userSmarts®
The Semantic Web Middleware

From Research to Engineering

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History

- Started in 2000 and opened our doors as an LLC in January 2001
- Won SBIR Phase I and Phase II for Semantic Technologies
- Currently in Phase III

- Achievements
  - Image Matters has been investing in next generation Smart Web Services (Semantic Web); ~$1.5M.
  - Well on track for Release of our Smart Service Middleware (userSmarts®) by the end of the year.
  - We are the leading Interoperability Engineering resource for the OpenGIS Consortium.

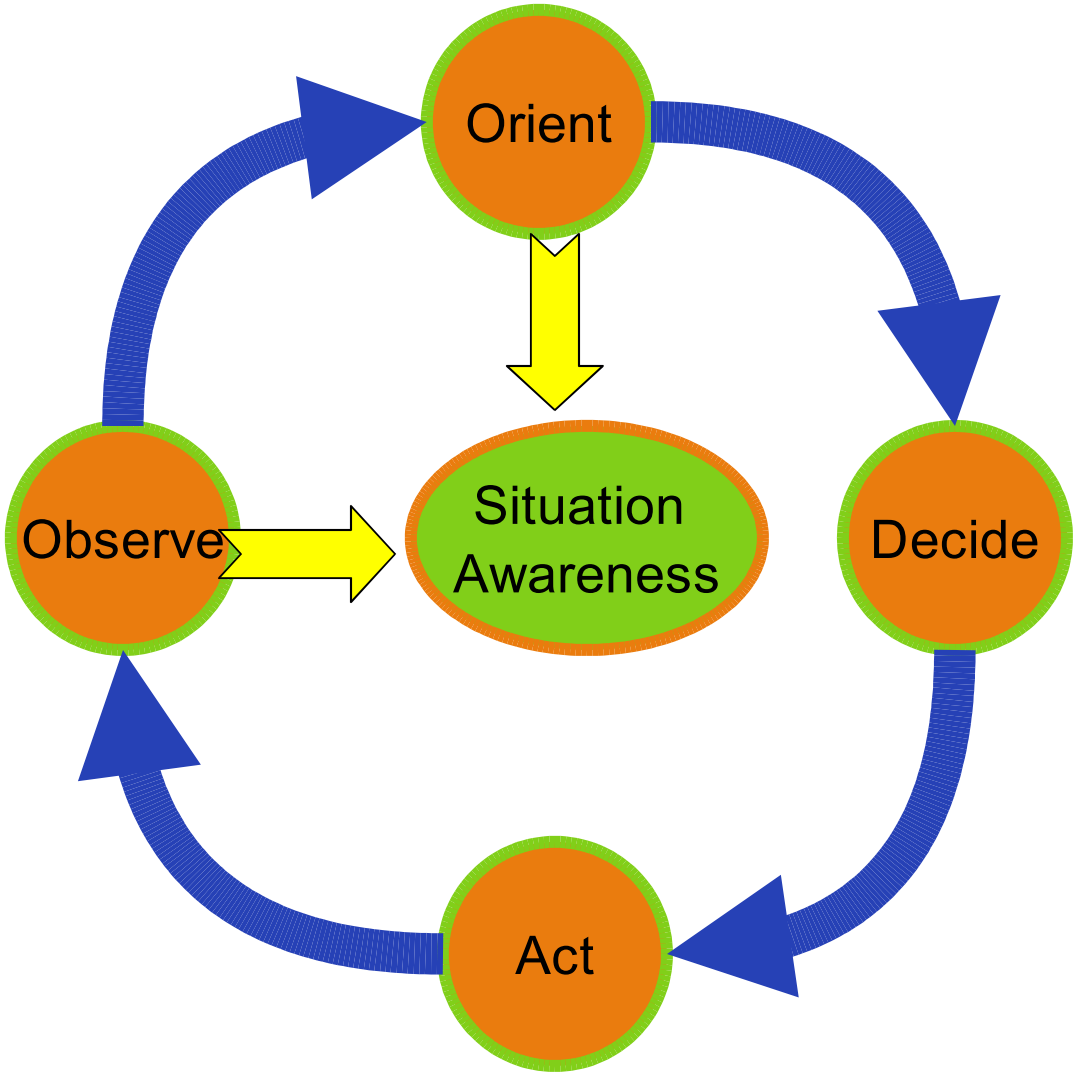
Business Activities

- Advanced Geospatial Semantic R&D
- userSmarts® Product Development
- Interoperability Engineering Consulting

Mission

To be the Leader in Products and Services for the "Geospatial Smart Web"

Characterizing the Problem: Decision Making



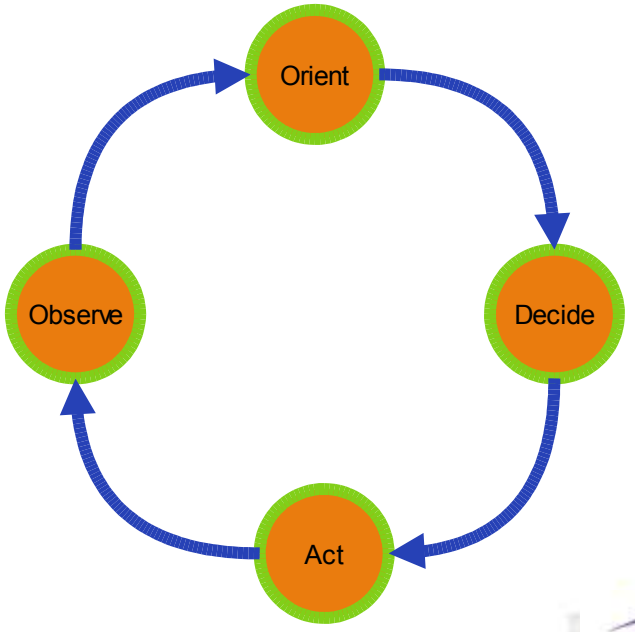
Setting The Stage

- The Semantic Web
  - An extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation. (W3C)
- Situation Awareness
  - The perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future. (Endsley, 1988).
- Components
  - Sensory Network to sense the environment → time, space, behavior, state
  - Knowledge Model of the environment → Comprehend the environment
  - Reasoning and Analytical Tools → Projection and Status
  - Usability Engineering and HCI → Visualize and Convey the situation

Situation Awareness Problem Statement

- Present systems
  - Information poorly organized, unfiltered, unprocessed
  - Information difficult to search/access
  - Information has marginal relevance to decision-makers
- Decision-makers want
  - Reduce the OODA time Loop
  - Shared understanding among stakeholders
  - Near real time Common Relevant Operational Picture (CROP)
  - Actionable knowledge
  - Tailored decision frameworks

- Situation Awareness
  - Actors
  - Goals and objectives
  - Courses of action
  - Tactics
  - Critical events
  - Space, Time and Flow

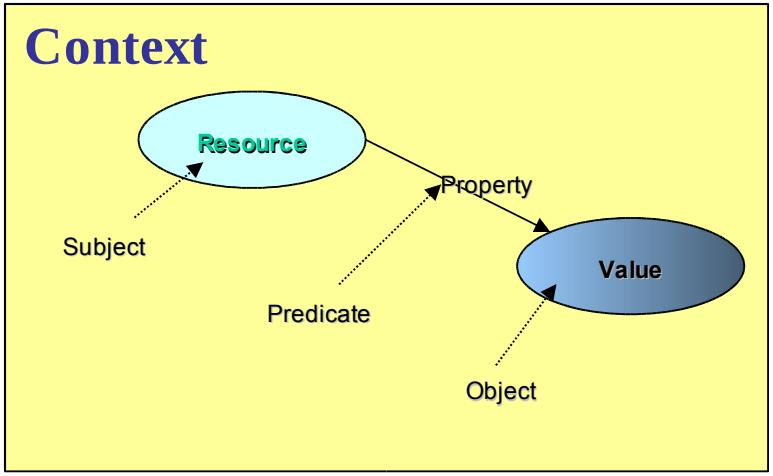


Situation Awareness System Concept

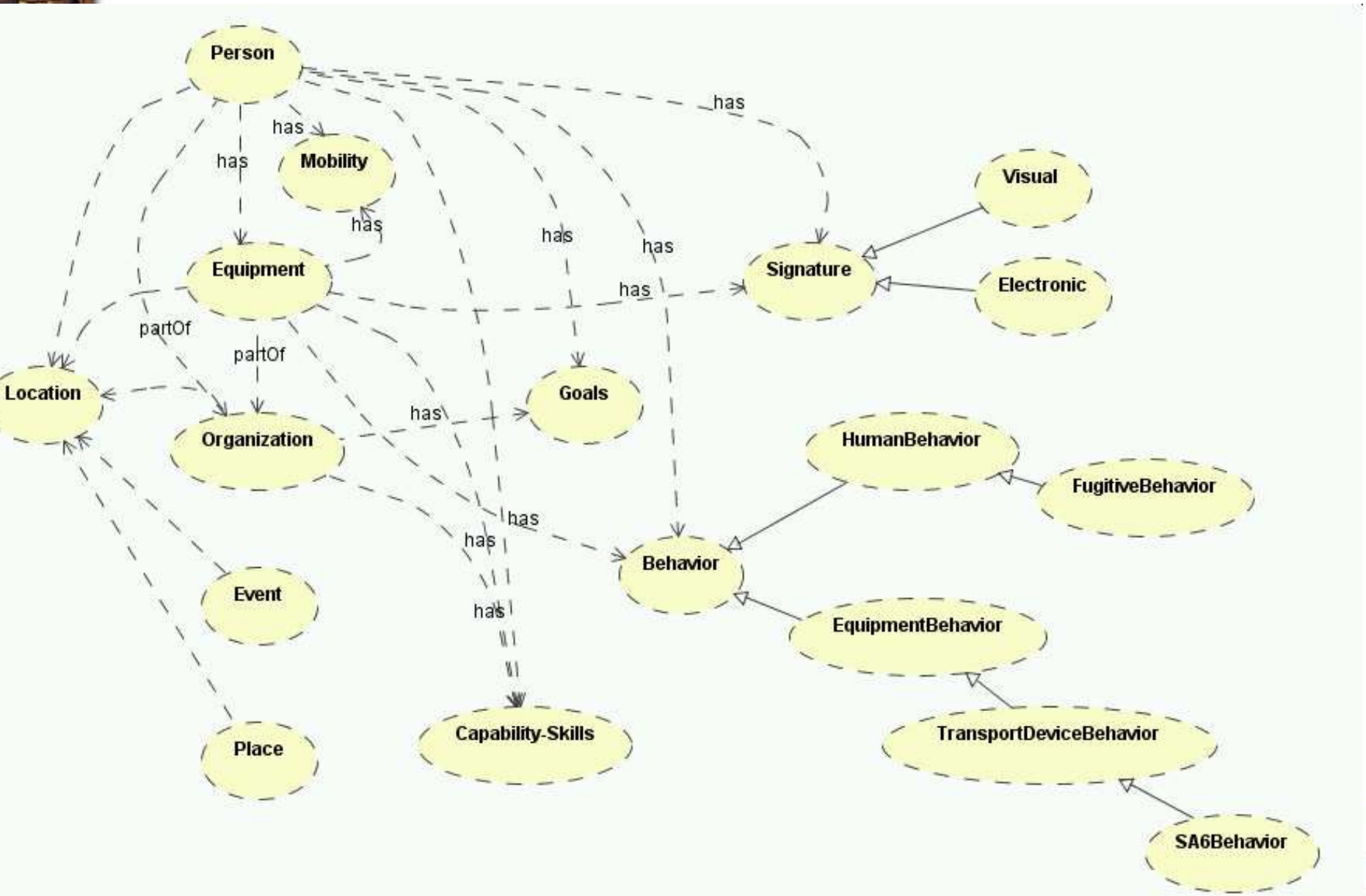
- Dynamically collects and organizes information that is relevant to a situation *and* the commander's decision process, i.e., Information in "Context"
  - Goal driven (not just data driven)
  - Complex operations with multiple stakeholders
- Supports/integrates
  - Warnings and Notifications: Support Push/Pull instead of only Pull
  - Dispatch (CAD) and Vehicle Location (AVL) technology
  - Damage Assessment
  - Command & Control
  - Interagency Coordination
  - Public Information and Warning

Semantic Model

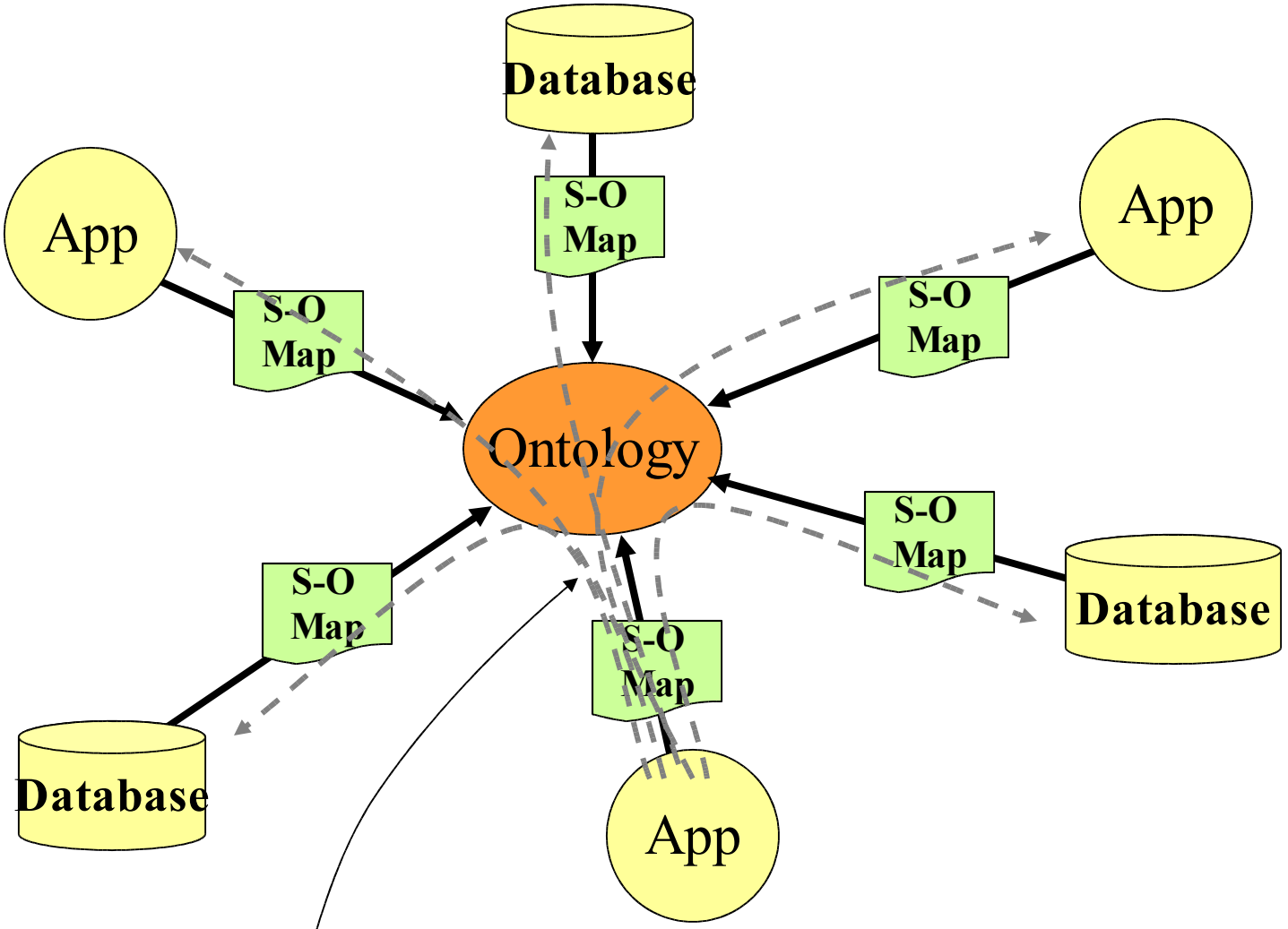
- Model - Set of quadruples
- Quadruple – truth assertion
  - <Context, subject, predicate, object>
- Class – resource classifier
  - subclassOf
- Property – predicate types
  - Domain constraints
  - Range constraints
- Schema – vocabulary of Types and Predicates
  - Defines a closed KB namespace
  - Can import other schemas
- Containers
  - Collections of Values
    - Resource
    - Literal



Top Level Ontology in UserSmarts



Scalable Semantic Interoperability



Explicit semantics = ↑ Interopability/Reuse/Utility

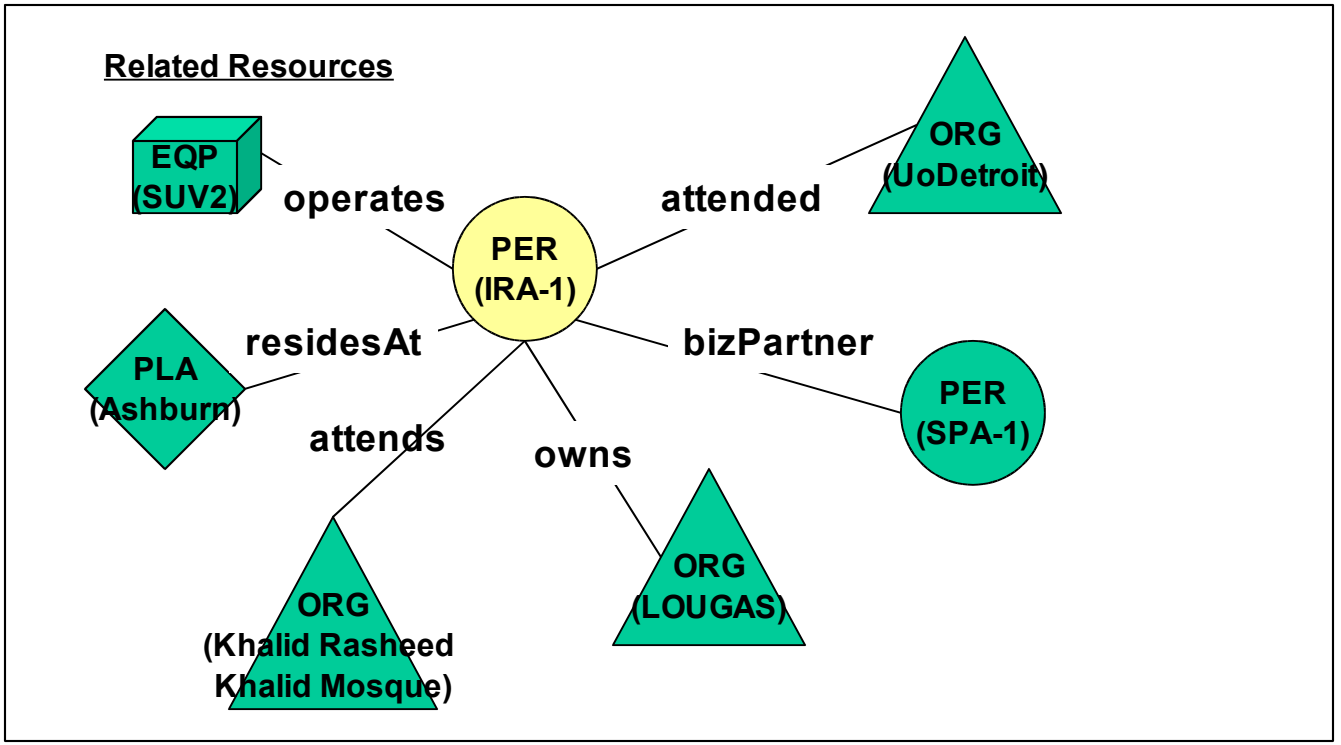
Person: IRA-1

Personal:
First: **Abdul**
Last: **Bahieri**
Gender: Male
DOB: 2003-36=1967
POB: Iran
Nationality: US
Id: (US-passport#)
Height:
Weight:
Complexion:
Hair Color:
Eye Color:

Contact:
Other Name:
Alias:
Email:
Work Phone:
Home Phone:
Mobile Phone:

Address:
Home Address:
Home City: Ashburn
Home State:Virginia
Home Zip:
Home Country:
Work Address:
Work City:
Work State:
Work Zip:
Work Country:

Attachments:



Personal Narrative:

Male, age 36, no wants/warrants/aliases, one speeding traffic ticket issued by Loudoun County in 1998; Born Iranian; immigrated to the US in 1987 via London, England. He is a legalized US citizen and maintains a valid US Passport. Established initial residence in Detroit, Michigan; in 1992 graduated from the University of Detroit with a degree in Industrial Engineering; relocated to the Washington DC area in 1993. In 1994, established the Loudoun Industrial Gas Supply Company (LOUGAS) in Leesburg, Virginia. He is the principal owner/operator and his business partner is known to be Franco Luis Marico. He is divorced from Soulham Kali Bahieri who returned to Tehran in 1996; they have no children; he lives in Ashburn, Virginia; he attends the Khalid Rasheed Khalid mosque in Great Falls, Virginia. His extended family is in Tehran, Iran; there are no reported concerns expressed by the Government of Iran. **He is known to be critical of US Mid-East policy in general. Importantly, he is highly critical of the expanded US anti-terrorist efforts implemented after September 11,2001.**

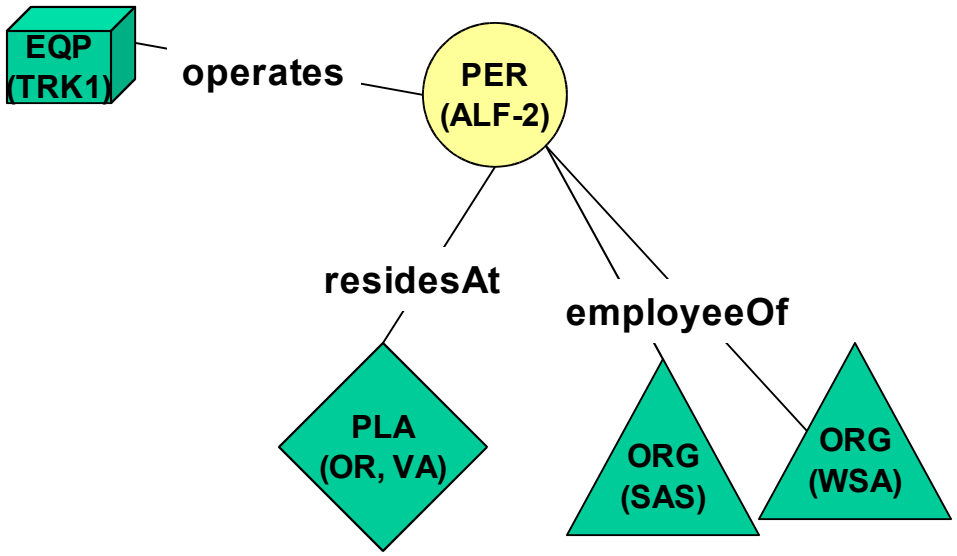
Person: ALF-2

Personal:
First: Pang
Last: Mango
Gender: Male
DOB: 2003-30=1973
POB:
Nationality: Indonesia
Id: (Indonesia-passport#)
Height::
Weight:
Complexion:
Hair Color:
Eye Color:

Contact:
Other Name:
Alias:
Email:
Work Phone:
Home Phone:
Mobile Phone:

Address:
Home Address: unknown
Home City:
Home State:
Home Zip:
Home Country:
Work Address: SAS, Front Royal Airport
Work City: Front Royal Airport
Work State: VA
Work Zip:
Work Country: USA

Related Resources



Personal Narrative:

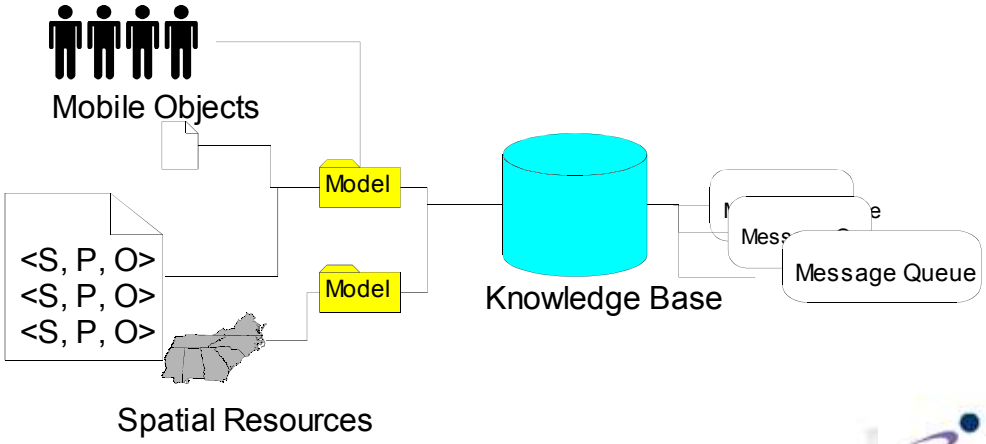
Pang Mango (Alfi-2)is 30. It was noted that when in the Indonesian Security Service, Mango was qualified as a Munitions Specialist

Attachments:

Knowledge Base

- Semantic Repository
  - Type & Property Schemas
  - Contextual Knowledge Models
- Folder Service
  - General Resource Repository
  - Location Organized Folders
  - Mobile Objects
  - Situation Awareness Folders
- Query Services
  - Semantic
  - Spatial
  - Temporal
- Notification
  - Knowledge Models
  - Folders & Resources

- Implementations
  - Oracle 9i Version
    - Native XML types
    - Spatial Data Option
    - Oracle Advanced Queuing
      - XML payload
      - PL/SQL Filtering
  - Berkley DB
  - Planning to implement on Oracle 10G



UserSmarts®

- Context-Sensitive™ Personalized Service delivery
- Enterprise Architecture based on J2EE
- Middleware Technology
- Real-time Event Driven
- Agent Framework for Goal Oriented Programming
- Information Model based on Ontology (RDF+OWL)
- Knowledge Representation Framework OFC™ (Ontology Foundation Classes)
- Highly Scalable Knowledge Persistence System
- Inference Capabilities including Horn Clause and Event-Condition-Action (ECA)

Messaging Server | Calendar Server | Directory Server | Identity Server

Instant Messaging Server | Portal Server | Secure Remote Access | Mobile Access

Portal Services

EIS

Geodata

Workstation

Thick Client

Web Services

Thin Client

Mobile WIreless Client

Load Distribution

Trusted System

DMZ Routers

Proxy Servers

Public Access Portal

Emergency Planning Center Portal

EOC Portal

App Services | Registry

KB | Gateway Service

Info Delivery | Context Agents

userSmarts

J2EE Platform

Sensors

Messages & Alerts

Storage, Clustering Systems

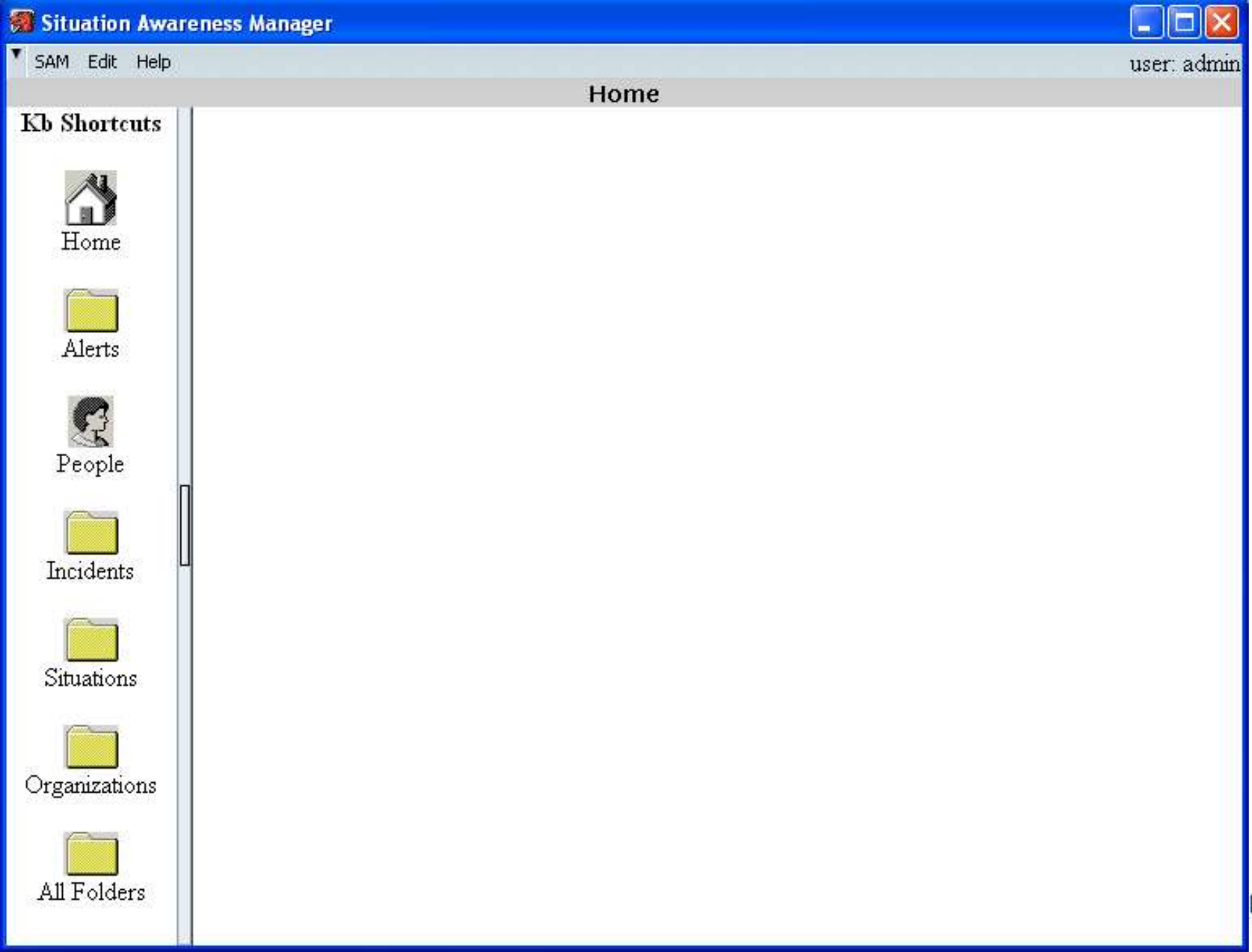
Enterprise clustering Solutions | Storage Solutions

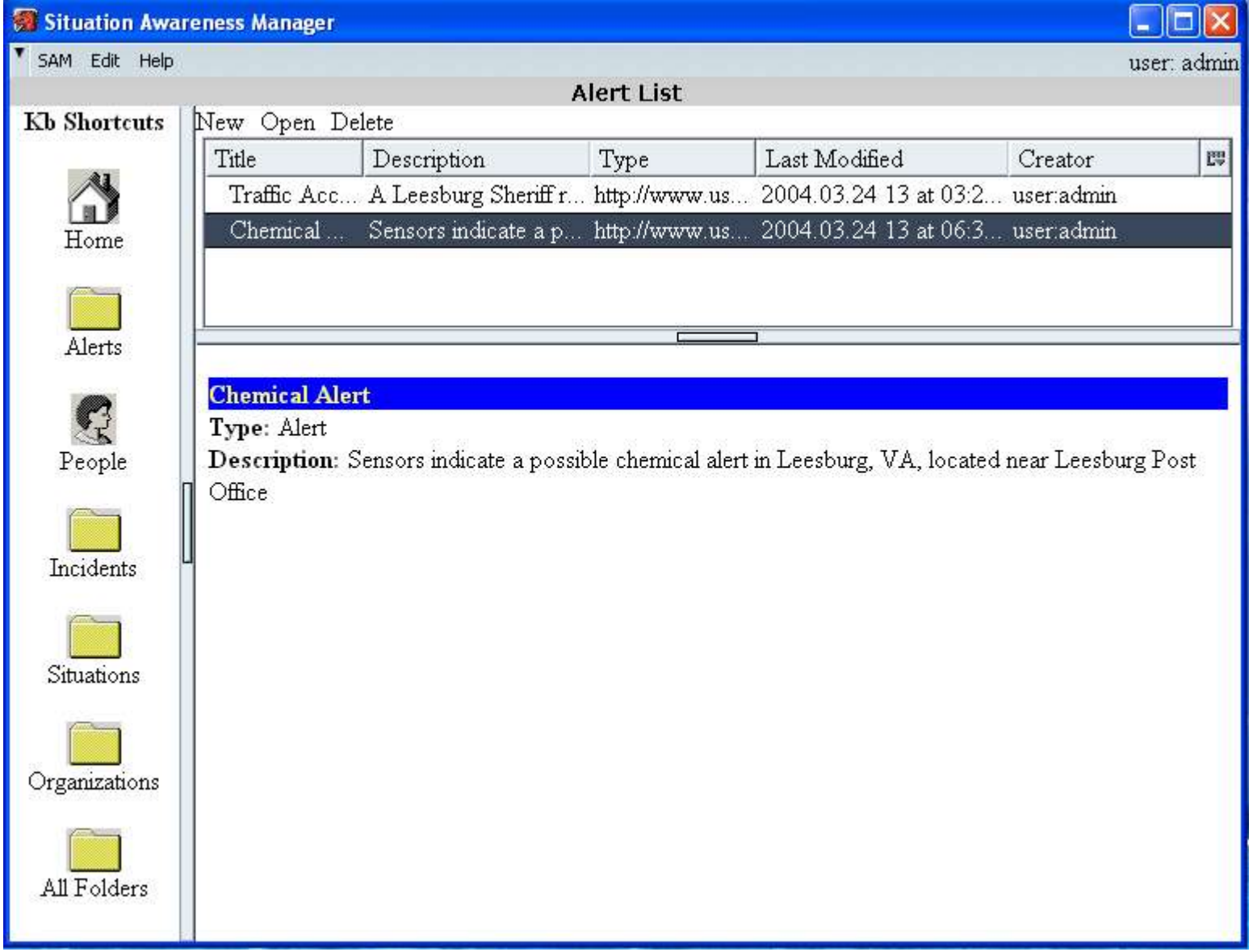
User Layer

DMZ

Application Layer

Distributed Resource Layer


Situation Awareness Manager
SAM
Edit
Help
user: admin
Home
Kb Shortcuts
Home
Alerts
People
Incidents
Situations
Organizations
All Folders



Folder Edit Help

Overview | Content | Edit

Folder Overview

guid:1938039:fb747cece3:-7fed

Type:	http://www.userSmarts.com/2003/folder#Folder
Identifier:	guid:1938039:fb747cece3:-7fed
Type:	http://www.userSmarts.com/2003/alert#Alert
Root:	guid:178460d:fb79e9e988:-7f3c#_0
Description:	Sensors indicate a possible chemical incident in Leesburg, VA, located near the Leesburg Post Office.
Creator:	user:admin
HasLocation:	guid:178460d:fb79e9e988:-7f3c#_1
HasParent:	urn:safe:folders
Title:	Chemical Alert

Alerts

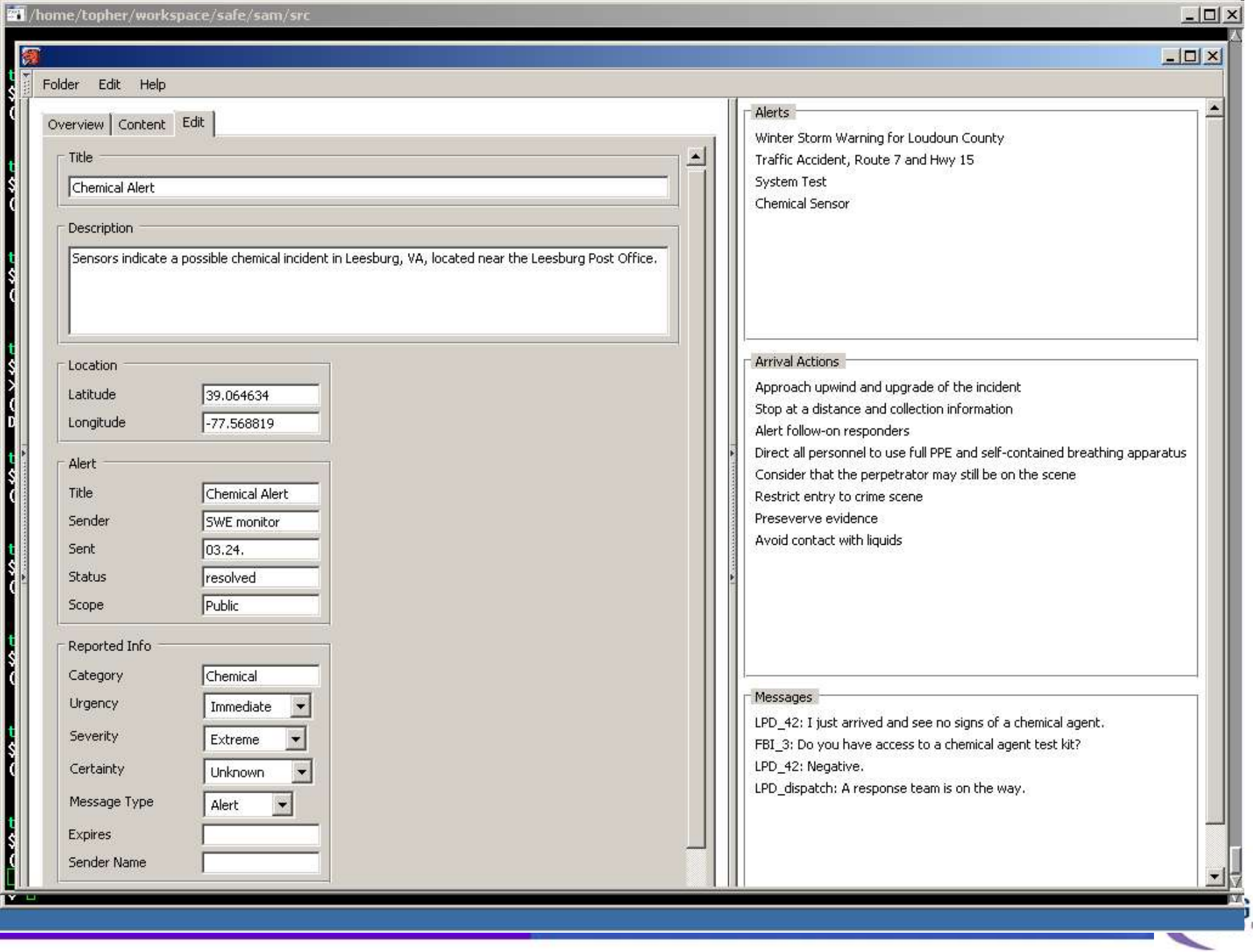
Winter Storm Warning for Loudoun County
Traffic Accident, Route 7 and Hwy 15
System Test
Chemical Sensor

Arrival Actions

Approach upwind and upgrade of the incident
Stop at a distance and collection information
Alert follow-on responders
Direct all personnel to use full PPE and self-contained breathing apparatus
Consider that the perpetrator may still be on the scene
Restrict entry to crime scene
Preseverve evidence
Avoid contact with liquids

Messages

LPD_42: I just arrived and see no signs of a chemical agent.
FBI_3: Do you have access to a chemical agent test kit?
LPD_42: Negative.
LPD_dispatch: A response team is on the way.


/home/topher/workspace/safe/sam/src
Folder
Edit
Help
Overview
Content
Edit
Title
Chemical Alert
Description
Sensors indicate a possible chemical incident in Leesburg, VA, located near the Leesburg Post Office.
Location
Latitude
39.064634
Longitude
-77.568819
Alert
Title
Chemical Alert
Sender
SWE monitor
Sent
03.24.
Status
resolved
Scope
Public
Reported Info
Category
Chemical
Urgency
Immediate
Severity
Extreme
Certainty
Unknown
Message Type
Alert
Expires
Sender Name
Alerts
Winter Storm Warning for Loudoun County
Traffic Accident, Route 7 and Hwy 15
System Test
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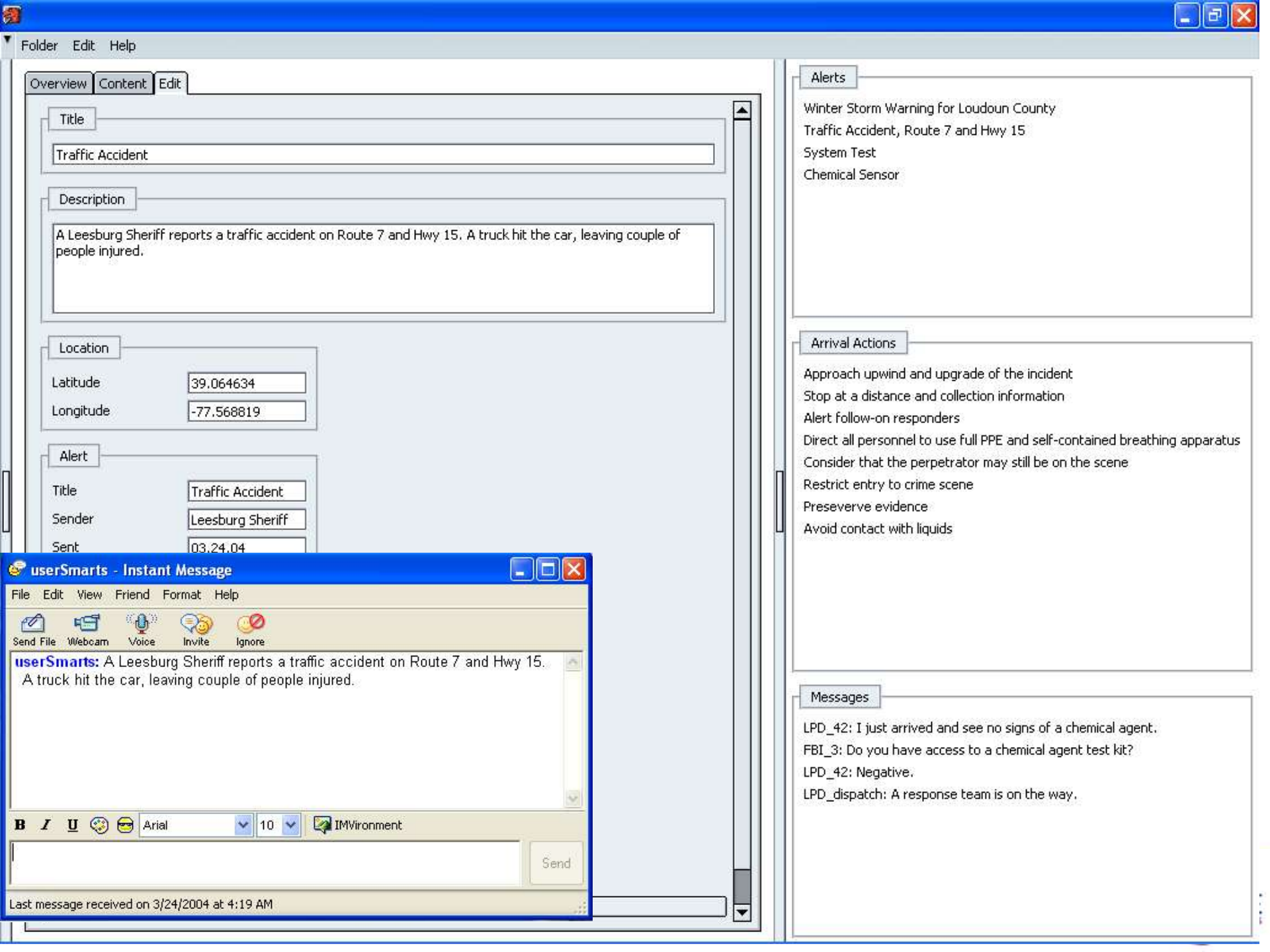
Folder Edit Help
Overview Content Edit
Title
Traffic Accident
Description
A Leesburg Sheriff reports a traffic accident on Route 7 and Hwy 15. A truck hit the car, leaving couple of people injured.
Location
Latitude 39.064634
Longitude -77.568819
Alert
Title Traffic Accident
Sender Leesburg Sheriff
Sent 03.24.04
userSmarts - Instant Message
File Edit View Friend Format Help
Send File Webcam Voice Invite Ignore
userSmarts: A Leesburg Sheriff reports a traffic accident on Route 7 and Hwy 15. A truck hit the car, leaving couple of people injured.
Arial 10 IMVironment
Send
Last message received on 3/24/2004 at 4:19 AM
Alerts
Winter Storm Warning for Loudoun County
Traffic Accident, Route 7 and Hwy 15
System Test
Chemical Sensor
Arrival Actions
Approach upwind and upgrade of the incident
Stop at a distance and collection information
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Final Remarks

- Geospatial Semantic Web is a key technology for Situation Awareness
- Well defined Geospatial Knowledge Model (Ontology + Rules) is key to Situation Awareness
- CROP is enabled by providing Context Sensitive™ Actionable Information to users
- userSmarts is a technology that enables highly scalable and agile active/reactive Situation Awareness Applications

Major Challenges

- Building “consistent” Ontology
- Management of Knowledge
- Extending Knowledge while maintaining consistency
- Integrating Ontologies with existing ES
- Trust
- Change of ideology: From modeling structures to modeling logical relationships
- Diffusion of Innovation

Thank You

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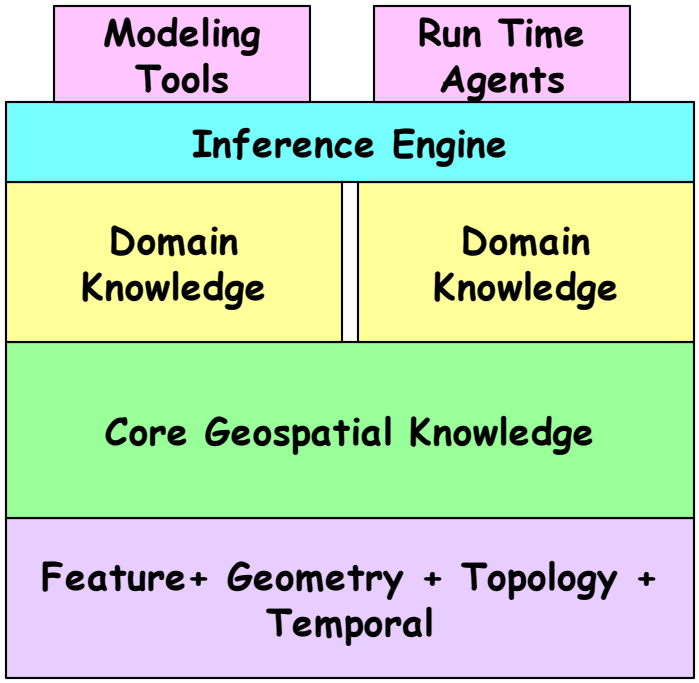
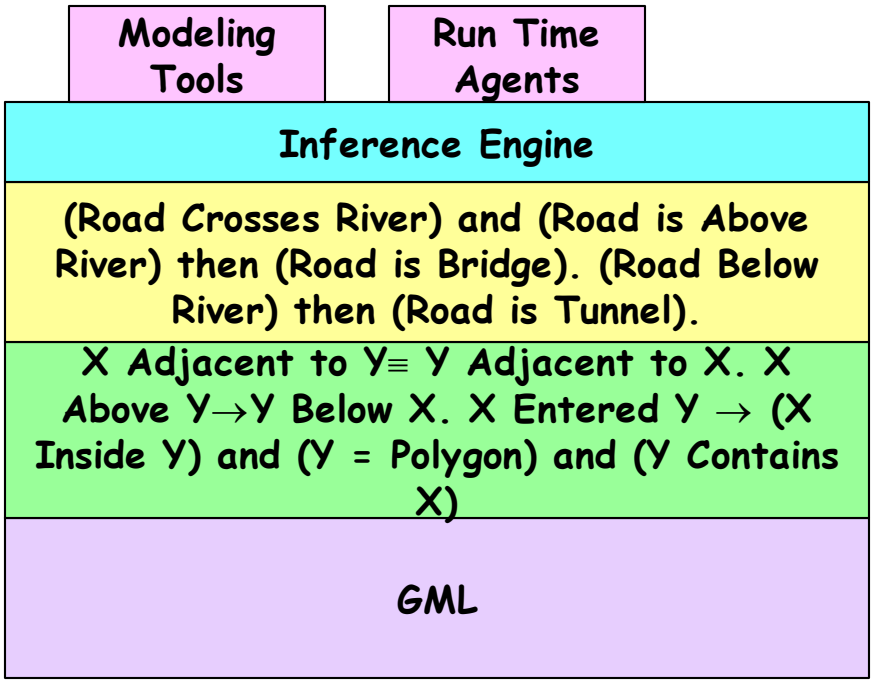
Back up Slides

Geospatial Knowledge Layers

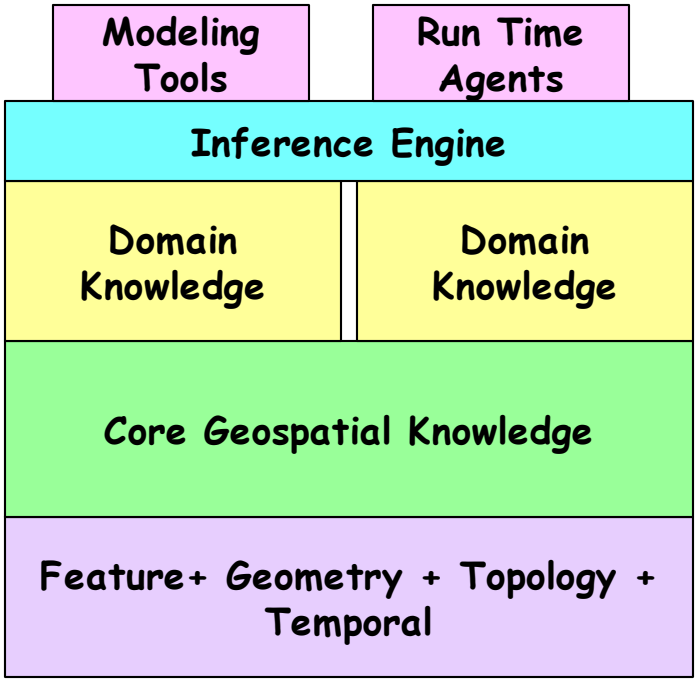


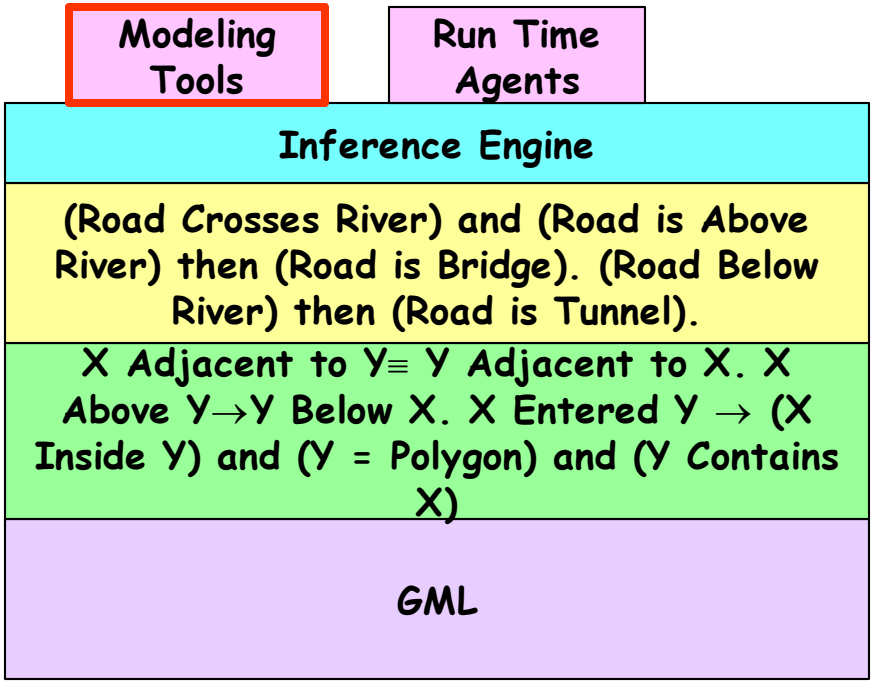
Abstract Model



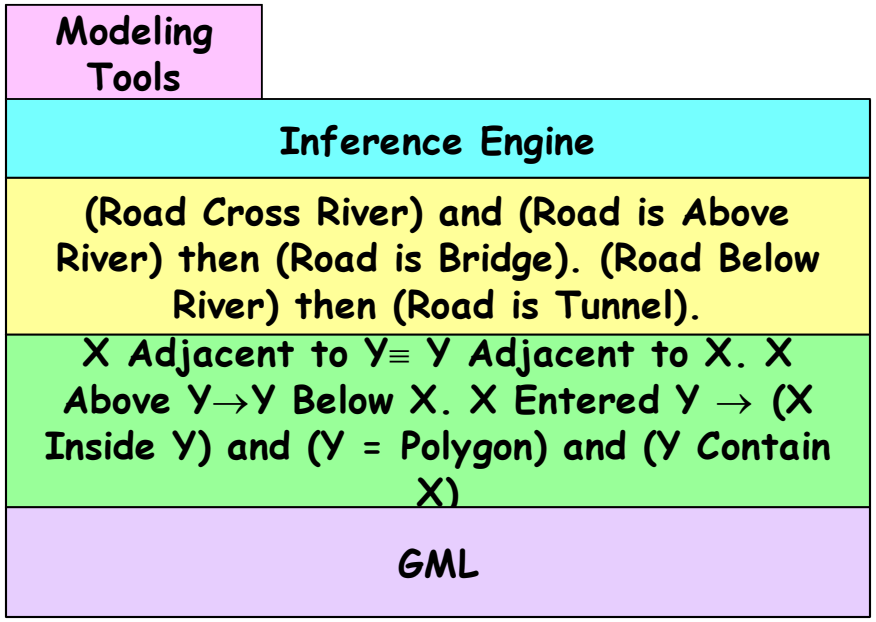
Implementation Example

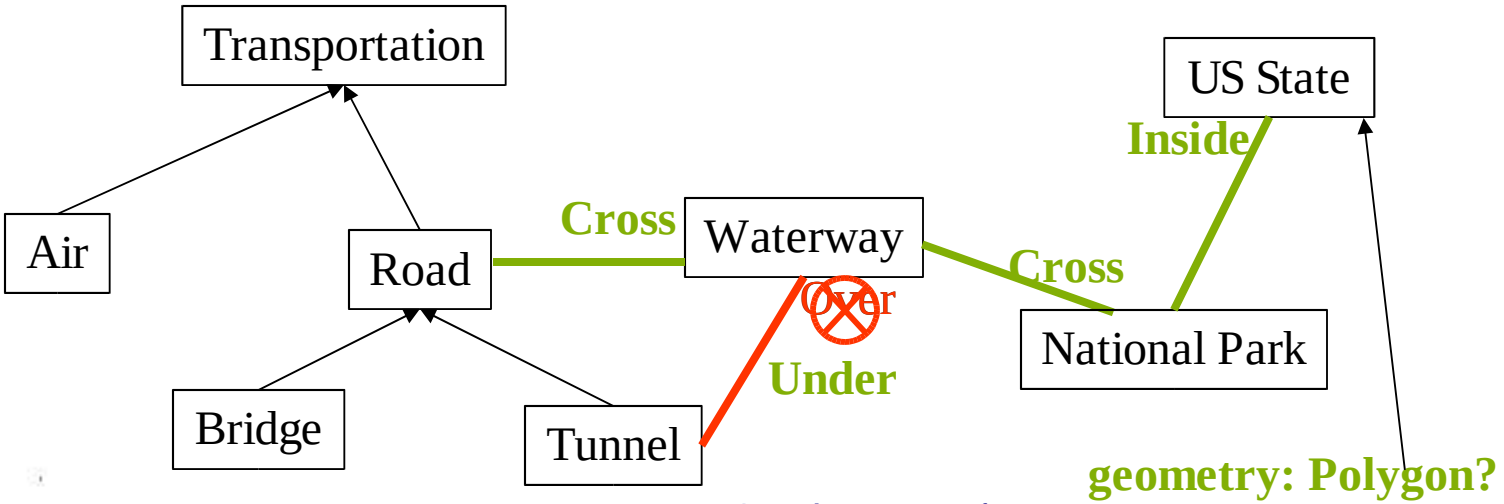
Geospatial Knowledge Layers





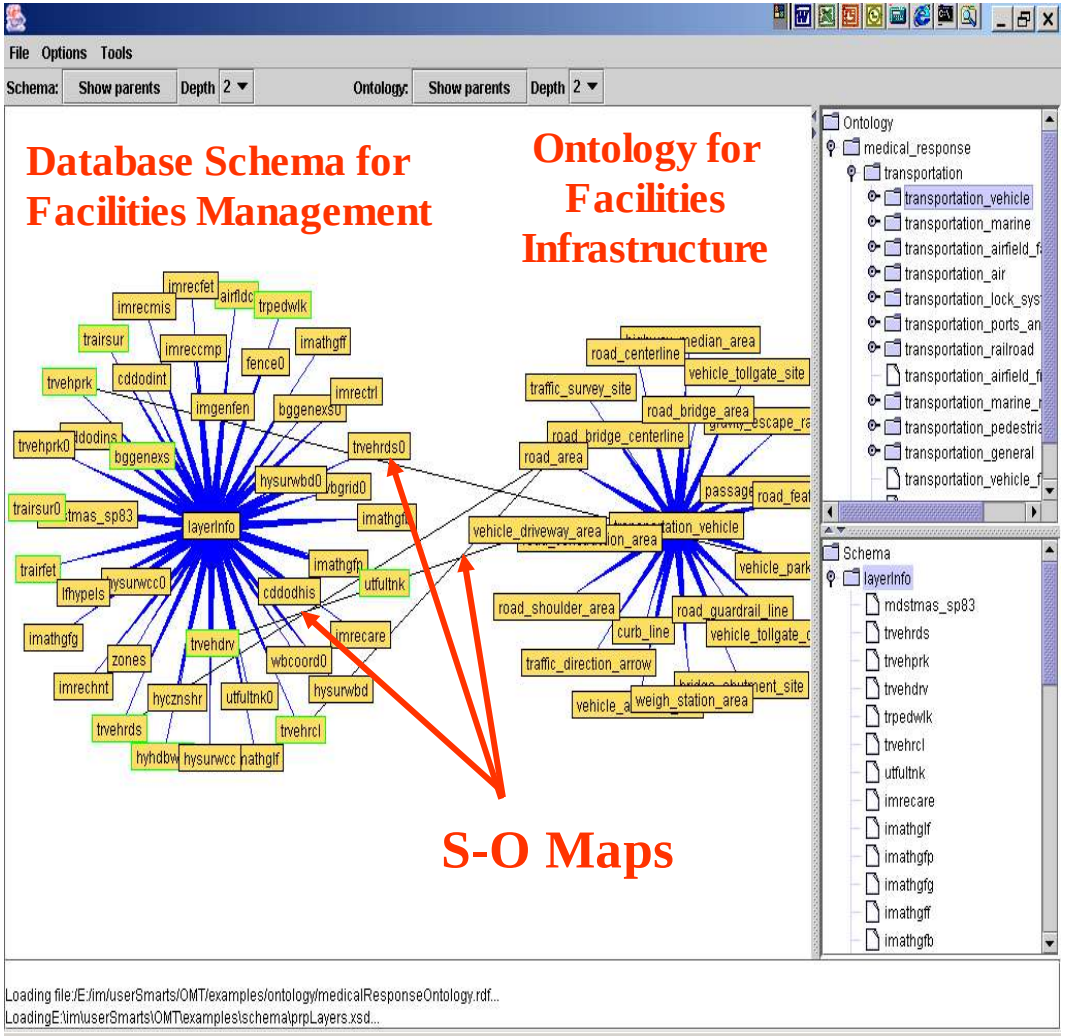
Example of Semantic Modeling Tools



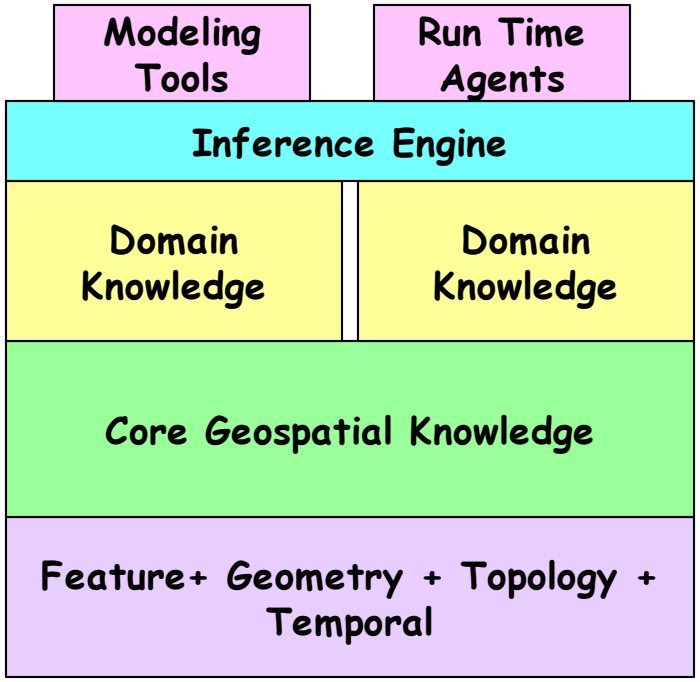


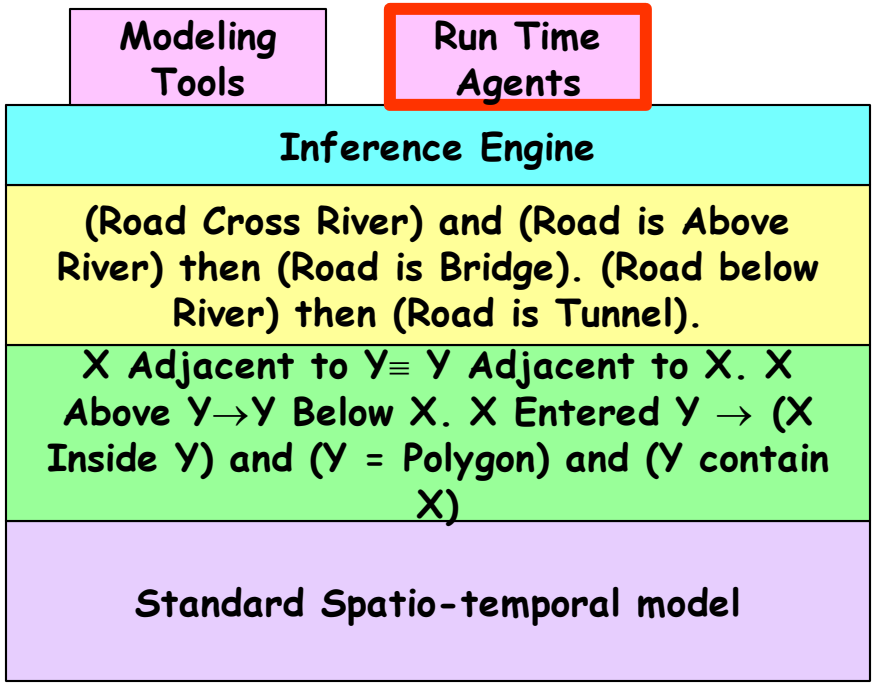
S-O Editor

- Visualize the structure of both schema and ontology
- Assign explicit semantics to schema elements
- Validate logical consistency of mappings
- Highlight recommended mappings
- Supports standard encodings of schema and ontology



Geospatial Knowledge Layers





Example: With the Semantic Web

NIMA Data

FeatureID: 1234
Type: Interstate
Attribute List: name: I95
length: 35
pavmentType: Asphalt
speed limit: 65
MaxWeight: 70 Tons
TruckPermission: 7PM – 6AM

Query Answer: No

Army Data

FeatureID: 2356
Type: ArmoredTruck
Attribute List: Licence: Arm234
CargoType: Toxic Chemical
Weight: 60 Tons
speed limit: 50

Road Network
Secondary Road
Interstate
Street
UnionOf
Ontology
DriveOn
HazmatTruck
Domain
Time Permission
Range
Time Period

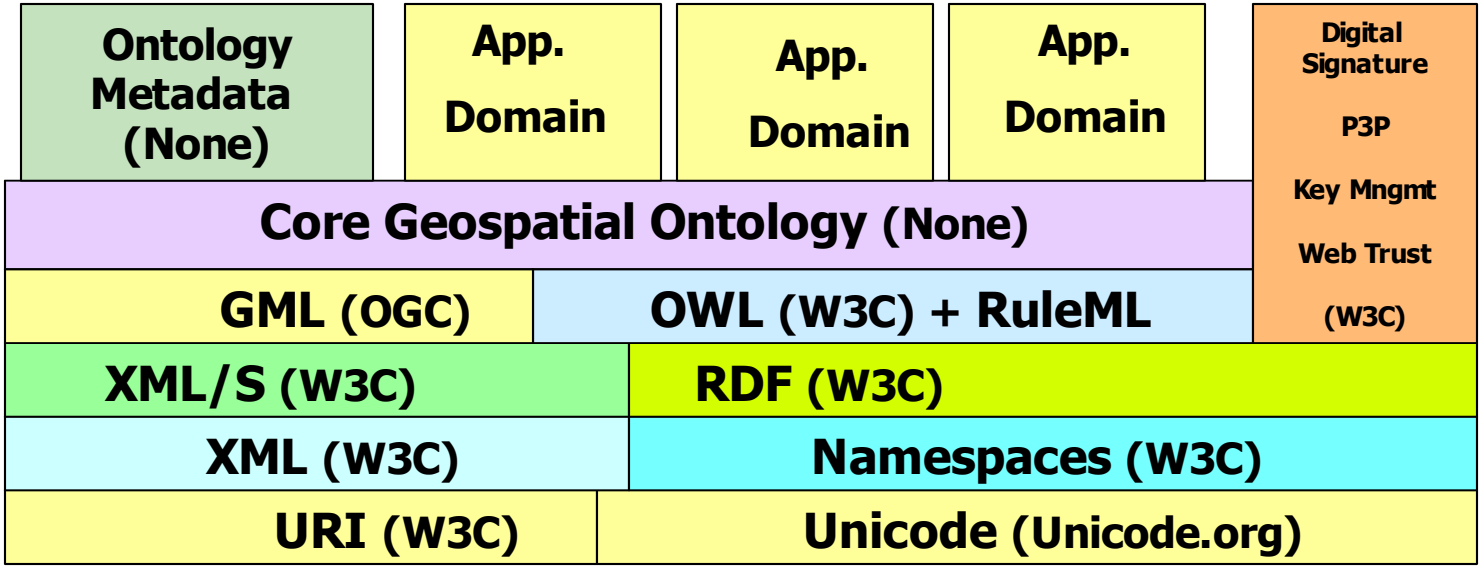
Truck
CargoType
SubPropertyOf
ArmoredCargoCarrier
CargoCarrier
DecontaminationTruck
HazmatCargo
HazmatType
Domain
Chemical, Biological

US DOT

FeatureID: 1234
Type: Interstate
Attribute List: name: I95
length: 35
HazmatPermission: 12AM-6AM

Ontology 2

What is the Technology Stack?



- RDF provides the basic building blocks for constructing logical statements.
- The OWL and RuleML layer enables writing ontologies and is built upon RDF and XML/S
- The GML Layer provides the atomic spatio-temporal types as well as the generic feature model
- The Core Geospatial Ontology Layer provides the high-level semantic rules and constraints for geospatial applications
- The Ontology Metadata layer enables us to search for ontologies and evaluate their fitness for use
- Web Trust, Digital Signature, and Key Management provide mechanisms for applications to determine trust level, and it also enables ontology providers to put certain access restrictions on all or part of the ontologies.

NIMA Geospatial-Intelligence Knowledge Architecture