements.

While the DoD is changing its usage model for information systems, various initiatives in the DoD are altering the way those information systems are produced and fielded. The public sector continually produces new technological opportunities, industry standards, and guidelines for our systems. Therefore, we must:

- Modernize our systems using new technological opportunities.
- Align with upcoming initiatives at a low cost.
- Be agile enough to reassemble capabilities to support new missions in a timely manner.

In summary, users need cohesive and flexible information systems. Ideally, they want a single, seamless system that accomplishes what they want now and changes quickly to provide what they want tomorrow. The goal of net-centricity is to deliver systems that meet these requirements.

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<sup>4</sup> Department of Defense, Office of Force Transformation, *Network-Centric Warfare: Creating a Decisive Warfighting Advantage*, Winter 2003, [http://www.oft.osd.mil/library/library\\_files/document\\_318\\_NCW\\_GateFold-Pages.pdf](http://www.oft.osd.mil/library/library_files/document_318_NCW_GateFold-Pages.pdf)

## 2.1 Scope

NESI presents a set of guidance and best practices based on today's technologies and probable near-term developments. NESI provides guidance that can accelerate a program toward net-centricity.

### 2.1.1 Goals

The key goals of NESI are to:

- Guide future development and acquisition direction in compliance with the net-centric architecture specified in reference (g).
- Provide the basis for enterprise integration and interoperability through reuse of enterprise design patterns, well-defined public service interfaces, and loosely coupled<sup>5</sup> components. These are key elements to meet the criteria in reference (n).
- Specify the major components of NESI infrastructure:
  - **Enterprise Services** provided and managed across the enterprise by the Net-Centric Enterprise Services (NCES) program.<sup>6</sup>
  - **Nodes**, which provide local infrastructure and mission functions. Nodes are functional and management constructs that support cohesive mission functionality. Nodes also contain the infrastructure elements required for mission services that are not available from the enterprise.
- Specify a technical, component-based,<sup>7</sup> N-tier<sup>8</sup> framework for application development such as a Service Oriented Architecture (SOA<sup>9</sup>). It should promote reuse of software components so that they can be easily composed into new mission capabilities with minimal development effort. Software reuse *per se* is not required for NESI to achieve its goals. However, providing a basis for leveraging reuse opportunities is required.

### 2.1.2 Non-goals

NESI does not provide detailed specifications of node information services or software components. These are specified by their respective acquisition managers.

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<sup>5</sup> Loosely coupled: A computing model where application elements require a simple level of coordination and allow for flexible reconfiguration. Interconnection is often asynchronous and message-based.

<sup>6</sup> Defense Information Systems Agency, Net-Centric Enterprise Services (NCES) Technology Development Strategy, Version 2.3, 22 March 2004.

<sup>7</sup> Component-based: A computing model in which an application is built from small binary objects or programs. Each object implements a specific function and is designed to operate easily with other components and applications. Partitioning systems into components allows for component sharing and reuse across multiple applications.

<sup>8</sup> N-tier: A computing model in which an application is partitioned into multiple software layers. Each layer uses dedicated services and provides specific functions. The N-tier model facilitates the development of flexible and reusable applications. By breaking up an application into tiers, developers only have to modify or add a specific layer in order to change the application.

<sup>9</sup> See Section 4.4 for additional discussion of SOA.

NESI does not specify commercial off-the-shelf (COTS) products. Acquisition managers select the specific products they will use. NESI provides a technical standards framework as the basis for product selection.

NESI does not specify how to provision and deploy services. These implementation choices (e.g., centralized vs. distributed services and data) are made by acquisition managers.

This version of NESI does not address all of the problems of real-time computing, or of applications running on disconnected networks. The NESI strategy can be extended to cover these areas, and future versions of NESI may contain this guidance.

### **2.1.3 Limitations**

NESI does not provide all of the guidance needed for net-centricity, for the following reasons:

- A number of hard technical questions exist related to net-centricity that are not yet addressed or well understood given today's technologies (e.g., providing Quality of Service measures for web services).
- Program-specific implementation details must be analyzed in the context of the program. NESI provides general guidance, which is not intended to apply uniformly to all contexts. Improvise and improve as needed, and share the results.
- NESI does not attempt to predict the direction, progress, or capabilities of future technology.
- NESI does not address any of the processes or methodologies for developing systems (e.g., spiral development). This framework, however, is compatible with all commonly accepted methodologies and development models.
- NESI guidance does not provide all of the technical specificity required for net-centricity. Use the NESI technical criteria as guidance for system engineering analysis, system review, and as a point of departure for system- or platform-specific engineering.
- NESI does not provide a "build to" specification. The size and complexity of the enterprise combined with the rapid rate of technology evolution preclude that level of detail.

## **2.2 Audience**

The intended audience for this document includes:

- Program managers
- Contracting officers
- Chief engineers
- System engineers
- Software developers
- Acquisition managers
- Test & Evaluation managers

## 2.3 NESI product overview

The technical principles of NESI are widely used in industry; best-of-breed companies use them in the ways described here. NESI is structured into a set of guidance products that program managers and contractors should use to achieve net-centric interoperability within their Programs of Record (PORs). The guidance should be followed during all phases of a program's lifecycle. The general guidance should be considered in all aspects of "doing business," and there are also specific examples of language that may be incorporated into program acquisition and capabilities documents (e.g., JCIDS documents, acquisition strategies and contracting artifacts). This section describes the current products and their intended use and audience. Each audience may tailor the NESI products to their needs. Readers should use the descriptions below to choose the guidance documents most helpful for their particular program.

The primary scope of this strategy is non-real-time software applications. Extending the same strategy to real-time systems requires additional, more detailed, development guidance.

### 2.3.1 Part 1: Net-Centric Overview

Part 1 presents government program managers and DoD contractors with a technical implementation framework for building information systems that conform to the net-centric environment. This framework is based on an enterprise architecture and technical implementation guidance. The architecture provides an enterprise structure and context for building mission capabilities. Use in all phases of the acquisition process.

### 2.3.2 Part 2: Net-Centric ASD (NII) Checklist Guidance

Part 2 guidance is aligned with reference (n). It is intended for managers of new programs or programs that are undergoing a transformation or major upgrade. Use especially during the pre-systems acquisition and systems acquisition phases.

Reference (n) uses net-centric design precepts called **tenets** to guide the move into the net-centric environment. NESI provides specific technical direction for satisfying reference (n). Note that some tenets address doctrinal or procedural requirements; this guidance does not address those areas.

### 2.3.3 Part 3: Net-Centric Migration Guidance

Part 3 guidance is intended for the program managers and DoD contractors of existing programs. These programs use pre-planned product improvement or maintenance funds to incorporate net-centric characteristics. This guidance presents a strategy to migrate deployed applications to the net-centric paradigm during the maintenance phase. It describes how to implement a phased software migration strategy to deliver net-centric capability and to fulfill current contractual and program maintenance obligations. Use especially in the sustainment phase.

### 2.3.4 Part 4: Net-Centric Node Design Guidance

Part 4 helps government program managers, system engineers, and DoD contractors who develop applications and systems to conform to NESI node guidance. Use especially in the systems acquisition phase.

This guidance specifies the criteria for building nodes and their associated infrastructure in the net-centric environment. Nodes are the basic building blocks of NESI for the net-centric enterprise. The net-centric enterprise comprises a set of nodes, where each node comprises a set of mission functions and services implemented on a common infrastructure.

This guidance focuses on the capabilities the Node Platform Infrastructure (NPI) provides to support mission applications, services, and components.

The primary scope of this strategy is non-real-time software applications. Extending the same strategy to real-time systems requires additional detailed development guidance.

### **2.3.5 Part 5: Net-Centric Developers Guidance**

Part 5 provides developers with style guidance, detailed programming guidelines, reference software code, and open-source library references. It is intended for developers building applications, services, and components for use in the net-centric environment. Use during the system acquisition phase.

The guidance has two components:

- A standalone introductory document for developers and non-developers
- A web browser-based HTML package containing detailed software development guidance, including code samples, examples, good coding practices, and lessons learned.

### **2.3.6 Part 6: Net-Centric Acquisition Guidance**

Part 6 is intended for program managers and DoD contractors. It outlines the acquisition process and system/product requirements appropriate to achieving NESI compliance. It relates the steps of the System Acquisition Framework<sup>10</sup>, from concept refinement to post-contract award, to NESI tenets and principles. Use especially in the pre-systems acquisition and systems acquisition periods.

## **2.4 Background**

Although C2ERA and RAPIDS form the core of the NESI effort, NESI incorporates additional service-specific supportive guidance:

- Air Force Node Information Services (NIS) guidance for building loosely coupled information services using web services technology<sup>11</sup>
- Air Force XML implementation guidance for the construction and use of XML for information interchange<sup>12</sup>

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<sup>10</sup> Reference (b)

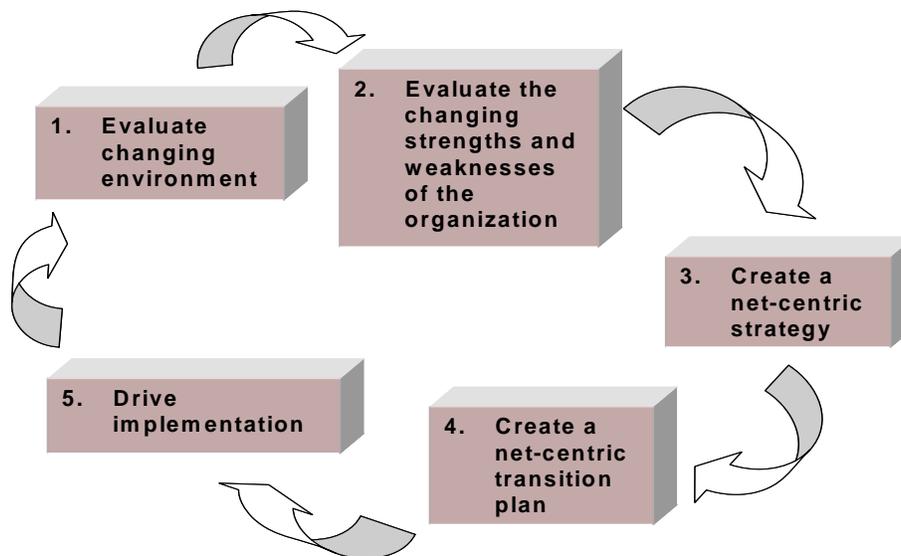
<sup>11</sup> Department of the Air Force, Headquarters Electronic Systems Center, *Node Information Services - Guidance for Implementing Web Services on C2 Nodes*, Version 3.2, 2 September 2003, [http://herbb.hanscom.af.mil/tbbs/r582/node\\_information\\_services\\_\\_3\\_2.doc](http://herbb.hanscom.af.mil/tbbs/r582/node_information_services__3_2.doc).

- Navy FORCEnet Architectures and Standards providing Navy-specific direction for migrating toward the DoD's Global Information Grid (GIG)<sup>13</sup>
- Navy Open Architecture<sup>14</sup>
- *DON XML Developer's Guide* and *DON XML Policy*<sup>15</sup>

## 2.5 Evolution

NESI guidance will evolve along with our understanding of net-centricity. The specific details of the net-centric and enterprise capabilities referenced in these guidance documents may change.

Continuous monitoring of emerging technologies, policies, and practices guides the evolution of NESI. This evolving process is depicted in Figure 1 below.



**Figure 1: NESI Guidance Process**

The NESI approach unravels functions embedded within current systems to make data and capabilities more accessible. Implicit in this approach is the potential need for retraining program managers, developers, integrators, and system administrators.

This method requires:

- New approaches to managing mission capabilities as services.
- New monitoring tools and techniques.

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<sup>12</sup> Department of the Air Force, Headquarters Electronic Systems Center, *Extensible Markup Language (XML) Implementation Guidance*, C2 Enterprise Integration, 16 April 2002, [http://herbb.hanscom.af.mil/C2ED\\_new/index.asp](http://herbb.hanscom.af.mil/C2ED_new/index.asp).

<sup>13</sup> Department of the Navy, Office of the Chief Engineer, SPAWAR 05, *FORCEnet Architecture and Standards, Volumes I and II*, V1.4, 30 April 2004.

<sup>14</sup> Department of the Navy, *Open Architecture*, Volumes 1-5, 2003.

<sup>15</sup> Department of the Navy, *XML Developer's Guide* version 1.0, 29 October 2001; *XML Policy*, 13 December 2001.

- New testing and deployment approaches.
- New hardware and acquisition planning.
- New user support functions.

Recognizing the breadth and depth of this change—which represents a general rethinking of system design—is fundamental to the task of evaluating the DoD’s current organization. The outcome of the process will be alignment with the operational shift from TPED (Task, Process, Exploit, Disseminate) toward TPPU (Task, Post, Process, Use).

### 3 Mapping net-centric attributes to enterprise technology objectives

ASD (NII)/DoD CIO has published a matrix of technical attributes (reference (q)) that net-centric applications should exhibit. That matrix serves as the framework for NESI guidance. *NESI Part 2: Net-centric ASD (NII) Checklist Guidance* and *NESI Part 3: Net-centric Migration Guidance* map each guidance statement to these attributes through a set of enterprise technology objectives, as described below.

**Table 1: ASD (NII) Net-centric Attributes**

Net-centric Attribute	Description	Metric
Internet Protocol (IP)	Data packets routed across network, not switched via dedicated circuits.	IP as the convergence layer.
Secure and available communications	Encrypted initially for core network; goal is edge-to-edge encryption and hardened against denial of service.	Black transport layer.
Only handle information once (OHIO)	Data posted by authoritative sources and visible, available, usable to accelerate decision making.	Reuse of existing data repositories.
Post in parallel	Business process owners make their data available on the net as soon as it is created.	Data tagged and posted before processing.
Smart pull (vice smart push)	Applications encourage discovery; users can pull data directly from the net or use value-added discovery services.	Data stored in public space and advertised (tagged) for discovery.
Data centric	Data separate from applications; apps talk to each other by posting data.	Metadata registered in DoD Metadata Registry.
Application diversity	Users can pull multiple apps to access same data or choose same app (e.g., for collaboration).	Apps posted to net and tagged for discovery.
Assured sharing	Trusted accessibility to net resources (data, services, apps, people, collaborative environment, etc.).	Access assured for authorized users; denied for unauthorized users.
Quality of service	Data timeliness, accuracy, completeness, integrity, and ease of use.	Net-ready key performance parameter.

To help focus development and maintenance actions in support of these attributes, NESI analyzed the ASD (NII) Net-centric Attributes list and derived the following concrete and engineering-oriented enterprise objectives.

**Table 2: NESI Enterprise Technology Objectives**

Technology Objective	Description	Derived from ASD (NII) Net-centric attributes
Capability on demand	<p>Delivery of and/or access to capabilities (data, applications, connectivity) incrementally and as needed, on demand, and controlled by user clearance.</p> <p>Examples include:</p> <ul style="list-style-type: none"> <li>• Making available new data sources in different security domains.</li> <li>• Downloading needed applications without disrupting current operations.</li> <li>• Reallocating communication bandwidth to meet today's operational needs and providing those needs to another organization tomorrow.</li> </ul>	<ul style="list-style-type: none"> <li>• Application diversity</li> <li>• Assured sharing</li> <li>• Data centric</li> <li>• Internet Protocol (IP)</li> <li>• Quality of service</li> <li>• Secure and available communications</li> </ul>
Distributed operations	<p>Battle-force commanders can:</p> <ul style="list-style-type: none"> <li>• Gain immediate access to essential expertise.</li> <li>• Leverage off-board resources and expertise.</li> <li>• Coordinate diverse aspects of operations with timely, reliable resources (i.e., trusted, remote access to collaboration environments for planning and data exchange).</li> <li>• Access reliable services to coordinate synchronized operations.</li> </ul>	<ul style="list-style-type: none"> <li>• Assured sharing</li> <li>• Internet Protocol (IP)</li> <li>• Quality of service</li> <li>• Secure and available communications</li> </ul>
Customized applications	<p>Applications can be tailored on a continuing basis to meet current Rules of Engagement (ROE) and readjusted to meet tomorrow's needs.</p> <p>For example, users can choose between a collaborative environment that allows them to access and share full-frame images or an environment for limited bandwidth communications, depending on the current need. They can adjust geographic displays to access archives of high-resolution terrain for specific, changing areas of interest.</p>	<ul style="list-style-type: none"> <li>• Application diversity</li> <li>• Data centric</li> <li>• Post in parallel</li> <li>• Smart pull (vice smart push)</li> </ul>

Technology Objective	Description	Derived from ASD (NII) Net-centric attributes
Multi-user access	<p>Multiple users can simultaneously access data stores, use applications, and analyze and direct operations.</p> <p>For example:</p> <ul style="list-style-type: none"> <li>• Operators can develop and play back multiple ingress/egress scenarios to accomplish more comprehensive, faster mission planning.</li> <li>• Multiple users can update data archives without overwriting each other.</li> <li>• Operators can use the same situational awareness picture.</li> </ul>	<ul style="list-style-type: none"> <li>• Application diversity</li> <li>• Assured sharing</li> <li>• Data centric</li> <li>• Only handle information once (OHIO)</li> <li>• Post in parallel</li> <li>• Smart pull (vice smart push)</li> </ul>
Customized delivery	<p>Smart push and pull of data reduces overload and provides the requested data to operators when they need it. Tailored discovery, publish, and subscribe capabilities allow operators to register for specific data and services in specific timeframes.</p> <p>For example, operators can request track updates every four minutes. They can also request real-time data feeds that stream onto a non-real-time display for specific data types at specific times.</p>	<ul style="list-style-type: none"> <li>• Data centric</li> <li>• Post in parallel</li> <li>• Quality of service</li> <li>• Smart pull (vice smart push)</li> </ul>
Assured sharing	<p>Consistent authentication over the network provides trusted accessibility to resources such as data, services, applications, people, and collaborative environments.</p> <p>For example:</p> <ul style="list-style-type: none"> <li>• Operators can access their data archives from diverse locations and share specific data as needed.</li> <li>• Essential expertise is available collaboratively.</li> <li>• Access to unique applications can be provided with reduced risk.</li> <li>• Secure access can be permitted easily and quickly.</li> </ul>	<ul style="list-style-type: none"> <li>• Assured sharing</li> <li>• Quality of service</li> <li>• Secure and available communications</li> </ul>

Technology Objective	Description	Derived from ASD (NII) Net-centric attributes
Incremental upgrade	<p>Certain capabilities can be modernized without impacting other capabilities.</p> <p>For example, developers can upgrade the display stations and software without changing how the application is used or replacing the on-board servers. They can upgrade databases without replacing applications that access the data.</p>	<ul style="list-style-type: none"> <li>• Application diversity</li> <li>• Quality of service</li> </ul>
Data exchange	<p>Operators can move data between applications easily and without losing data or capabilities. Data may carry security labels allowing for its exchange with partners operating at coalition or multinational releasable security levels.</p> <p>For example, multiple applications can access a single data archive. Users can display maps identically on any display system that has access to the underlying capabilities.</p>	<ul style="list-style-type: none"> <li>• Application diversity</li> <li>• Data centric</li> <li>• Only handle information once (OHIO)</li> <li>• Post in parallel</li> <li>• Smart pull (vice smart push)</li> </ul>

## 4 NESI guidance

Today there is no single, comprehensive technology deployment suitable for the entire DoD Enterprise. The complexity of the enterprise makes centralized implementation impractical. Its survivability requires independent, redundant, loosely-coupled entities.

The core technical concept of net-centricity is a completely secure network that is accessible worldwide. The network must deliver messages in a timely manner, such that the application or human who receives them can make decisions appropriately. The messages are either for services (“*Do something*”) or for information (“*Tell me what I need to know*”).

The net-centric vision needs to be concrete and explicit so that systems can implement it. Both legacy and new applications need simple, transparent, robust methods to acquire and share information across traditional system, service, and community boundaries.

NESI’s contribution to this vision is to provide implementation guidance for building solutions to satisfy this vision. These solutions must meet the requirements specified in reference (n).

### 4.1 Information interoperability

Net-centricity requires applications to share information with each other. To do this, applications must be able to exchange data and to agree on its meaning.

The first part requires access to data. That is, one application must be able to obtain data provided by another. NESI facilitates this by providing a least-common-denominator data access mechanism that all applications can use. This removes arbitrary implementation barriers to data exchange. NESI also includes guidance for adding customizability to applications, including “on-the-fly” reconfiguration.

The second part requires a *semantic match* between users and developers. That is, users and developers must be able to determine whether the data they receive is suitable for their purpose, and they must be able to cope with any *representation mismatch*. For example, if the source application provides volume measurements in gallons, but the receiving application requires liters, then a translation function must be applied. NESI does not directly address semantics at this time. The necessary shared understanding will be supported by common vocabularies developed by communities of interest.

### 4.2 Communities of interest

NESI provides significant guidance for building systems that support **Communities of Interest** (COIs). A COI is a collaborative group of users who exchange information for their shared goals, interests, missions, or business processes. The success of this exchange depends on a shared vocabulary.<sup>16</sup> Within NESI, COIs have the following properties:

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<sup>16</sup> Reference (i), <http://www.dod.gov/nii/org/cio/doc/Net-Centric-Data-Strategy-2003-05-092.pdf>

- A COI is a group of people who share a common vocabulary. There is typically a deliberate effort to produce this community vocabulary.
- A COI may be institutional, expedient, functional, or cross-domain.
- A COI may be a subset of another COI.
- A COI always encompasses more than one system or node. A system is a source of data and/or capability, and often participates in more than one COI.
- A COI typically encompasses more than one organization.

### 4.3 NESI elements

NESI organizes the enterprise into three elements:

- **Enterprise Services** provide enterprise-wide capabilities to link nodes, services, applications, and components.
- **Nodes** provide local hardware and software to support COIs and users.
- **Services, Applications, and Components** provide the mission capabilities the warfighters need.

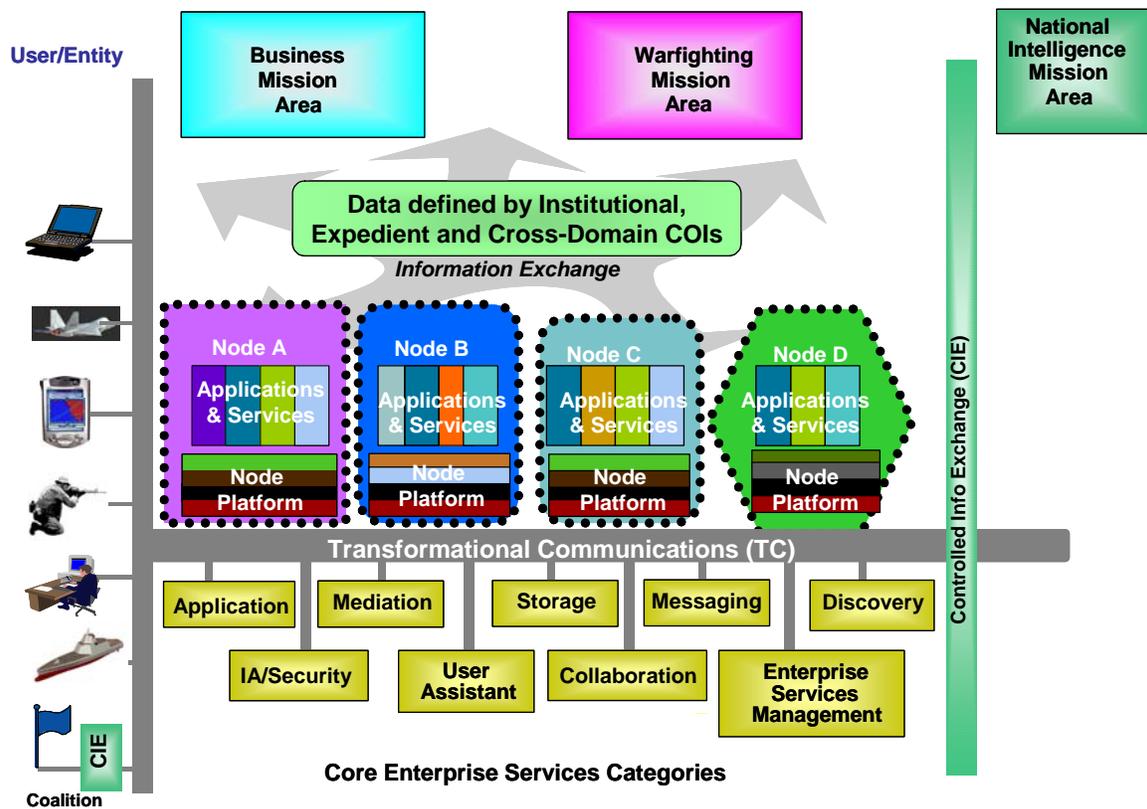
NESI prescribes an N-tier architecture model with client, presentation, middle, and data tiers. NESI relies upon the Net-Centric Enterprise Services (NCES) program.<sup>17</sup> The combination of NCES and NESI yields an open-standards architecture that allows the enterprise to encapsulate the elements of existing or new systems. The elements plug together seamlessly and can be upgraded and expanded more easily.

The NCES architecture does *not* currently provide detailed guidance for developing systems or applications to support COIs. NESI complements NCES by expanding the guidance for COIs and for the infrastructure required to build mission applications that integrate into COIs and the enterprise.

The DoD Enterprise includes software components delivered by different organizations on different schedules. All components, however, are organized around the architecture shown in the figure below. Figure 2 shows the types of components that coexist in the enterprise and support each other.

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<sup>17</sup> Discussed in section 4.5, *Enterprise services*.



**Figure 2: DoD Net-Centric Enterprise**

At the top of Figure 2 are the basic DoD domains: warfighting, business operations, and intelligence. COIs that share data are formed within and across these domains.

The **node** is the infrastructure that supports COIs. Figure 2 shows several node types, which communicate using the GIG. Nodes use core services (shown at the bottom of the figure) to support inter-node activities such as messaging.

NCES services will not meet all internal needs of nodes and COIs. The local node infrastructure provides services for applications and users within the COI and node.

## 4.4 Service-oriented architecture

A Service-Oriented Architecture (SOA) best fulfills the requirements of a net-centric environment. Multiple clients and other services can access mission application functionality as a set of services. These services are layered on separate node-based and enterprise-wide infrastructures.

The SOA approach has two key benefits:

- It promotes flexibility and reuse. This enables developers to compose complex software systems from clearly defined, implementation-neutral interfaces rather than through brittle implementation mechanisms such as tightly coupled, highly integrated applications or APIs.
- It isolates the specifics of data implementation from the service interface, allowing systems to evolve their internal implementation without impacting other systems.

In a SOA business, functions are provided as services one or more clients may invoke. Services expose business functions through well-defined interfaces that separate implementation from interface. Services are designed to be highly interoperable, loosely coupled, and discoverable across the enterprise. This approach provides significant benefits, as shown in Figure 3.

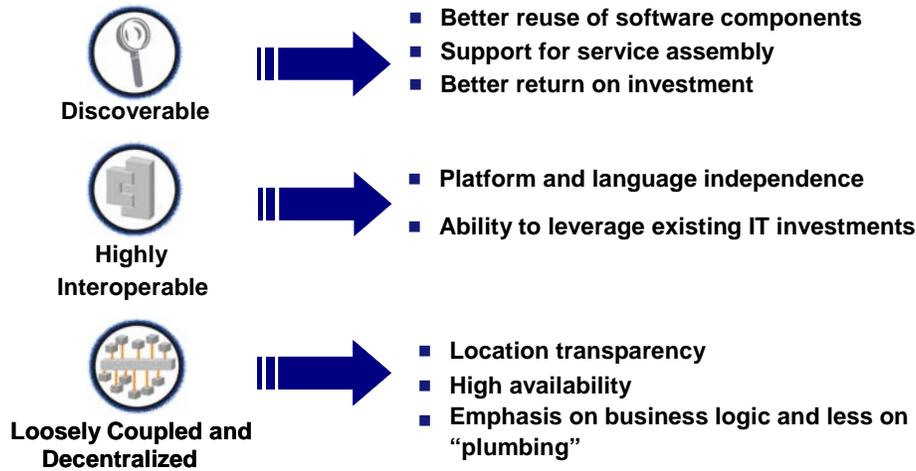


Figure 3: Benefits of an SOA and web services

#### 4.4.1 SOA roles

In a SOA there are three roles (see Figure 4):

- **Service Provider:** Makes a service available, including the service interface. A service provider publishes a service interface and may provide additional service metadata in a service registry.
- **Service Consumer:** Invokes and uses a service according to rules in the service interface.
- **Service Discovery:** Provides descriptive information about a service as metadata, enabling the lookup and discovery of services.

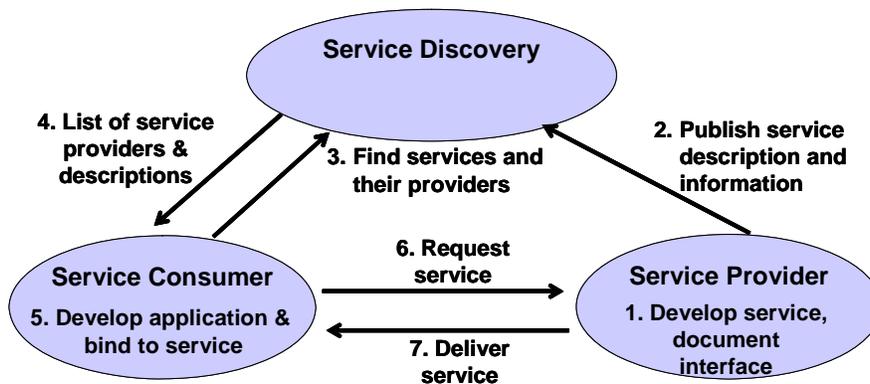


Figure 4: Service-Oriented Architecture

#### 4.4.2 Service interfaces

Service interfaces have the following properties:

- They must be defined independently of implementations.
- New interface versions require strict configuration management so that service consumers can migrate independently.
- Newer versions of services must be backward compatible with existing interface contracts.
- The version sequence of the interface should be different than the version sequence of the code and data implementation, and it should be able to evolve independently.

### 4.5 Enterprise services

Enterprise services and nodes provide infrastructure capabilities that underlie the SOA paradigm.

NCES defines a set of core enterprise services. NCES services are the set of net-centric utilities that the DoD and Defense Information Systems Agency (DISA) defined to enable secure, reliable, timely, and interoperable information exchange.

The GIG architecture allows for additional domain- and mission-related services, called COI services, which extend the enterprise beyond NCES. Services provided by nodes will generally be developed as COI services.

NESI guidance is primarily intended for developers of systems that provide and use COI services and use NCES services.

#### 4.5.1 Net-Centric Enterprise Services<sup>18</sup>

The Net-Centric Core Enterprise Services (NCES)<sup>19</sup> program will provide enterprise-level Information Technology (IT) services and infrastructure components for the DoD GIG. The net-centric enterprise relies on the NCES infrastructure. NCES in turn relies on GIG transport services such as the Defense Information System Network (DISN) and tactical communications systems. While NCES relies upon the GIG transport services, visibility into transport details is not an inherent component of NCES.

Many of the NCES services referenced in NESI guidance are evolving. The implementer should use these services where available. Where they are not yet available, the developer should provide an application-specific, nodal, or COI implementation based on the NCES interface definition. The developer should design the implementation based on best commercial practice so that it is straightforward to replace it with the NCES implementation of the service, when that is deployed.

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<sup>18</sup> Net-Centric Enterprise Services, <https://ges.dod.mil/>.

<sup>19</sup> *Capability Development Document for Net-Centric Enterprise Services*, Draft Version 0.7.15.2, 9 April 2004.

## 4.6 Nodes

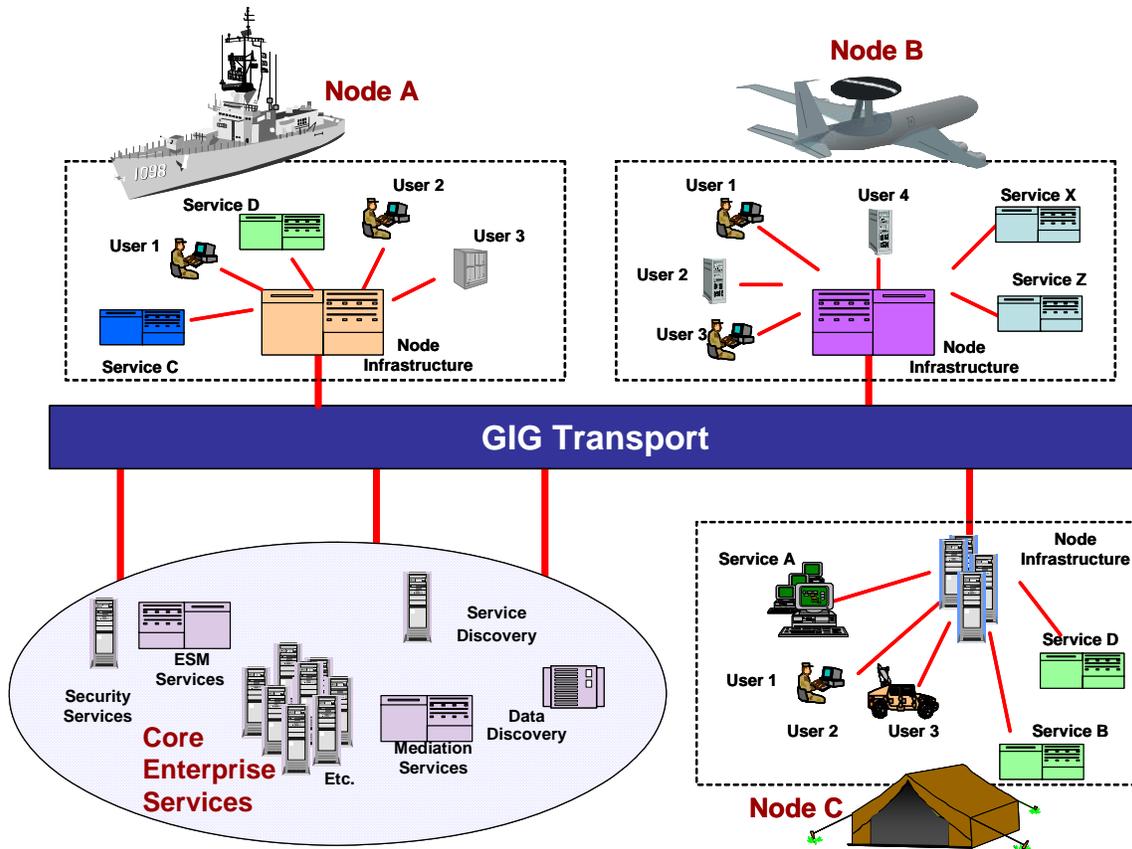
This section summarizes the key principles and characteristics of nodes. See *NESI Part 4: Net-Centric Node Design Guidance* for details on nodes.

A **node** is a set of information systems that are acquired and managed as a single element in the net-centric enterprise. Nodes support distributed services for a collection of systems, applications, data, and components that share a common set of mission functions on a common infrastructure. Nodes represent a departure from the past “stovepipe” acquisition and development of single systems with tightly integrated infrastructure and mission function. Nodes collect mission functions that are built on a common, local infrastructure.

A node is also a management construct for organizing and implementing mission capabilities. The needs of the mission drive development of the node infrastructure, services, components, and applications.

Nodes can include components such as web servers, portal servers, application servers, and database servers to support their COIs and the enterprise. To support its COIs, a node shares information with other nodes connected to the enterprise network. If a node loses enterprise connectivity, it must still serve its local community reliably in “disconnected operations” mode. Each node must provide local IT capabilities, called the Node Platform Infrastructure (NPI), to meet the reliability requirements of its COIs while maintaining interoperability with the enterprise.

Figure 5, below, depicts a notional DoD enterprise based on nodes.



**Figure 5: Nodes in the Enterprise**

The net-centric enterprise comprises a set of nodes, where each node comprises a set of mission functions and services implemented on a common infrastructure. The enterprise can be managed as a collection of nodes without concern for the intra-node implementation details.

Nodes optimize their infrastructure and services to support their missions. The enterprise is optimized to provide continuity, consistency, interoperability, and persistence across the enterprise.

#### 4.6.1 Node platform infrastructure

In a node, related applications and services operate on a common Node Platform Infrastructure (NPI). The NPI:

- Supports the development and deployment of N-tier mission applications.
- Interfaces with enterprise services.

Mission requirements and security issues may require a node to have multiple infrastructure components, such as different database servers. Different nodes may have varied implementations of their infrastructure. *NESI Part 4: Node Design Guidance* specifies the minimum capabilities and functions that the NPI must provide. Additional capabilities may be needed, however, to satisfy specific operational needs.

Nodes may evolve independently of one another, but they must maintain information interoperability via enterprise metadata with agreed semantics.

The set of services required for each node will evolve, and different implementations may organize the services differently.

Node implementations may be deployed in multiple locations to support a distributed node. This distributed architecture should be transparent to the end user.

## **4.7 Relationship of NESI to the Net-Centric Operations and Warfare Reference Model**

Reference (m) describes the DoD enterprise aspects of an objective NCOW information environment for the GIG. The NCOW RM:

- Provides a common, enterprise-level reference model for the DoD's enterprise architecture, and a reference for acquisition programs to use in focusing and gaining net-centric support through the GIG.
- Enables a shared perspective of enterprise information environment operations.
- Helps decision-makers promote enterprise-wide unity of effort.

The goal is to have a uniform, DoD-wide reference for program development and oversight. Individual and enterprise programs should use it to address all net-centric IT-related issues in a consistent, coherent, and comprehensive manner.

NESI provides the technical guidance and enterprise design patterns for building net-centric capabilities as services and components that align to the NCOW reference model. Within NESI, the combination of NCES and nodes implement the NCOW RM requirements.