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Actionable Knowledge Guided HTC Visualization

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Outline

I. Problem Statement
II. Introduction
III. System Overview
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I. Problem Statement

I. Problem Statement (1)

- Visualize Holistic Target Characterization
  - Focused on Commander's Objective
  - Provide an meaningful and intuitive visualization of the possibly very large HTC
- Ability to display interdependencies and non-obvious relationships
  - Allow users to navigate & manipulate high order links and nodes
  - Provide multi-modal visualization of links and nodes

II. Introduction

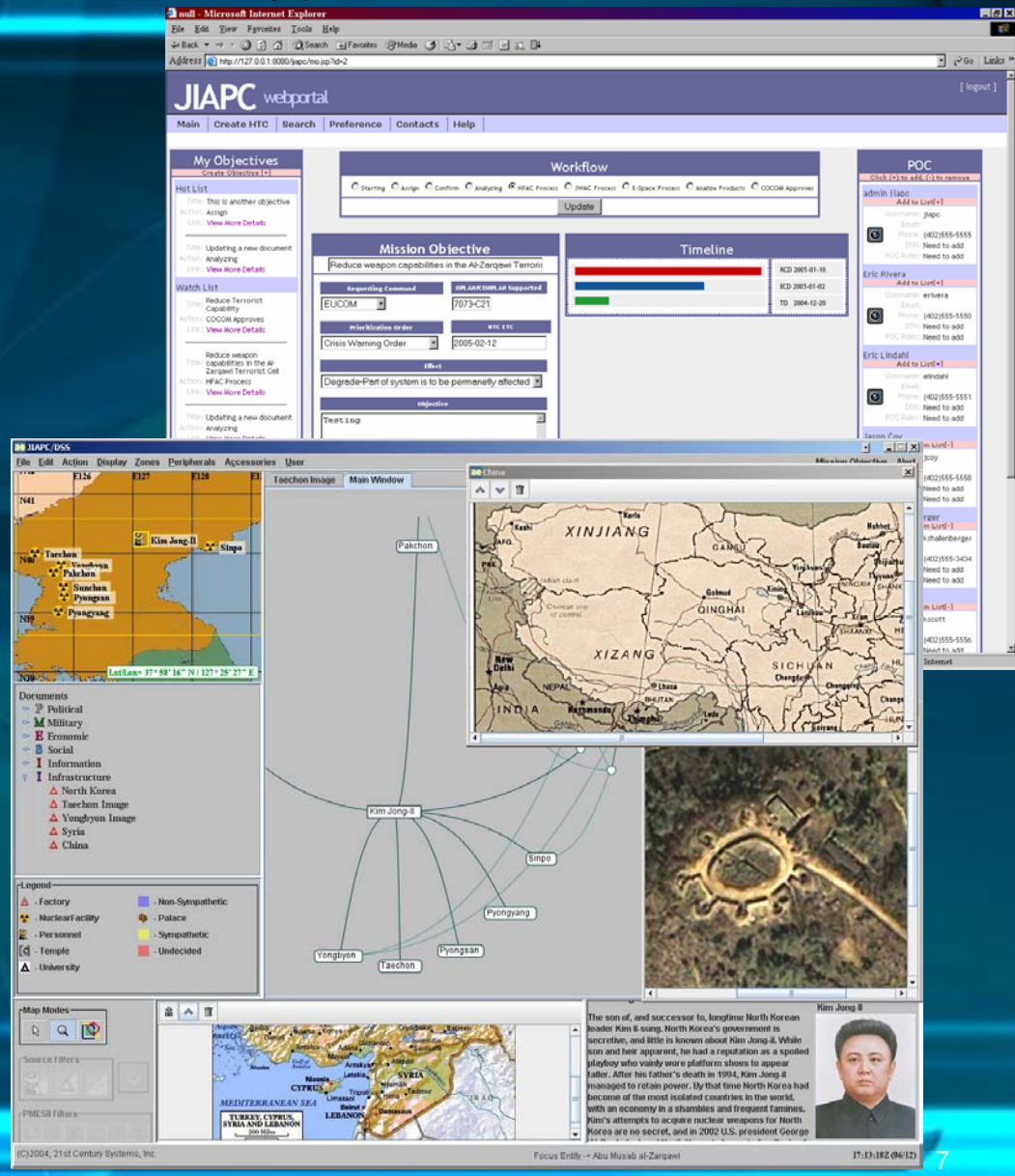
II. Introduction (1)

Project Requirements

- Two & Three Dimensional Depiction of Links/Nodes & Entities/Relationships
  - Must work across multiple data formats
  - Allow for N-dimensional link/nodes analysis
- Rapid Scanning of Documents at Multiple Security Levels for Potential Relevance to Established Objective and Alert User
- Ability to Drill Down Rapidly to Underlying Data/Analytical Products
- Ability to Access Planning Tools via Web Portal

II. Introduction (2)

- JIAPC will "...provide holistic analytical support to combatant commanders" - IO Roadmap.
  - Provide Holistic Target Characterization across the information, cognitive, and physical domains
  - Produce kinetic and non-kinetic options that facilitate the IO planning efforts of combatant command staffs
  - Decision Under Uncertainty
  - Offer all combatant commands connectivity to JIAPC knowledge base



Actionable Knowledge Guided Visualization

- **What is it?**
  - Simply, it's the maintenance of the commander's intent WRT the mission objective throughout the visualization process.
- What's in it for me?
  - Actionable knowledge allows more problems to be solved better, by both human and machine.
- How did you use it?
  - 21CSI used it to create the JIAPC Holistic Target Characterization Visualization; a multi-modal, semantic-based visualization

III. System Overview

III. SYSTEM OVERVIEW (1)

Major Concepts

1. ***Visualize Asymmetric Relationships***
   - Provide multi-modal semantic based visualization capable of showing relationships from amongst different types in different ways.

2. ***Facilitate Building Relationships***
   - Efficient integration of evidence from multiple disparate domains into the HTC.

3. ***Tools for Analyzing Non-Obvious High Order Relationships***
   - Propagating PMESII, or other weights in a meaningful way to analyze high order possibilistic structures.

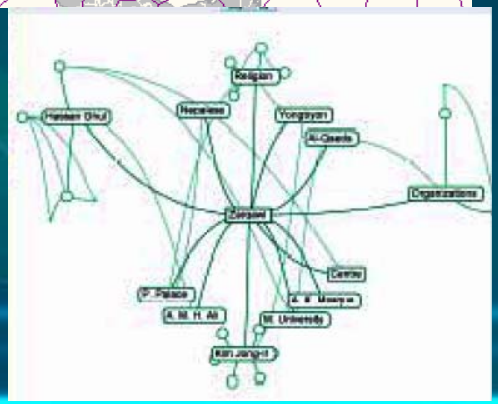
IV. TECHNIQUE DESCRIPTION

IV. Technique Description (1)

Key Technical Points

1. Knowledge Visualization

- **Knowledge Representation**
  - Multi-modal visualization for multiple SME ontologies, knowledge representations
  - Ontological structures used for semantically guided visualization
    - Required for AKGHTC
- **Semantic Distances**
    - If one can be built for a significant frame of discernment, then the knowledge can have semantic tessellation
      - Semantic tessellation
    - Helps graph visualization
      - Force directed visualization
      - Voronoi clustering
    - Open research problem
      - Chosen according to heuristics



IV. Technique Description (2)

"Up to my knee-pits in data…"

2. *Visualization Induced Malapropism*

- **Making a choice based on properties of the visualization rather than the data the visualization is supposed to represent.**
  Very real danger!

  – **Not the same as facile answers**
  – **What is 'apropos'?**
    - **It's the fitness to the *'true'* AK representation**

  – **Chaining based on large datasets may result in waste of resources, or worse, propagate into tasking.**

- **Malapropos 'Concept Checker'**

  – **Determine patterns of malapropisms**
  – **Requires a ontological changes**
  – **Very hard for cross-discipline CIE**

IV. Technique Description (3)

3. Actionable Knowledge Representation

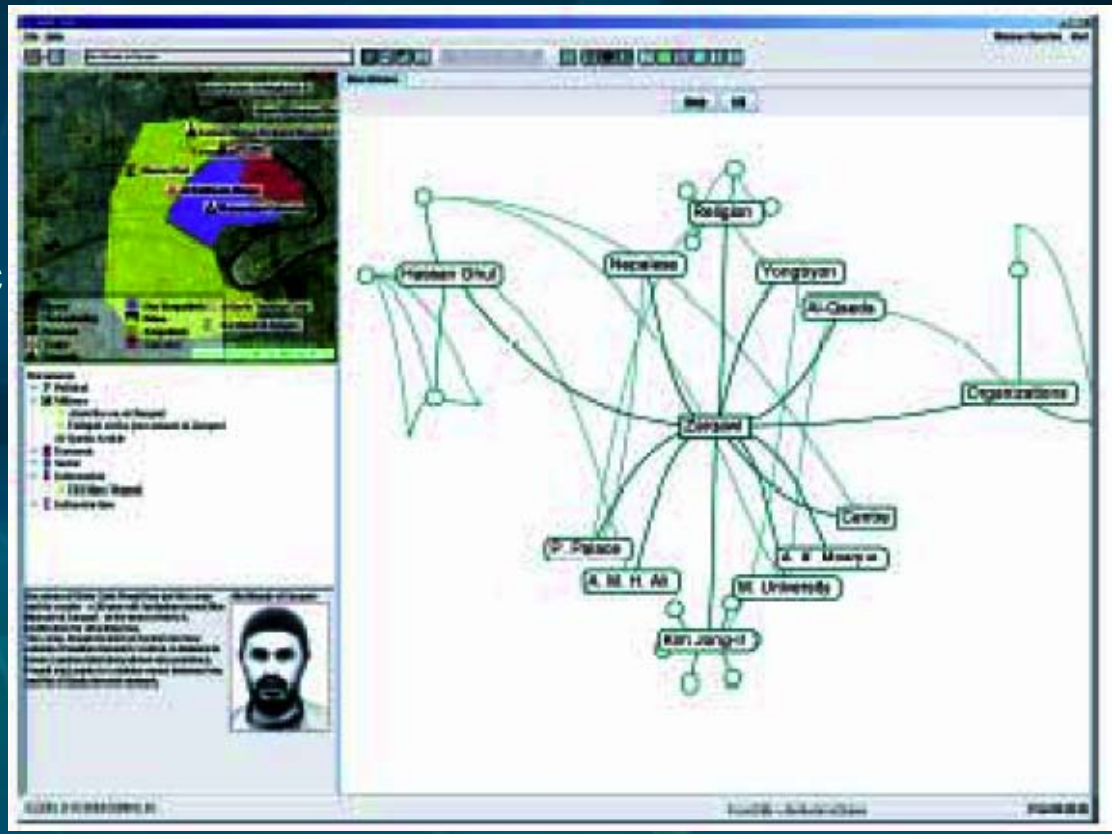
- **Ontology**
  - Basis for actionable knowledge representation
  - Knowledge is Inherently Consensual
    - Open-source ontologies and electronic dictionaries more likely to be vetted.
  - Provide 'Rosetta' translations to disparate domains with their own ontology
- **Semantic Distance**
  - Basis for metrics, strengths, clustering, specificity, etc.
  - Creates equivalence partitions for heuristics
    - (although, not sufficient for graph serialization)
- Actionable Knowledge
  - Provides additional weightings of utility
  - Utilizes existing ontology and semantic distance
  - Partially derivable risk/value models

V. SYSTEM IMPLEMENTATION

V. SYSTEM IMPLEMENTATION (1)

JIAPC HTCV Application

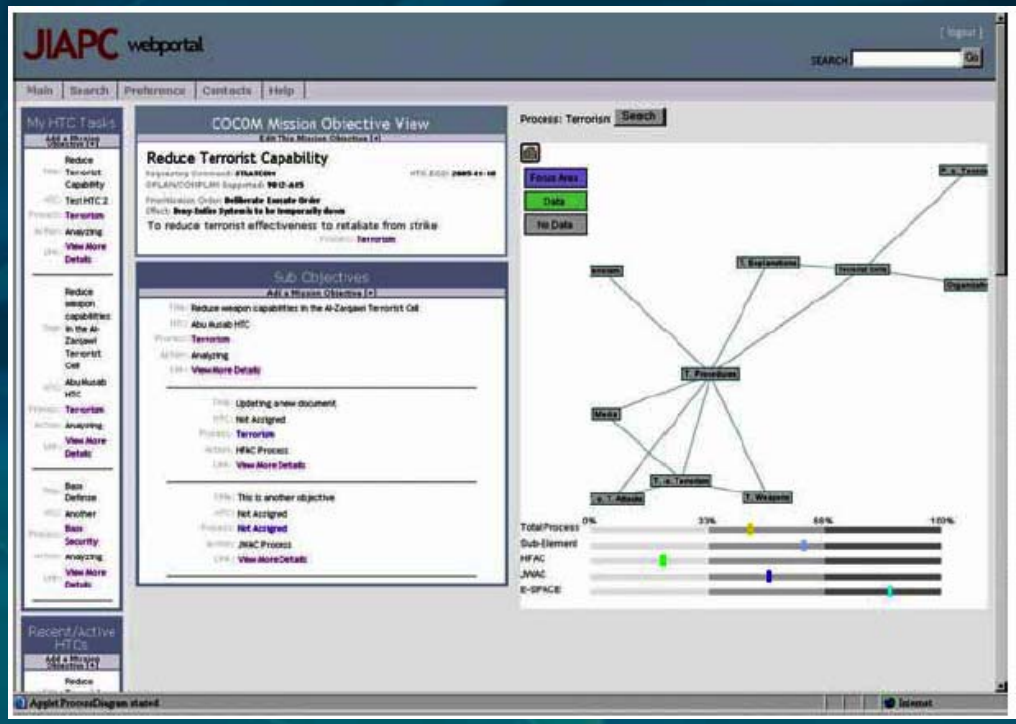
- **Multi-modal display of data**
  - Semantically-tagged items equivalent throughout
  - Semantic Iconography
  - GIS correlated with Hyperbolic Graph
  - Integration with Tree Navigation
  - Integrates with Web and Office documents
- **Leverages Underlying Expressive Ontology**
  - Process driven
  - English-free concept IDs
  - Semantic strengths



V. SYSTEM IMPLEMENTATION (2)

JIAPC HTCV Web Access

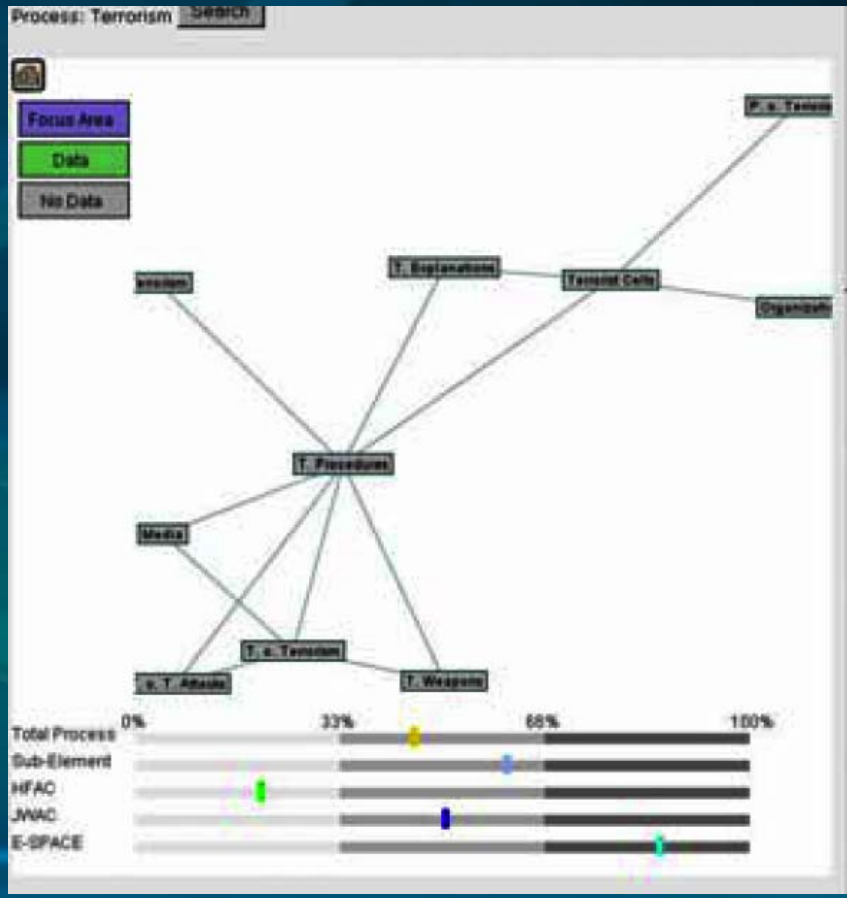
- **Web-enabled Access**
  - Supports multiple roles
  - Integrated Rolodex
  - Integrates with other web resources
- **Process Specific Semantic Queries**
  - Concept graphs generate queries to DB, Web, or SME
  - English-free concept IDs
  - Keeps track of query results per node.



V. SYSTEM IMPLEMENTATION (3)

JIAPC HTCV Process Templates

- Concept Graphs
  - Canonical pre-built according to known planning processes
  - Nodes represent constraints
  - Drill-down to supporting concept graphs
- Semantic Queries
  - Concept graphs represent constraints and can be translated to queries
  - Color-coded for 'fitness' of the evidence for that node
  - Process measures according to the supporting evidence



VI. CONCLUSION

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IV. CONCLUSION

Benefits of the Technology and Extended Applications

- Actionable Knowledge Improves Visualization of Massive Amounts of Data
  - AK-based utility provides a basic design pattern for preference ordering and partitioning information, which reduces cognitive load
  - AKR structures can represent multiple translations of intent, which can be interpreted as context for the recruitment of appropriate visualization heuristics.
- Rigorously Representing Mission Intent as a First Class Property of the CIE Improves Metrics of Effectiveness and Performance
  - Higher resolution translation of the AK in multiple disparate domains improves compliance with the mission objective, and thus effectiveness.
  - Algorithmic translations of the AK allows for better leveraging of heuristics and more accurate preference ordering, reducing work for both human and machine, and thus improving performance.
- Actionable Knowledge Provides a Bridge to Better Understanding Cognitive Modeling in C2 Applications
  - AKR ontologies forms the basis for studying reusable actions WRT utility
  - Partitionable utility functions provide a better representation of the problem space than embodying cognitive artifacts within information architectures by fiat.

ABOUT 21CSI

- 21st Century Systems, Inc.® (21CSI®) is a pioneer in agent-based decision support systems for time- and mission-critical military applications
  - Woman-owned, founded in 1996
- Decision support tools across the spectrum of missions
  - Individual Soldier Situational Awareness
  - Distributed Warship Command and Control
  - Decision Under Uncertainty
  - Homeland Security/Force Protection Situational Awareness
  - Secure R&D Collaboration…*and others*
- Our applications run on all types of hardware…
  - Wireless PDAs
  - Laptops, desktops, to massive parallel computers

  …*and are Operating System independent*
- Military Small Business Contractor Success Story
  - 100% Commercialization Achievement Index
- Offices in : NE, MO, HI, WA, RI
  - Top Secret Facility Clearance

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