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Semantic Web Technologies for Storing and Accessing Immediately Needed Training Data

Dr. William (Bill) Gerber
Gabriel Aviles
Karen Fraser
Wayne Randolph

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Presentation Outline

• Joint Explosive Ordnance Disposal (JEOD) Decision Support System (DSS)
  – Challenges
  – Overview

• DARPA - Semantic Web Research
  – Dynamic Job Aid System (DJAS)
  – Technology Behind the Scenes

• JEOD Knowledge Transfer Operational Demonstration (KTOD) Advanced Concept Technology Demonstration (ACTD)
  – Technology Overview
  – Content Authoring Tool (CAT)
  – Reference Assistant Tool (RAT)

• Summary

• Questions
JEOD DSS Challenges

• **Save Warfighter Lives**
  – EOD warfighters exposed to increasingly sophisticated terrorist improvised explosive devices (IEDs)
  – Inadequate Information Dissemination

• **Enable near real-time dissemination of critical content to mobile users**
  – Deploy network to enable mobile users access to semantic web
  – Near real-time Tactics, Techniques & Procedures (TTP) generation and dissemination

• **Reduce Cost for Procedural Instructional Content**
  – Provide a system to author and publish contextualized content to multiple form factors – “*author once publish many*”
Context: IED US Fatalities By Month

Source: http://icasualties.org/oif/IED.aspx
Context: JEOD Decision Support System (DSS) - Globally Deployable

Map showing various locations around the world with icons representing JEOD Core Sites, JEODNET Gateways, EOD Detachments, Operational Commanders, Coalition Partner Detachments, and Civilian or Non-DoD Government Entities.
JEOD DSS Context

- Joint Explosive Ordnance Disposal (JEOD) Advanced Concept Technology Demonstration (ACTD) is placing new tools in the hands of EOD techs facing IED threats.

- JEOD techs will use the Decision Support System (DSS) to access “just-in-time” Job Aids.

- Job Aids help them learn/recall how to perform their mission.

- DRC developed tools which leverage Semantic Web technology to:
  - Reduce development costs of authoring Job Aids by dynamically composing Job Aids from procedural knowledge bases on the fly.
  - Enable “just-in-time” training with tailored instructions based on current conditions (e.g., user roles, weather, location, mission phase, etc.).
JEOD DSS Overview

Network-Centric JEOD Training, Support, and Operations enabled by the JEOD Decision Support System

Empowering the operational JEOD community's response Teams to counter threats...

...with advanced automated tools and connectivity...

...to the training and support communities

DoDAF OV-1
Semantic Web Research and Dynamic Job Aid System (DJAS) Demonstration

Funded by DARPA
• Member of DARPA Agent Markup Language (DAML) research team
  – Focus on military applications of semantic web technology

• Leveraged our Training & Performance Support Business Solution
  – Training/Task Analysis
  – High Performance Team Training
  – Interactive Multimedia Instruction
  – Automated Training Management

• Developed Dynamic Job Aid System (DJAS)
  – Instantiated the system with Joint Explosive Ordnance Disposal (JEOD) related content:
    • Tactics, Techniques, and Procedures (TTPs)
Dynamic Job Aid System (DJAS)

• Proof-of-principle demonstration for filtering and formatting JEOD TTPs using Semantic Web markup

• Goals
  – Domain agility
  – Separation of content from format
  – Context-based filtering (dynamic)
  – Standard representations support sharing and inferencing

• Demonstration
  – Auto-author procedural-based instructional information
  – Content contextualized in real-time
  – Content used for just-in-time warfighter training while in the field
Dynamic Job Aid System (DJAS) Demonstration
The Semantic Web is the new evolution of the World Wide Web supported by ontologies.

Ontologies formally specify concepts and their relationships to other concepts.

- When classes, subclasses, and relationships among entities expressed in an ontology are defined, they provide a very powerful medium for assisting in the interpretation of the data by software agents.
- Ontologies can be encoded using the Web Ontology Language (OWL) which received W3C Recommendation Status in 10 February 2004.
  - OWL is built on XML/RDF, adding structure to web content that is required to support automated reasoning.

A set of related ontologies form the foundation of the semantic web.
Semantic Web Standards Layers

- Applications
  - Ontology Languages (OWL Full, OWL DL, and OWL Lite)
  - RDF Schema
  - RDF and RDF/XML
  - XML and XML Schema
  - URIs and Namespaces

- Implementation Layer
- Logical Layer
  - Ontological Primitive Layer
  - Basic Relational Language Layer
  - Transport/Syntax Layer
  - Symbol/Reference Layer

Figure © Lee W. Lacy - 2005
Dynamic Job Aid System (DJAS) Concept Diagram

- **Domain**
  - Condition-based Formatted Delivery
  - Content Authoring Effort

- **Delivery Tools**
- **Procedural Knowledge Base (RDF)**
  - Content Read by Software
  - Compliant with

- **Procedural Knowledge Ontology (OWL)**
  - Step 2
  - Step 3
DJAS Web Services

- **Filter Web Service**
  - Based on current conditions

- **Format Web Service**
  - Based on form factor (e.g., handheld, tablet PC) and desired presentation method
Filter TTP XML Web Service

Retrieves

TTP (RDF)

Filtered TTP (RDF)

Conform to

TTP Ontology

LEGEND

① Client Filter Request with:
  • Defined RDF TTP URL
  • Defined ConditionNodeSet

② Filter Web Service Response with:
  • URL for Filtered RDF TTP
LEGEND

3 Client Format Request with:
   • Defined RDF TTP URL
   • Defined FormatType

4 Format Web Service Response with:
   • URL for XHTML Formatted TTP

5 Client Format Request with:
   • Defined RDF TTP URL
   • Defined Index

6 Format Web Service Response with:
   • URL for XHTML Hyperlinked Indexes

DJAS Format Web Service Component Interaction Diagram

CLIENT

Format TTP XML Web Service

Retrieves

Filtered TTP (RDF)

Conforms to

TTP Ontology

Creates

XHTML
JEOD KTOD ACTD
Decision Support System (DSS)

Funded by JEOD KTOD ACTD
Evolution of DJAS to JEOD KTOD ACTD Decision Support System

• JEOD Advanced Concept Technology Demonstration (ACTD) recognized the potential of DJAS

• JEOD funded DRC to evolve DJAS into a Reference Assistant Tool (RAT) and to also develop a Content Authoring Tool (CAT)

• RAT is part of the Mobile Field Kit (MFK) of the JEOD Decision Support System (DSS) while CAT supports the content authoring in the Portal

• Initial DJAS TTP Ontology evolved to a suite of ontologies:
  – Mission Ontology
  – Content Ontology
  – Condition Ontology
Military Learning Objective

- Provide contextualized Just-In-Time (JIT) training of procedural content to warfighters while in the field.
Mobile Field Kit (MFK) Technology

Standoff Distance = max of HERO UNSAFE distance for wearable breadcrumb and N5’s.
Military Learning Solution

- Identified “just in time” instructional content needed by EOD Techs

- Created ontology suite representing instructional (job aid) material

- Developed a capture tool as part of the JEOD Portal that allows distributed authors to create hyperlinked content by populating a database that generated RDF/XML files compliant with ontology suite

- Created instructional component of the JEOD DSS allowing learners to retrieve context-sensitive (conditions based) training on-the-fly in multiple formats
“Just In Time” Instructional Content

- Content identified for use in the field by warfighters are Tactics, Techniques, & Procedures (TTPs) for Improvised Explosive Devices (IEDs)

- The TTPs may only be applicable to certain Universal Joint Task List (UJTL) conditions (ex: weather, terrain, light)
JEOD Ontology Suite

• Developed a set of ontologies to capture the JEOD IED domain

• Ontologies developed describe Mission, Content, and Conditions

• Ontology design documentation used UML-like notation

• Ontology design was used to evolve the design of the database used in the authoring of content
Mission Ontology Classes
- Mission
- Sub-Mission
- Threat Response Category
- Phase
- Sub-Phase
- Task
Content Ontology Design

• **Content Ontology Classes**
  - Task
  - Step
  - Content Item
Condition Ontology Design

- **Condition Ontology Classes**
  - Condition
  - Condition Group
  - Condition Descriptor
Knowledge Harvesting and Dissemination
Content Authoring Tool (CAT)
J2EE Portlet

Funded by JEOD KTOD ACTD
Content Authoring Tool

• Developed a Content Authoring Tool portlet on the JEOD Portal that allowed distributed authors to create TTP content

• Authored TTP content populated an Oracle database that generated RDF/XML files compliant with the JEOD ontology suite

• Content Authoring Tool (CAT) allowed authors to assign conditions to the developed content
Content Authoring Tool
Add Steps – Sub Steps
Content Authoring Tool
Add Step - Conditions


DISCLAIMER: JEODNet Portal DEVELOPMENT VERSION
Welcome, Karen Frantz!
Content Authoring Tool
Add Task - Steps

1. Task Name:
2. Task Keywords:
3. Step Name:
4. Add
5. Clear
6. Up
7. Down
8. Delete
9. Delete All
10. Save
Cancel
Reference Assistant Tool (RAT) on JEOD DSS Mobile Field Kit

Funded by JEOD KTOD ACTD
Reference Assistant Tool

- Enables the warfighter to search the knowledge base for instructional content

- The search results are filtered based on system conditions

- The RAT allows the user to retrieve context-sensitive (condition based) training formatted on-the-fly based on the users’ form factor

- The user is allowed to override system conditions which triggers a real-time re-authoring of the training materials
Reference Assistant Tool (RAT) Solution

- Resides on Mobile Field Kit (MFK)
  - part of the JEOD Decision Support System (DSS)
  - installed on Tablet PC platform
- Searches knowledge base for instructional content requested by warfighter (mobile user)
  - speech to text capability
  - natural language processing capability
- Filters search results based on current conditions
  - MFK can receive condition updates from sensors
- Retrieves context-sensitive training formatted for user’s form factor on-the-fly
- Triggers immediate re-authoring of the training materials based on user’s decision to override current conditions
Reference Assistant Tool (RAT) Demonstration

1. **Search History**: User is able to move back and forth through search history.
2. **TTP Content**: Tactics, Techniques, and Procedures are available for searching.
3. **Legacy Content**: More supported formats for searching: XML, HTML, XHTML, RDF, PDF, DOC, XLS, PPT, TXT, RTF.
4. **Lexicon Terms**: Terms and definitions from the default EOD lexicon available for searching.
5. **Read Results**: Results can be read aloud.

The figure illustrates the user interface of the Reference Assistant Tool, with features explained in the text. The tool allows users to search through various types of content, including TTP, legacy, and lexicon terms, and provides tools for reading the results aloud.
Reference Assistant Tool (RAT) Demonstration

1. Navigation
   User can navigate through content similar to web browsers.

2. Browser
   Standard browser (IE or Firefox) is embedded. This allows for more types of content to be displayed and abides by a common look and feel for the end user.

3. Read
   Content can be read aloud. Multiple formats supported (HTML, XML, XHTML, PDF, RTF, PPT, TXT, and XML).
Reference Assistant Tool (RAT) Demonstration

1. Navigation:
   User can navigate through tactics, techniques, and procedures similar to web browsers.

2. TTP Content:
   User can view tactics, techniques, and procedures.

3. Read:
   Tactics, techniques, and procedures can be read aloud.

4. Conditions:
   User can adjust current conditions on-the-fly to update tactics, techniques, and procedures for environment.

5. Feedback:
   Users can provide feedback on tactics, techniques, and procedures.

6. Conditions:
   Conditions can be set in general for tactics, techniques, and procedures so that all content can be filtered appropriately.
Summary

• Challenge
  – Save Warfighter Lives
  – Reduce Cost for Procedural Instructional Content

• Context
  – IEDs constantly evolving
  – JEOD ACTD – globally deployable DSS

• Military Learning Objective
  – Provide contextualized JIT training to warfighters in the field

• Semantic Web Background
  – Next Evolution of the Web (OWL)
  – Standards Layers allow automation based on content

• Military Learning Solution
  – DJAS as a prototype
  – JEOD DSS design/development