Core Enterprise Services, SOA, and Semantic Technologies: Supporting Semantic Interoperability in a Network-Enabled Environment

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Outline

• Why Semantic Interoperability matters
• Core Enterprise Services (CES) and the NATO Core Enterprise Services Framework
• Supporting Semantic Interoperability through CES and Semantic Technologies
• Use Case: 2011 SOA Demonstrator
• Outlook on CES and the use of Semantic Technologies
Bottom Line(s) Up Front

- Multinational coalitions and network-centric operations necessitate the use of semantic technologies to increase semantic interoperability.
- Semantic technologies are an integral part of Core Enterprise Services.
- Core Enterprise Services provide the foundation for semantically-enabled applications to support Communities of Interest and Functional Area Services.
Semantic Interoperability matters!

Some challenges:
• 28 NATO nations, multiple branches per nation
• Dozens of languages besides the two official NATO languages
• Different cultural backgrounds

Semantic Interoperability is a core element of every NATO mission
• Transporting data between two systems is not enough!
• Semantic interoperability problems have always existed.
• Greater reliance to machine-processable information, multinational coalition environments and the dynamicity of network-centric operations.
• Limited capacity for workarounds relying to human smartness.
Motivation

• NATO Network-Enabled Capability (NNEC): Semantic technologies are a key enabler for information superiority

The 4 Rs:
Right information
Right recipient
Right time
Right format

• Service Oriented Architecture and the use of semantic technologies have the potential to increase mission effectiveness.

• Relevant to CIS capabilities and the operational/business context.
SOA-based Core Enterprise Services

- Fundamental support to service-based frameworks, as **infrastructure and enabler services**
- **Single set** of reusable technical, generic (independent of business processes) “minimum required” services
- **Foundation for “higher level” services** (COI-Enabling, COI-Specific, User)
- Interoperability support via an agreed **common core baseline**
- Essential infrastructure services to support **semantic interoperability**
CES Framework

- **Information Assurance Services**
  - Discovery
    - Service Discovery Services
    - Information Discovery Services
  - Infrastructure
    - Application Services
    - Storage Services
- **Common COI Services**
  - Repository
    - Enterprise Directory Services
    - Metadata Registry Services
  - Mediation
    - Composition Services
    - Translation Services
  - Interaction
    - Messaging Services
    - Transaction Services
    - Publish/Subscribe Services
    - Collaboration Services
- **COI-Specific Services**
- **SM&C**
- **Network/Transport Services**

**Information and Integration Services**
(Core Enterprise Services)
Achieving semantic interoperability:

- Ensure that information is not just transported to the recipient, but also interpreted as intended by the originator.
- The 5th R – Right interpretation!

Support for Semantic Interoperability has to start with Core Enterprise Services and incorporate semantic technologies.

- Semantic technologies provide the glue between the COI and the Information & Integration layers, enabling COIs to use information more efficiently.
Semantic Technologies

Infrastructure to support semantically-enabled applications:
- Mediation services
- Knowledge Stores
- Rule engines
- Metadata and service registries
- Service and Information Discovery services

Separation of the conceptual knowledge from its representation increases reuse, facilitates integration, and ensures better adaptability to new systems:
- Encoding information, e.g. by using RDF, OWL
- Encoding business logic as rules, e.g. SWRL
2011 Norwegian SOA demonstration supported by NC3A

- Models a shared coalition environment
- NC3A acted as the intermediary between various national extensions, provided NATO prototype core enterprise services and end-user applications in the NC3A CES testbed.
2011 SOA Demonstrator
Exchange and use of RDF information

- RDF is used for breaking up system-specific XML artifacts (based on schemas) into smaller units (triples) that are easier to integrate.
- Support for correlation of information from heterogeneous sources (track data, incident data)
Use case: 2011 SOA Demonstrator

Aims (related to SOA and semantic technologies):

• Provide information in multiple formats, serve different C2 systems
• Support information integration from multiple sources.

Key for successful integration and use of these sources: Understanding the semantics of the information!

Diverse information sources; multiple formats; SAME OBJECT!

Consolidated view of information across all sources

Incident data

Track information

Registration data
2011 SOA Demonstrator

Use of Core Enterprise Services to support semantic interoperability:

**Service discovery:**
Discovery of NVG sources via mDNS/DNS-SD for visualization, UDDI-based discovery of pub/sub topic endpoints and schemas.

**Information discovery:**
Discovery of information from RDF sources via SPARQL endpoints.

**Translation Services:**
**Data:** Transformation of NFFI (NATO Friendly Force Information) track data to NVG (NATO Vector Graphics), KML, and RDF.
Provisioning of JOCWatch incident data as NVG and RDF.

**Protocols:** NVG to NFFI SIP3 conversion

**Publish/Subscribe services:**
Provisioning of track and incident data via ESB using WS-Notification.

**Collaboration Services:**
Use of XMPP chat clients to report 4-liner incident information (via JOCWatch Chat component)
Generalization of services for semantic interoperability:

- Core enterprise services as well as generic COI services for mediation, information integration and reasoning.
- Generation of service interface profiles for supporting semantic interoperability

Focus on COI-level services, using information integrated from different sources and rule-based reasoning, e.g.

- Issue automatic warnings for recent incidents in the projected path of a unit.
- Send automatic requests for support to units that are close enough to an emergency situation.
Related work on Semantic Interoperability

SI Demonstrator for Maritime Situational Awareness
• Prototype of semantically-enabled end-user application
• Integration of commercially available semantic platform with in-house developed technologies

Federated search application
• Prototype for investigating of elements of semantic infrastructure (knowledge stores, reasoners, query translation, metadata registry)
• Technical specification for semantic interoperability

Cross-domain ontology work
• Relating COI-specific concepts through cross-COI, cross-domain ontologies
2011 SOA Demonstrator, Summary

• Increasing semantic interoperability and supporting semantically-enabled COI services starts with Core Enterprise Services!
  – Service and Information Discovery
  – Mediation and Translation services

• The use of established W3C standards (RDF, SPARQL) facilitates the sharing and integration of information from heterogeneous sources.
Outlook

• Awareness of the operational benefits and potential of semantic technologies is still low.
  – Use of RDF and OWL in fielded applications is still very limited, especially in comparison to XML.
  – Some success stories, more are needed.

• Education on creating and using semantically rich representations is required
  – Using RDF and OWL for representing information
  – Transforming schemas into ontologies
  – Capturing operational processes as rules

• Tool support
  – Better, easier to use commercially available tools for developers, domain experts, and knowledge engineers
  – Inference engines, common rule formats/standards
Outlook

• Semantic technologies and SOA can improve information sharing between C2 systems and enable better support for COIs.
• Semantic technologies are not competing with traditional approaches, but will add additional value for information sharing.
• SOA and semantic technologies are the enablers for new functionality to increase semantic interoperability within the Alliance.
Sponsors

Allied Command Transformation (ACT)

NATO C3 Board (C3B)
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