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12-14 June 2007, at US Naval Academy, Annapolis, MD

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Semantic Web Technologies for Storing and Accessing Immediately Needed Training Data

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Gabriel Aviles
Karen Fraser
Wayne Randolph*

June 12-14, 2007

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**

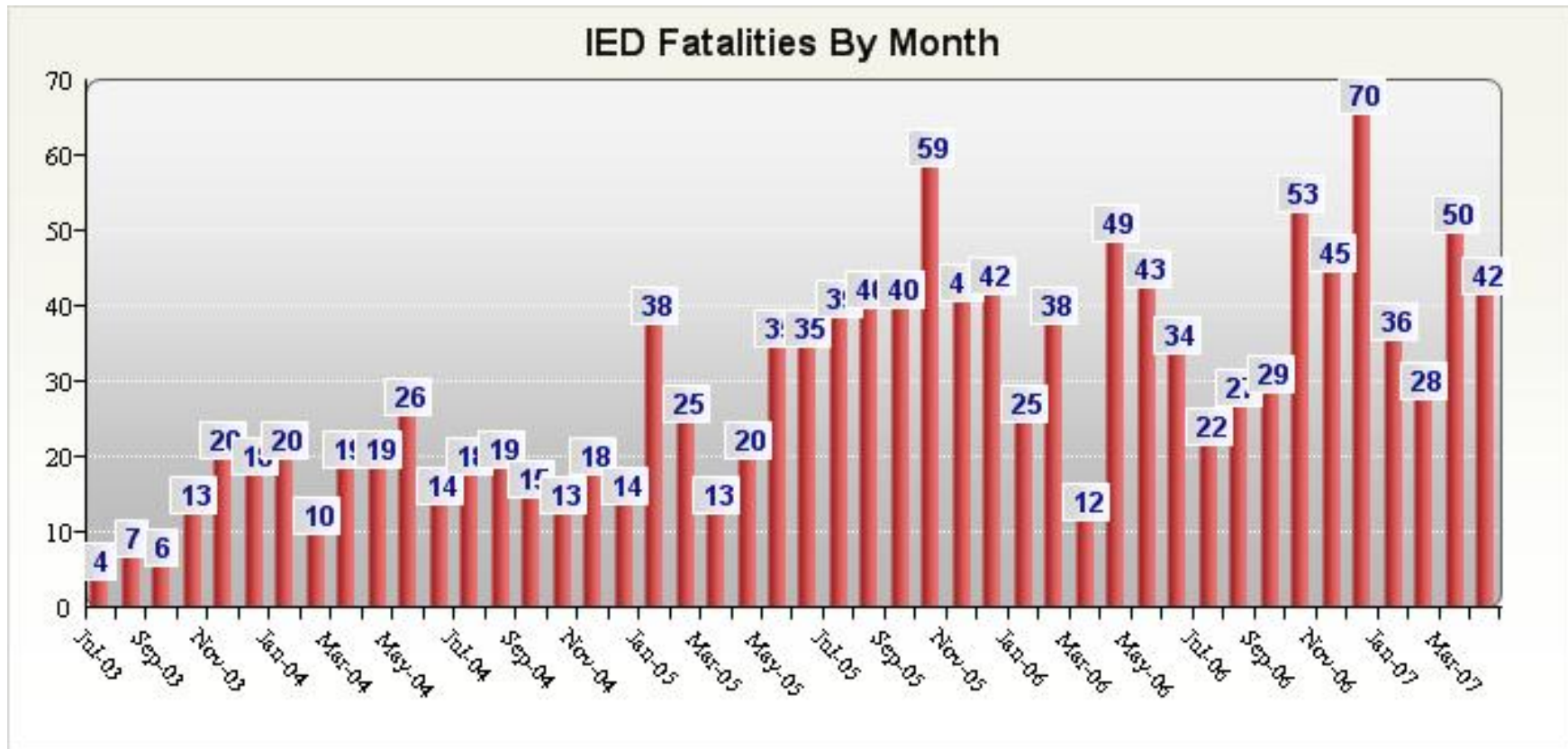


JEOD DSS Challenges

- **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”

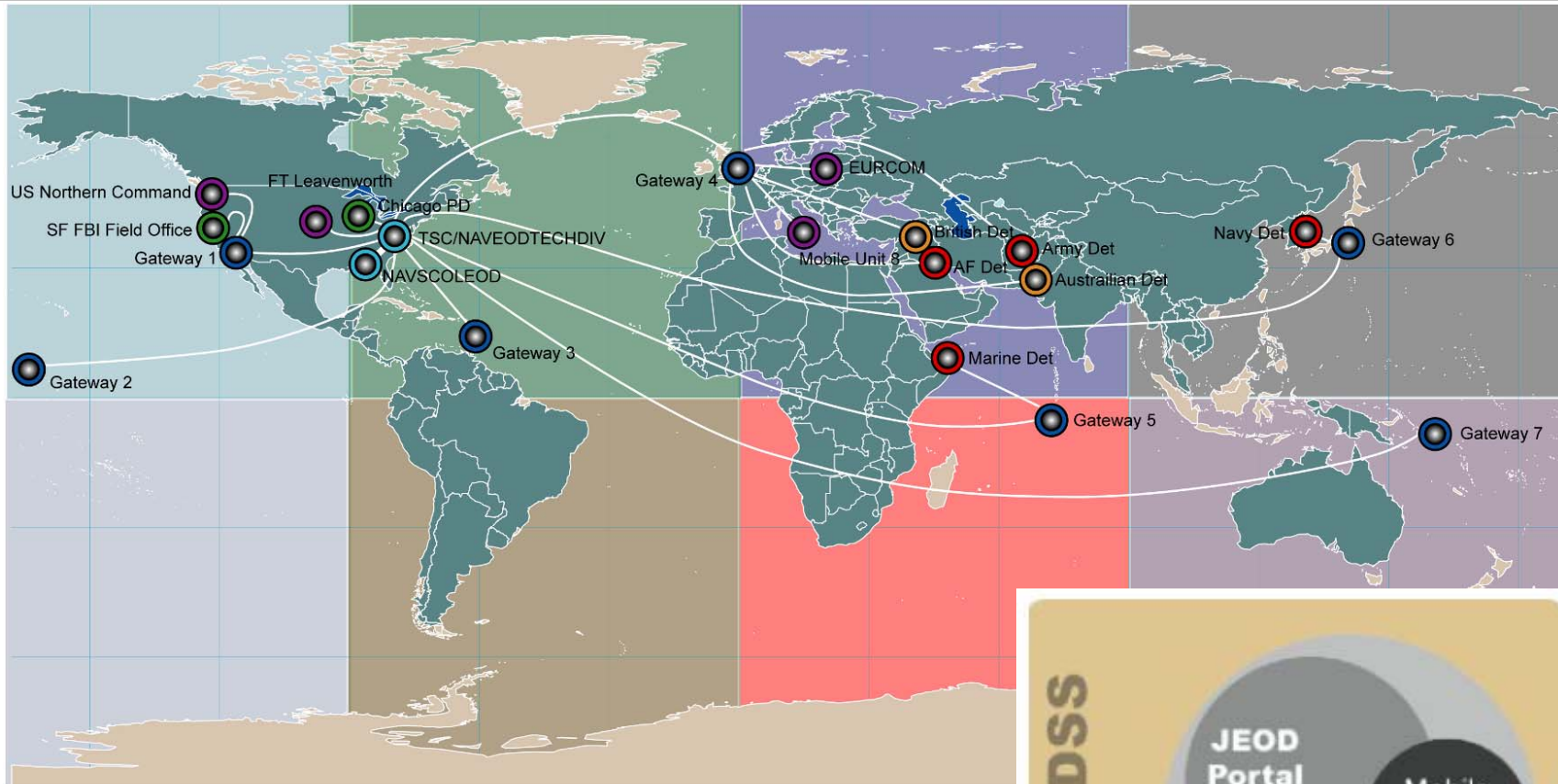


Context: IED US Fatalities By Month

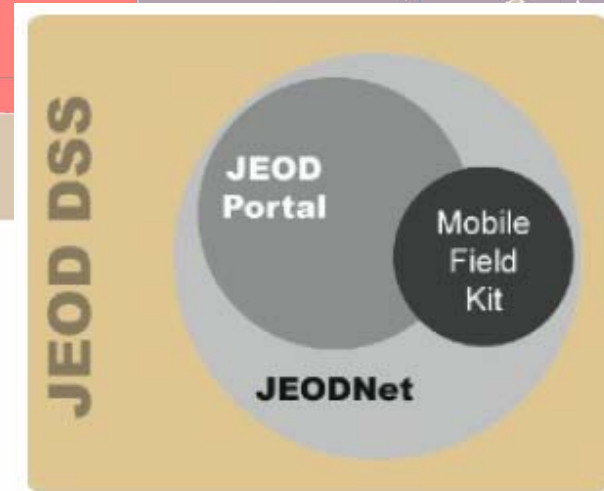


Source: <http://icasualties.org/oif/IED.aspx>

Context: JEOD Decision Support System (DSS) - Globally Deployable



-  JEOD Core Site
-  JEODNET Gateway
-  EOD Detachment
-  Operational Commander
-  Coalition Partner Detachment
-  Civilian or Non-DoD Government Entity



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

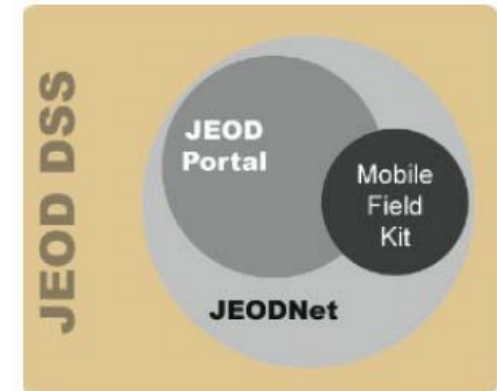
Network-Centric JEOD Training, Support, and Operations enabled by the JEOD Decision Support System

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

EOD Response Teams



Threats



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

JEOD Decision Support System

JEOD Portal



JEODNET Infrastructure



Mobile Field Kit



...to the training and support communities



Training Community



Support Community



Intelligence Community,
DoD Sites, and other
Government Agencies

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)

- **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



Dynamic Job Aid System (DJAS) Demonstration

Filtering and Formatting Selection

Select Conditions:

Domain:
ArrLoc-SuspPkg

User Role:
☒ Team Leader
☒ Master EOD Tech
☒ Primary Responder (P1)
☒ Secondary Responder (P2)

Filter Content

[View Source TTP](#)

[View RDF Condition List](#)

[View Filtered TTP](#)

Format Filtered Content:

Format Content

[View Checkbox Format](#)

[View Hyperlink Format](#)

[View Expanded Format](#)

[View Index Format](#)

Home Back

ArrLoc-SuspPkg

- ArrLoc-Hostage
- ArrLoc-Vehicle
- ArrLoc-SuspPkg
- ArrLoc-WMD
- RecID-SuspPkg-Manual
- RecID-Vehicle-Manual
- RecID-Vehicle-Remote
- RecID-WMD-Remote
- RecID-WMD-Manual
- Neut-Manual-GenDisrup
- Neut-Manual-SrgDisrup
- Neut-Manual-RemRemove
- Neut-Remote-GenDisrup
- Neut-Remote-SrgDisrup
- Neut-Remote-RemRemove
- Neut-Manual-Hostage

Dynamic Job Aid System

Arr/Loc:SuspPkg

- ☐ [Develop Multiple EOD Courses of Action](#)
- ☐ [Develop Multiple EOD Courses of Action](#)
- ☐ [Perform Risk Assessment for Each COA](#)
- ☐ [Perform Risk Assessment for Each COA](#)
- ☐ [Consider Wait Time \(Arrival\)](#)
- ☐ [Consider Wait Time \(Arrival\)](#)
- ☐ [Tool Selection \(Arrival\)](#)
- ☐ [Tool Selection \(Arrival\)](#)
- ☐ [Select Appropriate PPE](#)
- ☐ [Select Appropriate PPE](#)
- ☐ [Plan Easy Remote Approach](#)
- ☐ [Plan Easy Remote Approach](#)
- ☐ [Plan Safe Manual Approach](#)
- ☐ [Plan Safe Manual Approach](#)
- ☐ [Perform Team Brief](#)
- ☐ [Brief OSC \(Arrival\)](#)

Done Check All Check None

Dynamic Job Aid System

Arr/Loc:SuspPkg

Indexed View

A B C D E F G H I J K L M N O P Q
R S T U V W X Y Z

Dynamic Job Aid System

Arr/Loc:SuspPkg

Index - B

[Brief OSC \(Arrival\)](#)

[Brief entry team](#)

[Be alert for entrapment](#)

The Semantic Web Background

- **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

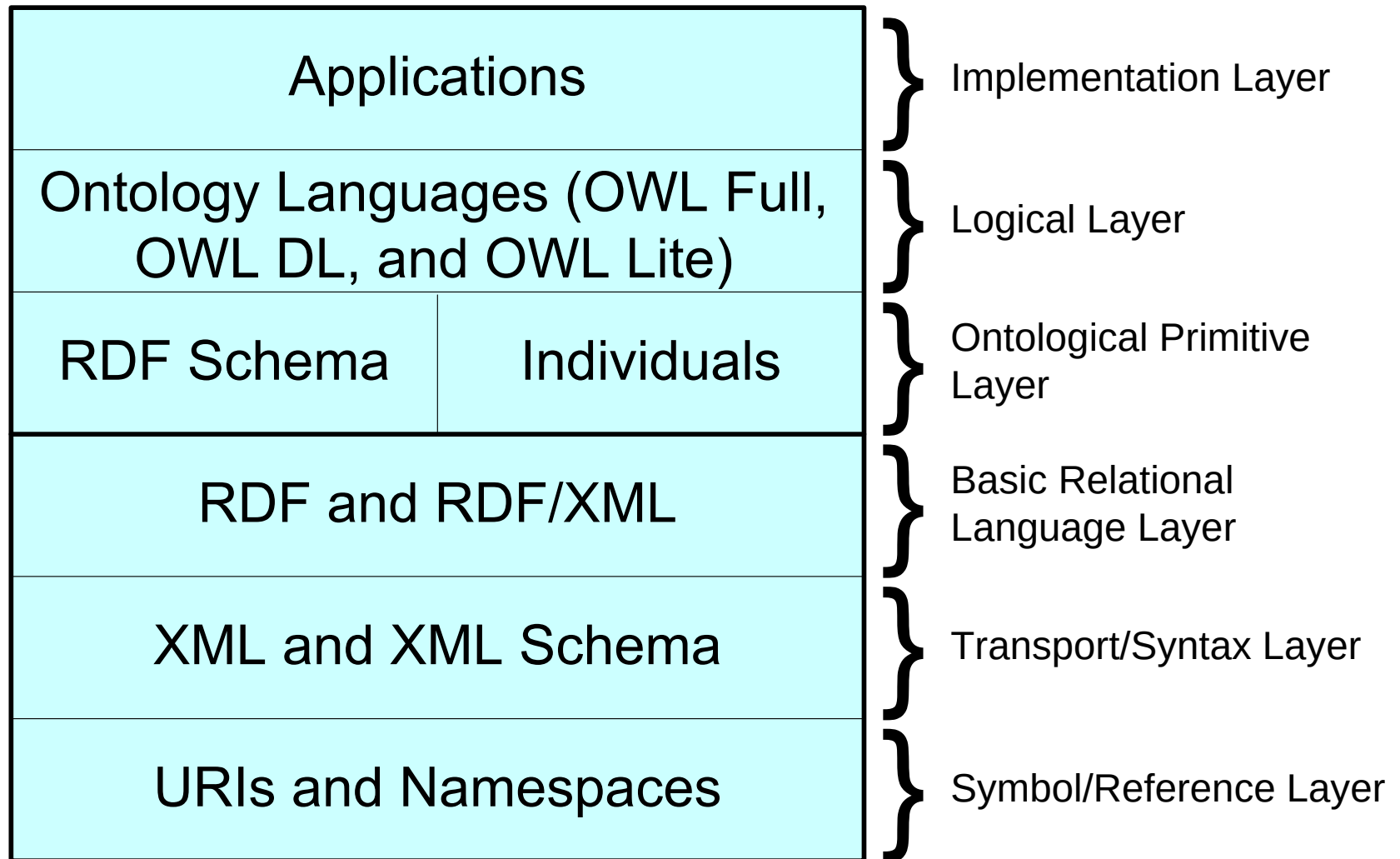
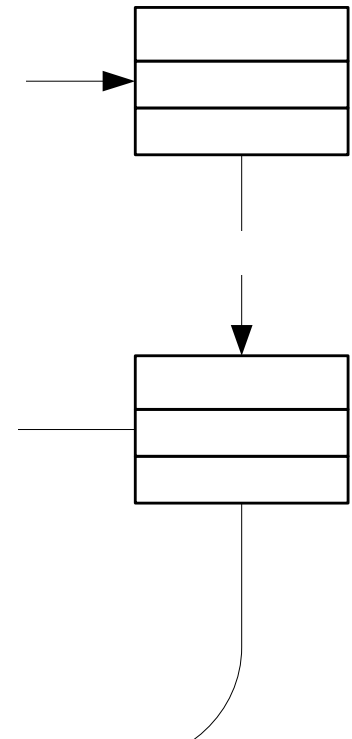
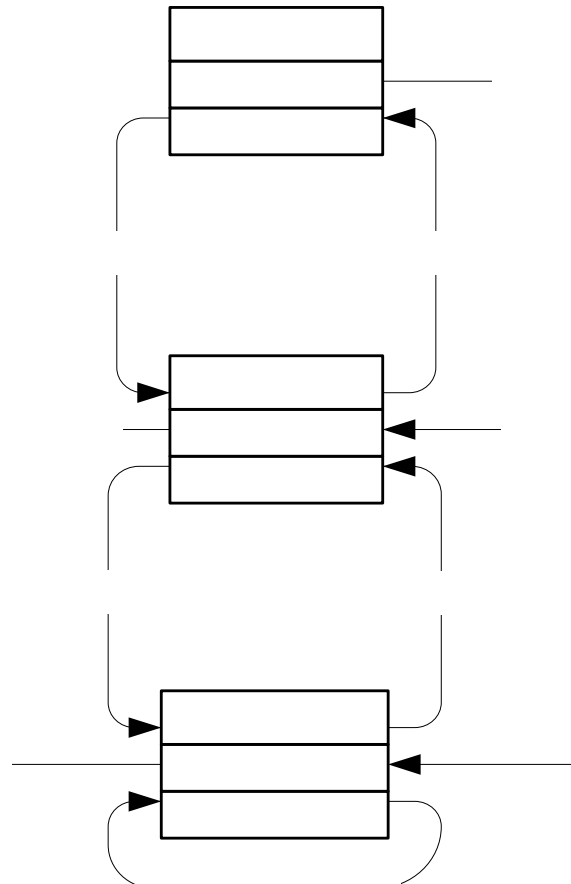
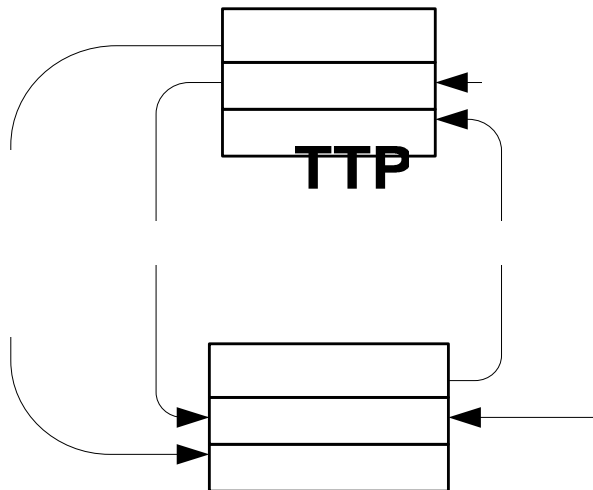
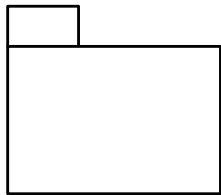
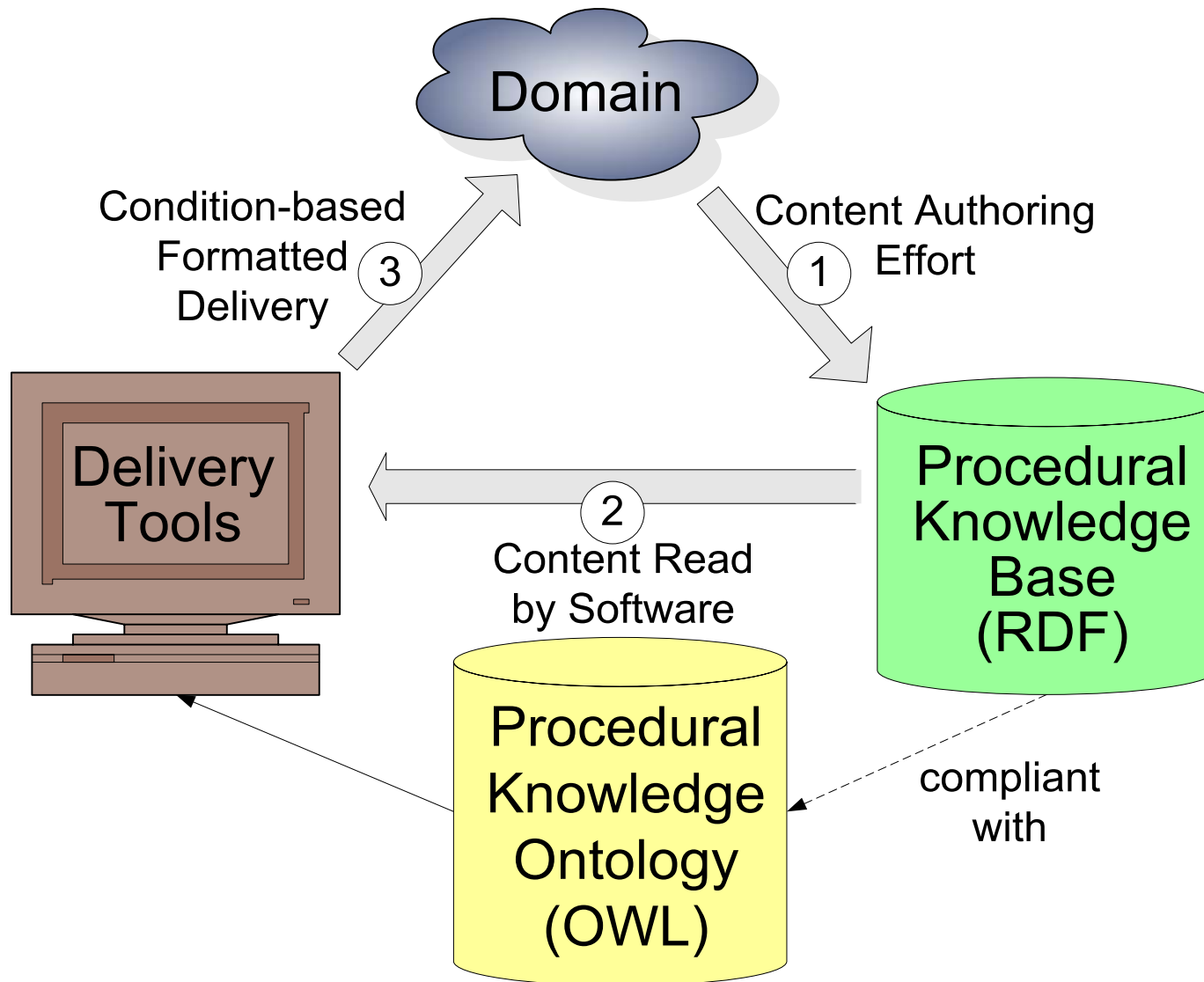


Figure © Lee W. Lacy - 2005

Tactics Techniques Procedures (TTP) Ontology Design



Dynamic Job Aid System (DJAS) Concept Diagram



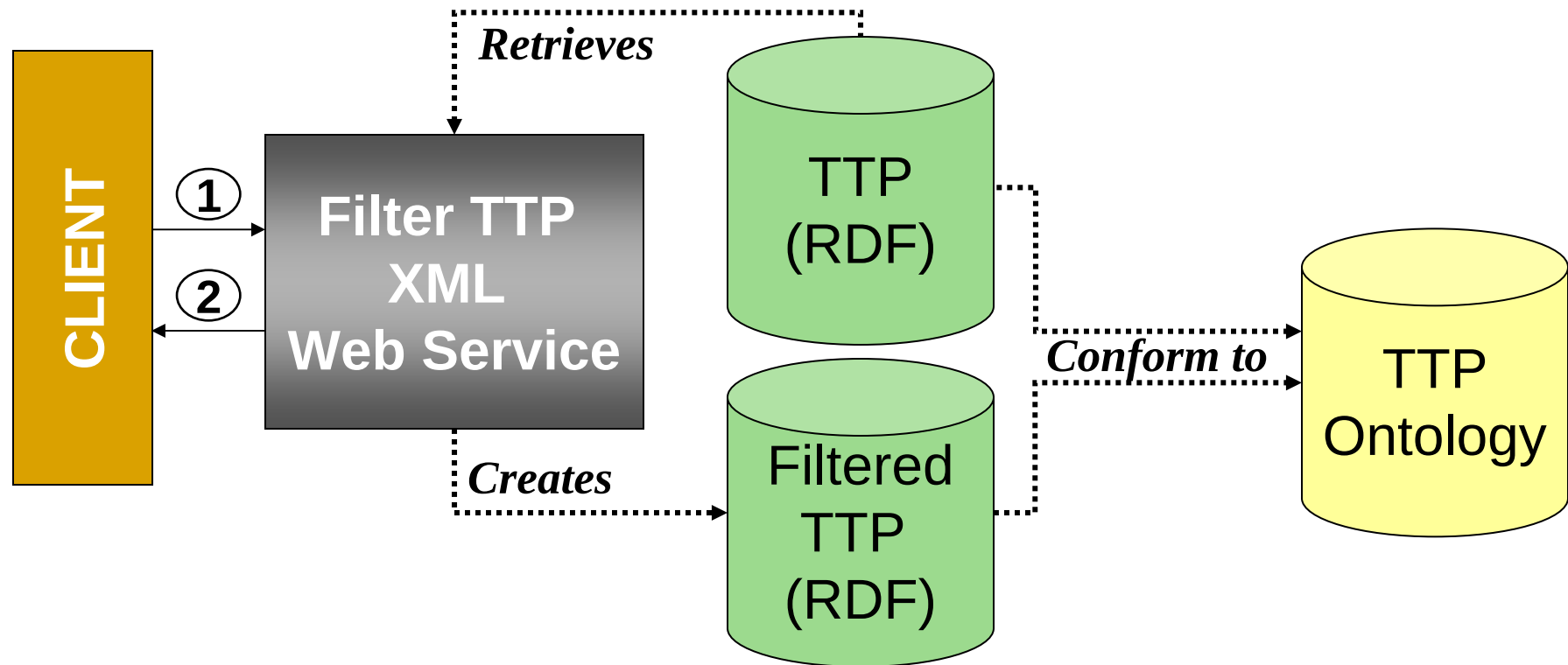
**Filter TTP
XML
Web Service**

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

**Format TTP
XML
Web Service**

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

DJAS Filter Web Service Component Interaction Diagram

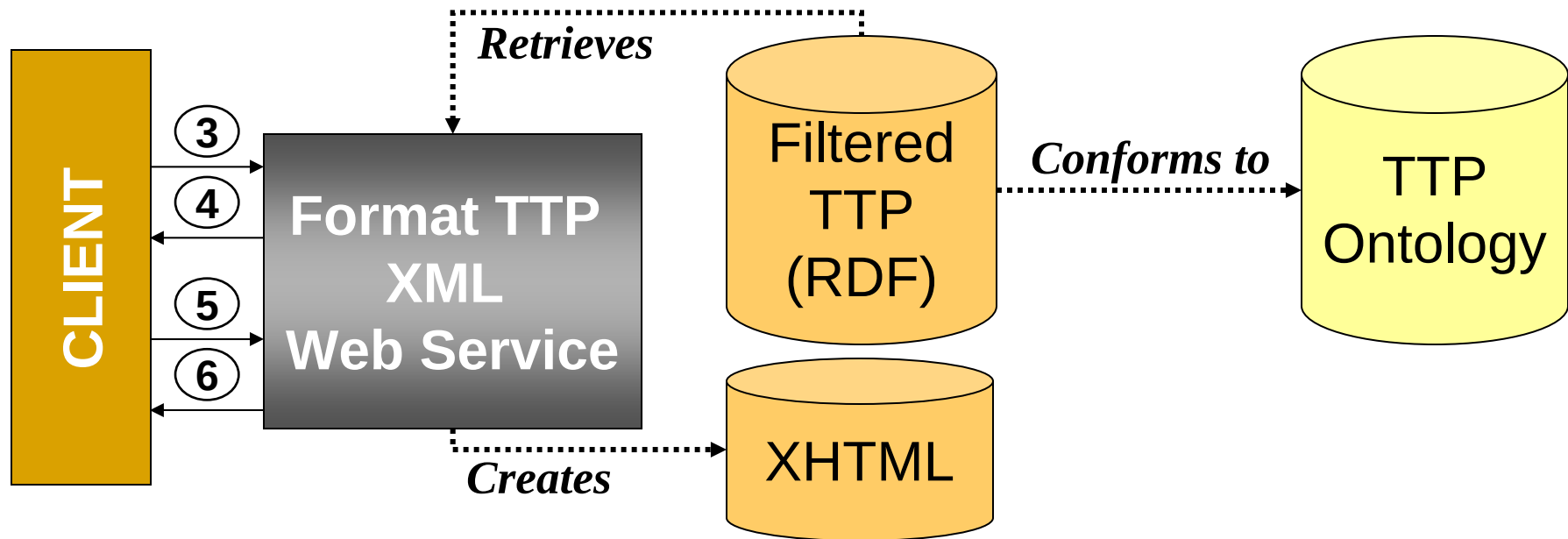


LEGEND

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

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

DJAS Format Web Service Component Interaction Diagram



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



JEOD KTOD ACTD Decision Support System (DSS)

Funded by JEOD KTOD ACTD



Evolution of DJAS to JEOD KTOD ACTD Decision Support System

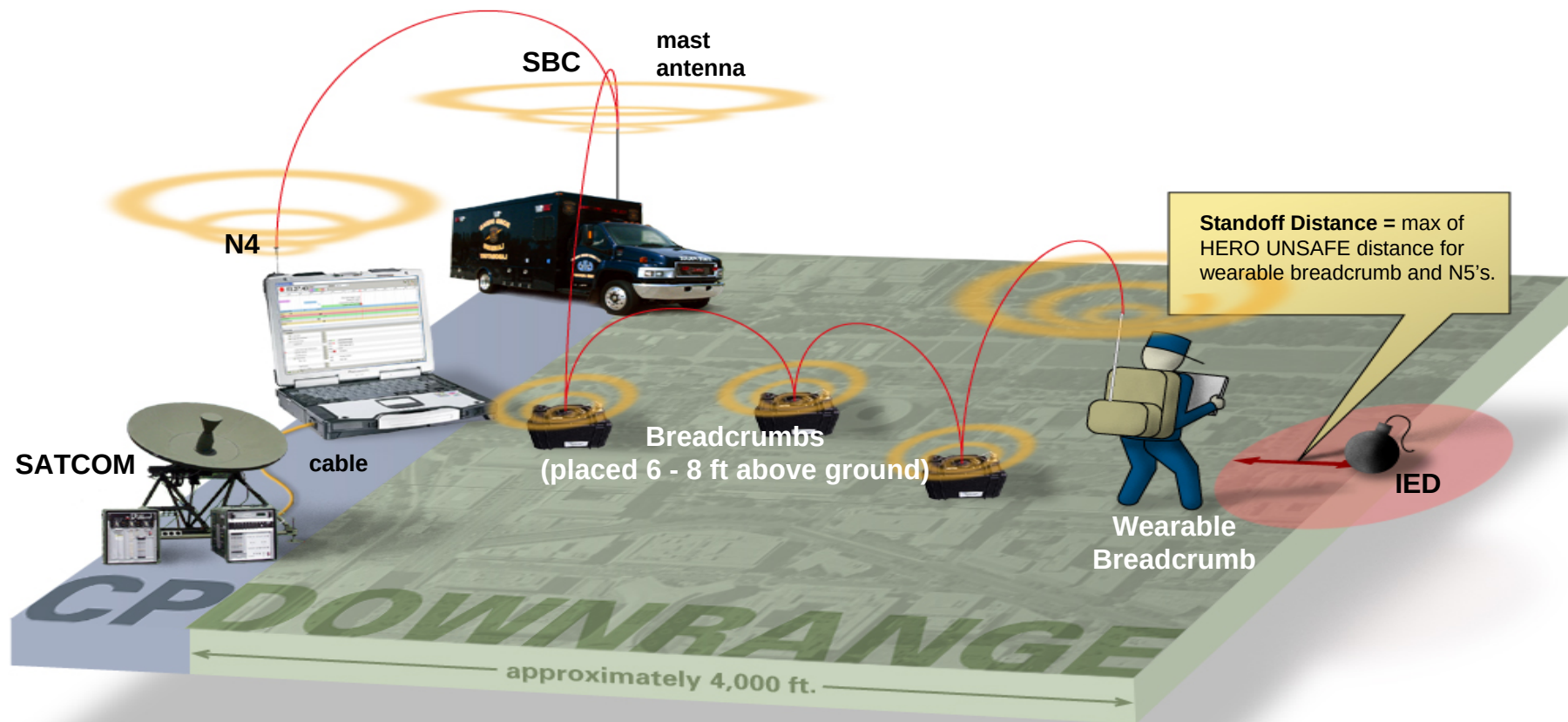
- **JEOD Advanced Concept Technology Demonstration (ACTD) recognized the potential of DJAS**
- **JEOD funded DRC to evolve DJAS into a Reference Assistant Tool (RAT) and to also develop a Content Authoring Tool (CAT)**
- **RAT is part of the Mobile Field Kit (MFK) of the JEOD Decision Support System (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



- 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

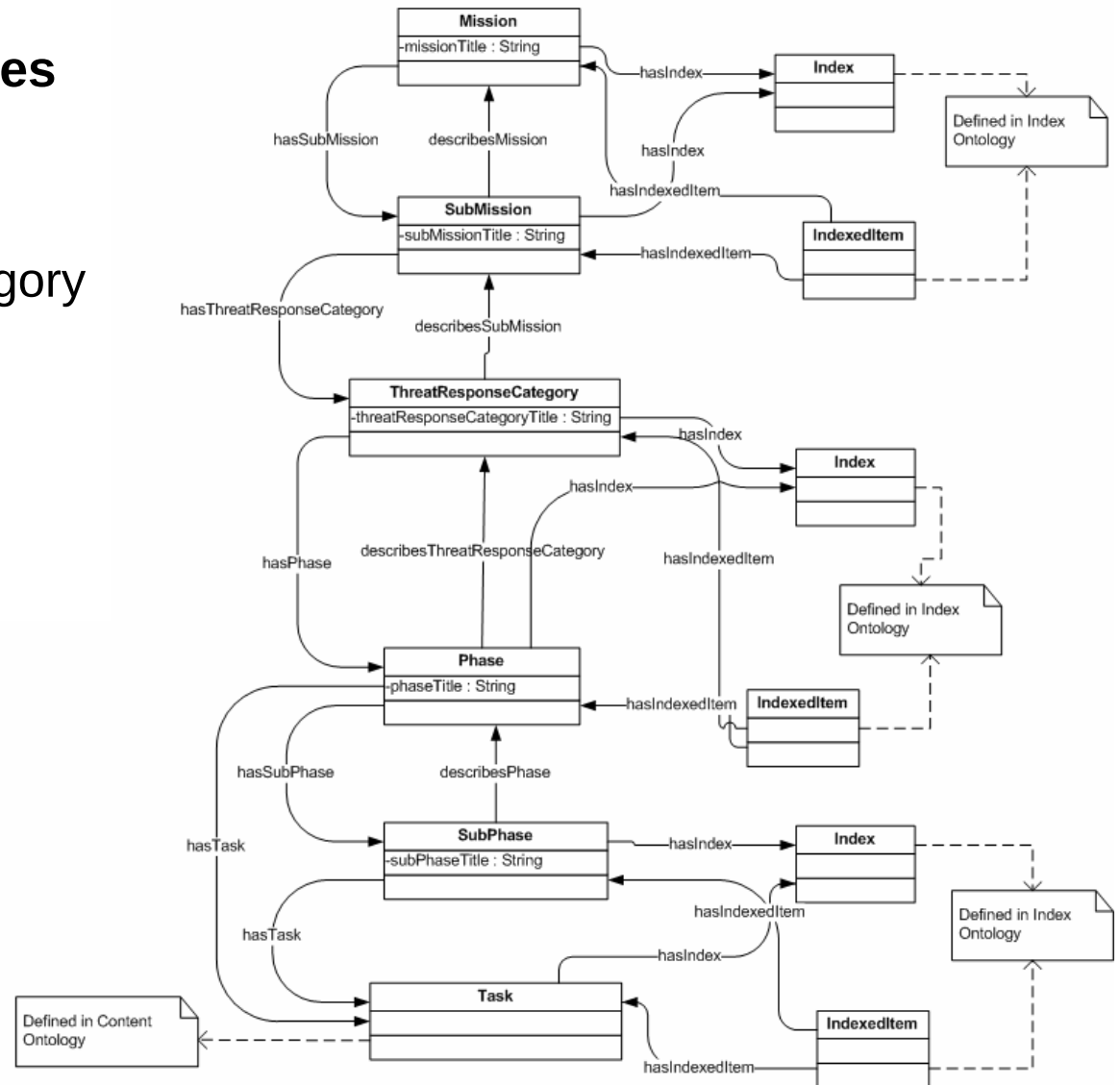
- Content identified for use in the field by warfighters are Tactics, Techniques, & Procedures (TTPs) for Improvised Explosive Devices (IEDs)
- The TTPs may only be applicable to certain Universal Joint Task List (UJTL) conditions (ex: weather, terrain, light)



- **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**

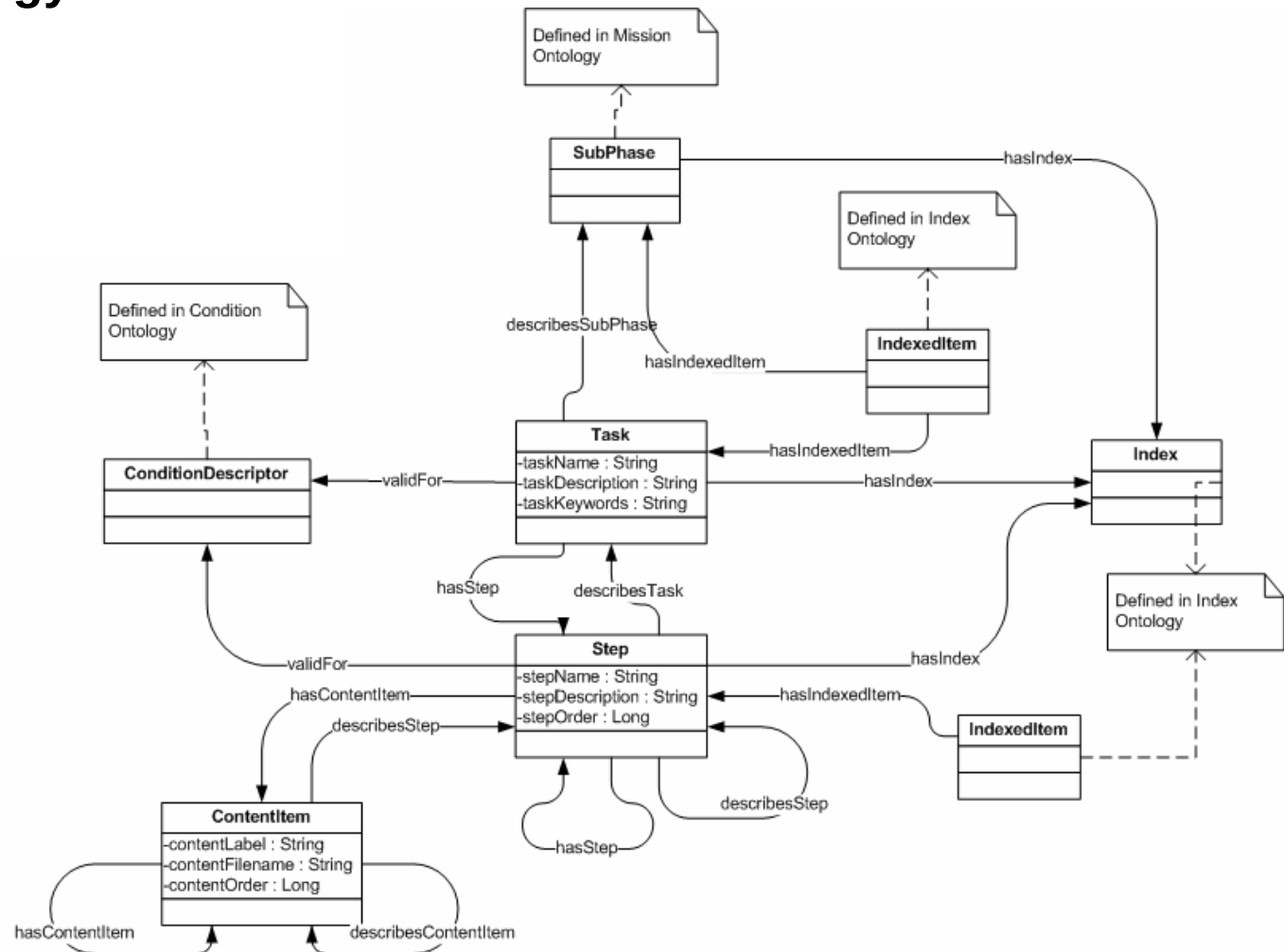
Mission Ontology Design

- **Mission Ontology Classes**
 - Mission
 - Sub-Mission
 - Threat Response Category
 - Phase
 - Sub-Phase
 - Task



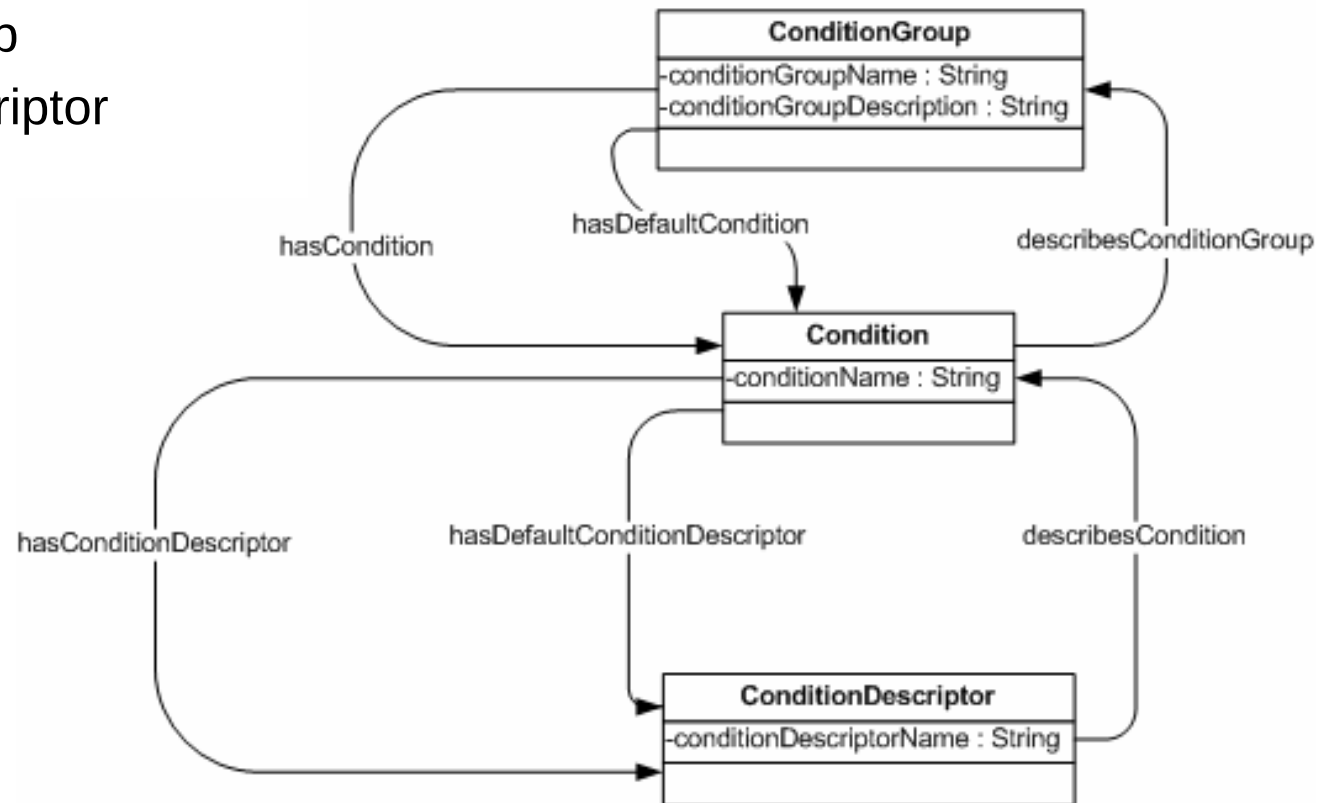
- Content Ontology Classes

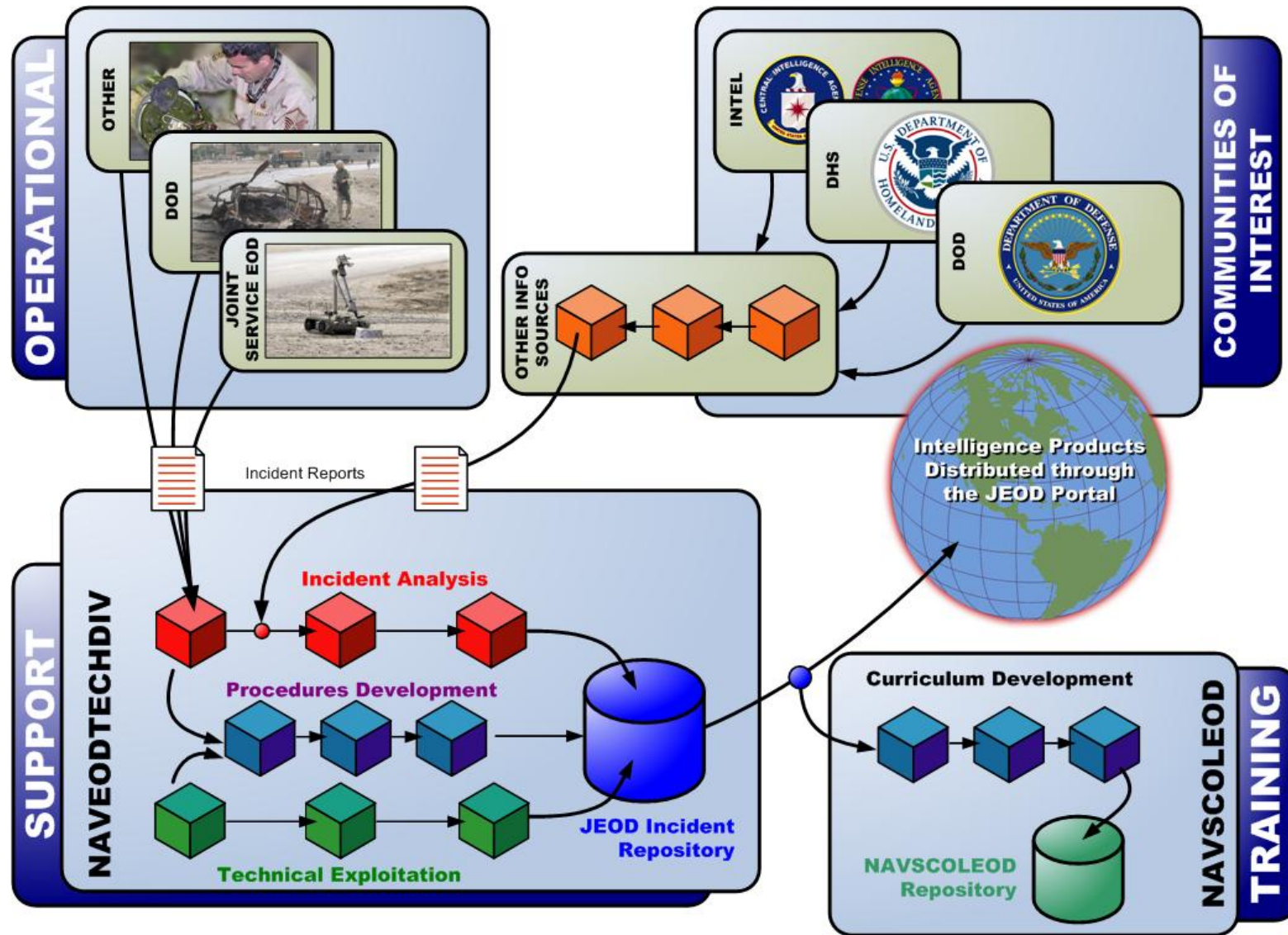
- Task
- Step
- Content Item



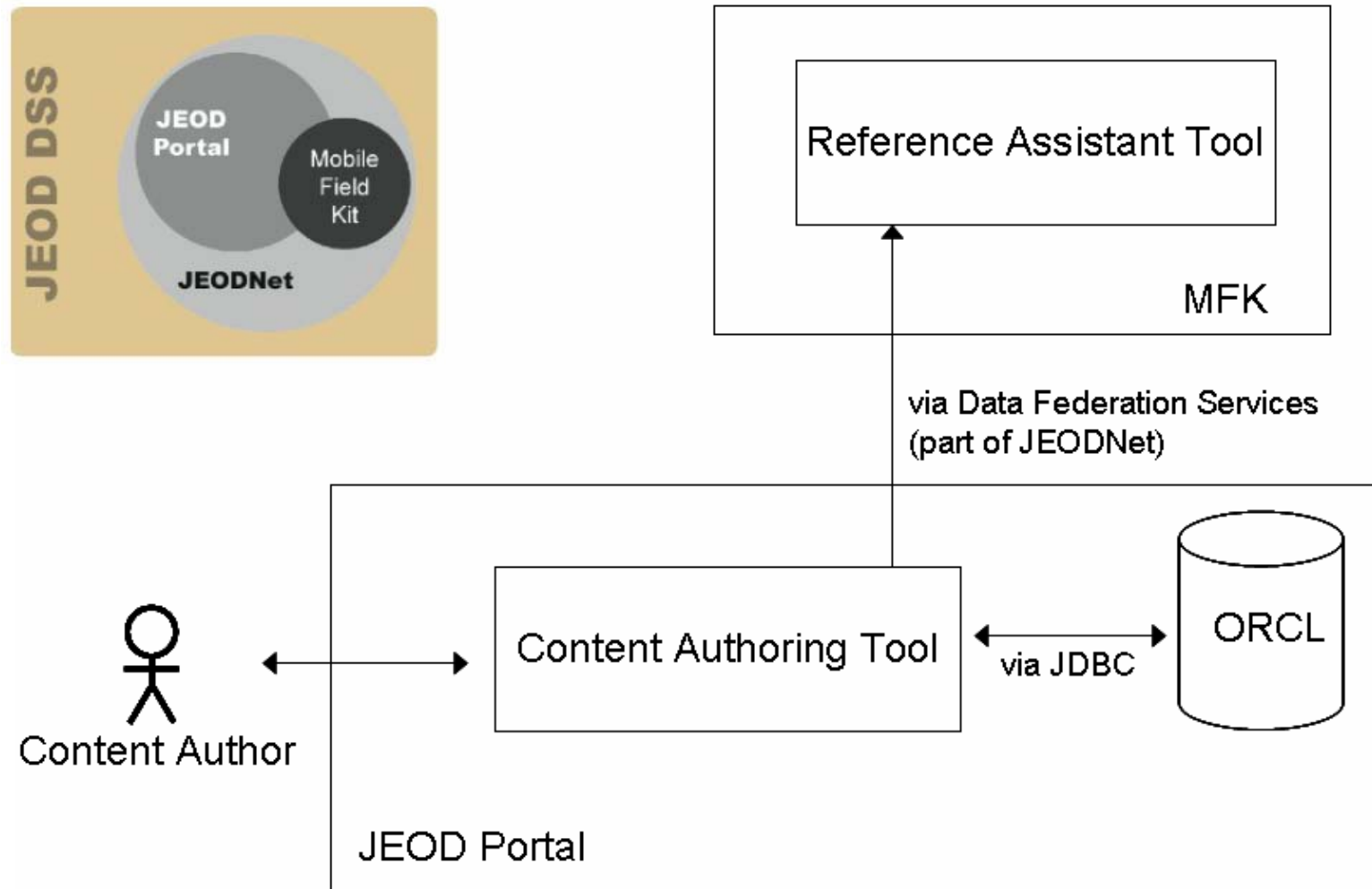
- **Condition Ontology Classes**

- Condition
- Condition Group
- Condition Descriptor





High Level Overview TTP based Tools



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

JEODNET

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Home IFIS ThinkMap AEODPS-NG GIS Lexicon **CAT**

Content Authoring Tool

[Step Information](#) [Task Information](#) [Organize Tasks](#) [List Maintenance](#) [Utilities](#) [Home](#)

Add Step

Step Name:

Sub-Steps Content Conditions References

Sub-Step Name

Sub-Step Name

Diagram illustrating the 'Add Step' interface with numbered callouts (1-9) indicating key components:

1. Step Name input field
2. Sub-Step Name input field
3. Add button
4. Clear button
5. Up/Down navigation buttons
6. Delete button
7. Delete All button
8. Save button
9. Cancel button

Content Authoring Tool

Add Step - Conditions

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Content Authoring Tool

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Add Step

Step Name:

Sub-Steps Content **Conditions** References

Condition Group

Condition

Condition Descriptor

Add Clear

Condition Group	Condition	Condition Descriptor

Delete

Delete All

Save Cancel

Annotations: 1 points to the 'Add Step' title; 2, 3, 4 point to the Condition Group, Condition, and Condition Descriptor input fields respectively; 5, 6 point to the Add and Clear buttons respectively; 7, 8 point to the Delete and Delete All buttons respectively.

Content Authoring Tool

Add Task - Steps

JEODNET

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Content Authoring Tool

[Step Information](#) [Task Information](#) [Organize Tasks](#) [List Maintenance](#) [Utilities](#) [Home](#)

Add Task

Task Name:

Task Keywords:

Steps Conditions References

Step Name

Add Clear

Up Down

Step Name

Delete Delete All

Save Cancel

1 2 3 4 5 6 7 8 9 10

Content Authoring Tool

Add Task - Conditions

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Content Authoring Tool

[Step Information](#) [Task Information](#) [Organize Tasks](#) [List Maintenance](#) [Utilities](#) [Home](#)

Add Task

Task Name:

Task Keywords:

Steps **Conditions** **References**

Condition Group

Condition

Condition Descriptor

Add Clear

Condition Group Condition Condition Descriptor

Delete

Delete All

Save Cancel

1

2

3

4

5

6

7

8

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**

- **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

search history 1

User is able to move back and forth through search history.

TTP content 2

Tactics, Techniques, and Procedures are available for searching.

legacy content 3

More supported formats for searching: XML, HTML, XHTML, RDF, PDF, DOC, XLS, PPT, TXT, RTF.

lexicon terms 4

Terms and definitions from the default EOD lexicon available for searching.

read results 5

Results can be read aloud.

The screenshot shows the Reference Assistant Tool (RAT) interface within a 'Mobile Field Kit - Incident #1; User, D' window. The interface includes a menu bar (File, View, Plugins, Options, Help) and a toolbar with various icons. The main search area has a 'Search for:' field containing the text 'how do I use a remote adapter'. Below this, a dropdown menu is set to 'All Content'. The search results are categorized into four sections: TTP Content, Legacy Content, and Lexicon Content. The TTP Content section lists two results: '1) ...TSK1058557779264.rdf....TTP content' with a score of 9.0%, and '3) ...STP1061323255932-d4e52.rdf....TTP content' with a score of 8.0%. The Legacy Content section lists two results: '4) ...antennasdata.pdf....Legacy content' with a score of 8.0%, and '2) ...Antennas.pdf....Legacy content' with a score of 2.0%. The Lexicon Content section lists two results: '1. Mechanical. Any modifying part, piece, or device, designed to facilitate connection, provide accommodation, enable applic.' with a score of 100.0%, and '2. Electrical. An item that provides the necessary accommodations to electrically connect two or more items whose design o' with a score of 100.0%. At the bottom of the window, a status bar shows 'On-line', '82 / 138', 'x attachments', and a 'Command: --' field.

Reference Assistant Tool (RAT) Demonstration

navigation

1

User can navigate through content similar to web browsers.

browser

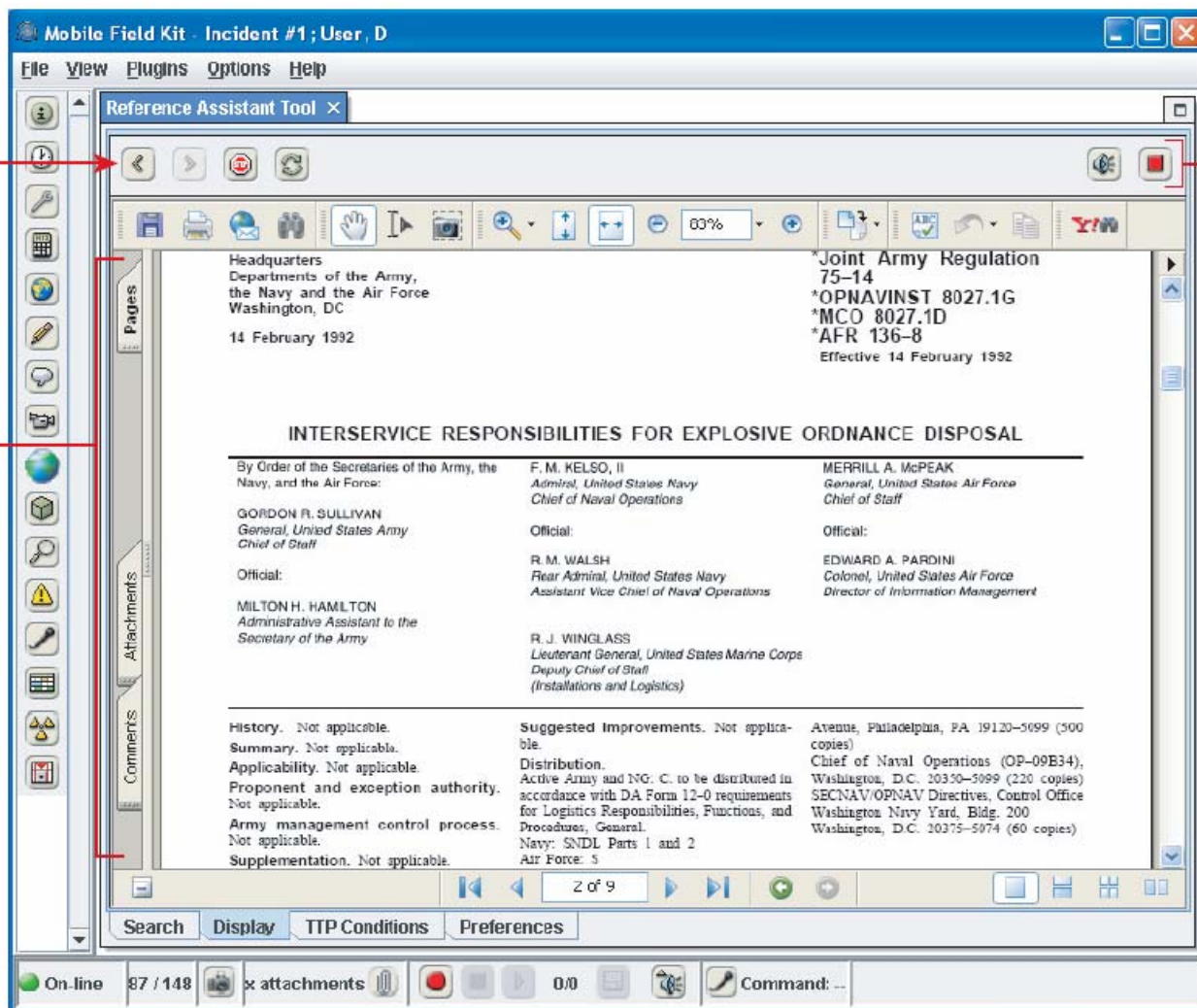
2

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.

read

3

Content can be read aloud. Multiple formats supported (HTML, XML, XHTML, RDF, PDF, RTF, PPT, TXT, and XLS).



The screenshot shows the Reference Assistant Tool (RAT) interface. The title bar reads "Mobile Field Kit - Incident #1; User, D". The menu bar includes "File", "View", "Plugins", "Options", and "Help". The main window displays a document titled "Reference Assistant Tool". The document content includes a header section with "Headquarters Departments of the Army, the Navy and the Air Force Washington, DC" and a date "14 February 1992". Below this is a section titled "INTERSERVICE RESPONSIBILITIES FOR EXPLOSIVE ORDNANCE DISPOSAL". The document is organized into a table with three columns, listing various officials and their roles. The bottom of the interface features a status bar with "On-line", "87 / 148", "x attachments", and a "Command: ..." field.

Reference Assistant Tool (RAT) Demonstration

The screenshot displays the Reference Assistant Tool (RAT) interface within the Mobile Field Kit. The interface is divided into several sections, each with a numbered callout:

- 1 navigation:** User can navigate through tactics, techniques, and procedures similar to web browsers. This points to the top navigation bar.
- 2 TTP content:** User can view tactics, techniques, and procedures. This points to the main content area showing 'SUB-PHASE: SuspPkg (PP)' and 'TASK: Plan Easy Remote Approach'.
- 3 read:** Tactics, techniques, and procedures can be read aloud. This points to the 'read' button in the top right corner.
- 4 conditions:** User can adjust current conditions on-the-fly to update tactics, techniques, and procedures for environment. This points to the 'CURRENT CONDITIONS' section, which includes a note about filtering content and options to select weather (Rainy, Sunny) and terrain type (Rocky, Sandy).
- 5 feedback:** Users can provide feedback on tactics, techniques, and procedures. This points to the 'CONTENT FEEDBACK' section, which includes a note about rating content and options to rate how useful the content was (Very, So So, Not At All).
- 6 conditions:** Conditions can be set in general for tactics, techniques, and procedures so that all content can be filtered appropriately. This points to the 'CURRENT CONDITIONS' section in a separate window, which shows the same options as the main window but with 'Sunny' selected for weather and 'Sandy' for terrain type.

The interface also includes a status bar at the bottom showing 'On-line', '81 / 138', 'x attachments', and a 'Command:' field.

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