

11.6 Semantic Web Technologies

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Some applications of Semantic Web Technologies

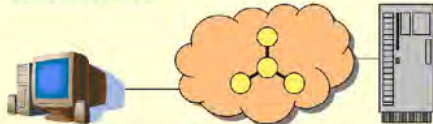
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Background

Knowledge is of two kinds. We know a subject ourselves, or we know where we can find information upon it. -Samuel Johnson



New knowledge is the most valuable commodity on earth. The more truth we have to work with, the richer we become. -Kurt Vonnegut, in *Breakfast of Champions*



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Semantic Web (briefly)

Information is given well-defined meaning

Structure to the meaningful content of Web pages

From a medium of documents where machines merely display the data at present

to

Making Machines process and reason with the data

Language for expressing both data and rules for reasoning about the data



RDF, N3, OWL, CWM
URI and XML

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URI & XML

• Uniform Resource Identifier

- Foundation of the web
- Name / Identifier for a "resource" (may or may not be over the Internet. May or may not provide for more information)
- Examples:
 - file:/users/anant/TECHNO-1/conv-sys/zonto2.n3#Anantaram
 - http://www.w3.org/2000/01/rdf-schema

□ XML lets everyone create their own tags

- Scripts or programs can make use of these tags
- Allows users to add arbitrary structure to their documents
- But what do the structures mean?



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RDF

□ Meaning is expressed (in a sense)

□ Sets of triples: <subject> <verb> <object>

- Each of these identified by a URI
- Triples written using XML tags
- Assertions: particular things have properties with certain values

□ Can describe most of the data.

Example

```
<rdf:Description rdf:about="#Puneet">
  <has_supervisor rdf:resource="#Gautam"/>
  <is_in_group rdf:resource="#DubaiPorts"/>
  <is_in_group rdf:resource="#TechnologyPrg"/>
  <is_member_of rdf:resource="#DubaiPorts"/>
  <is_member_of rdf:resource="#TechnologyPrg"/>
</rdf:Description>
```



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Notation3 - N3

Notation3 : N3

- Simple way to represent RDF information
- Define a prefix and use that prefix

Example

@prefix zds: <zontos.n3#>.

zds:WON zds:is_type_of zds:project.
zds:SWON zds:is_type_of zds:project.

zds:project zds:has_states "CREATED, SUBMITTED,
APPROVED, ACTIVE, CANCELLED"

zds:TechPrg zds:is_type_of zds:SWON.
zds:IACCS zds:is_type_of zds:WON.



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RDF schema

- Designed to be a simple datatyping model for RDF
- Has a set of pre-defined ontology that can be used
 - Class, Resource, Property
- Can define our own classes and sub-classes
- Has domains and ranges to specify the classes for the subject and object

Example

:Book	rdf:type	rdfs:Class .
:bookTitle	rdf:type	rdf:Property .
:bookTitle	rdfs:domain	:Book .
:bookTitle	rdfs:range	rdfs:Literal .
:MyBook	:bookTitle	"My Book" .

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Conversational Systems

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Web Ontology Language

Web Ontology Language (OWL)

- An ontology formally defines relations among terms
- Enables definition of domain ontologies and sharing of domain vocabularies
- Modeled thru an object oriented approach
- Structure of a domain described as classes and properties
- Equivalent to Description Logic (DL)
- Provides more vocabulary than RDF Schema
 - Relations between classes : disjointness, intersection etc.
 - Cardinality : exactly one, min, max etc.
 - Equality : equivalent class, equivalent property, sameAs
 - Characteristics of property : symmetry, transitive, etc.

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Conversational Systems

Motivation

- Current scenario of User Interface for business applications:
 - GUI consisting of menus/forms
 - E.g ERP packages, Online Banking, E-Commerce applications.
- Menus restrict choice
- Control implicit
- Context at top
- Novice, Skilled, Expert users
- Graphical menus - slow skilled user ?
- Expert users type ahead of screen
- Can user find the menu item they need ?



Users pick what they want to do from a list of alternatives

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Some Applications

Conversational Systems

Restricted Natural Language Conversational User Interface for Menu-driven systems, using Semantic Web Technologies

Multi-modal Reasoning in Data-Intensive Domains

Domains with voluminous data to process and reason may require multiple reasoning sources to work together. Represent global data-source using Semantic Web technologies.

Multimedia extensions to OWL

Multimedia extensions to OWL to aid in the semantic linking and semantic retrieval of multimedia contents distributed over the web.

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Menu-driven systems: Problems

- The user is expected to be familiar with the usage of the GUIs, web-browsers etc.
- No additional information can be entered as the UI is fixed
- Time consuming for the experienced users to browse through various web-pages and options available on them
 - E.g Retrieving a particular information about an employee in an ERP package

You know what you want - but do not know where to specify it; nor do you have the time



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Restricted NL Conv. Sys.

Problems in unrestricted natural language UI:

- Highly ambiguous words having more than one meaning.
- Requires lot of domain knowledge for correct interpretation.
- Continuous evolution and extension of NLS.

Solution

- Making the language restrictive to cover only a limited subset of the vocabulary and syntax of a full natural language.
- Coverage of only domain specific concepts to reduce ambiguities.
- Establish a dialog, drill down to what the user wants, and carry out the request.



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Broad architecture

- User describes task to be carried out in natural language.
- System identifies key concepts from user input based on domain ontology.
- Domain Ontology described using Semantic Web technology - N3 / OWL
- Reasoning carried out on the ontology using W3C tool CWM - generate RDF file
- Concepts in RDF file are parsed and loaded. RDF parser
- Initiates a conversation for additional information to clarify the required task.
- Computes weight of all possible tasks based on concepts raised.
- Performs the maximum weighted task after confirming with user.



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Aim: Conversational System

Interface that enables communication with a machine by establishing a dialog in natural language as used in human-to-human interaction

Advantages

- Provides easily learned and easily remembered human-computer interaction.
- Linguistic structures, such as connectives, conditionals, and quantifiers, allows users to group sets of basic actions
- Reduces navigation time (number of clicks) for experienced users.



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Example

User input : Tell me which projects are running under 20% profitability

Noise words removal : projects running under 20% profitability

Synonym replacement: (all) projects active less than 20% profitability

Concepts raised by this input are:

<concept_type> : project
<concept_status> : active
<concept_profitability> : < 20%

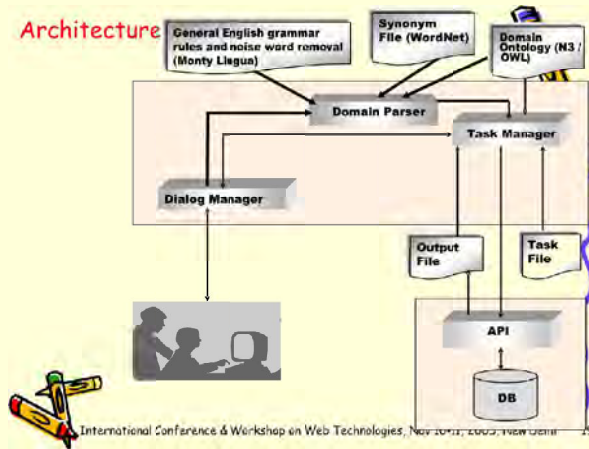
Concept list for task "project enquiry" :

<concept_type>, <concept_status>, <concept_team_members>
<concept_profitability>, <concept_duration>, <concept_revenue>.



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Architecture



Knowledge Representation (N3 / OWL)

Domain Lexicon

<Subject> : It identifies the subject of concept
<Predicate> : This identifies the relationship of the subject with the object.
<Object> : Indicates that the object in the relationship.

Example - Ontology

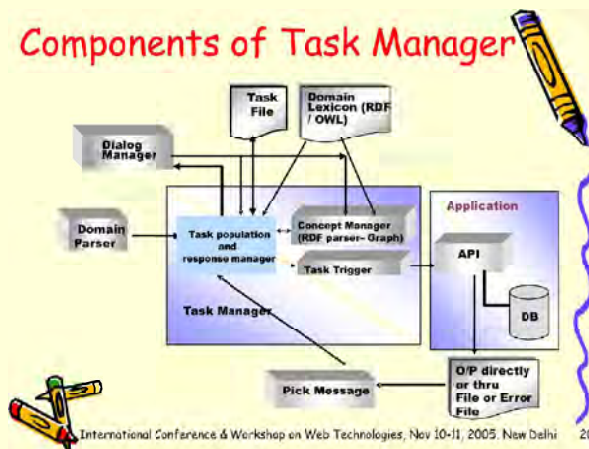
:WON	is_type_of	:project
:SWON	is_type_of	:project
:project	has_status	"CREATED, APPROVED, ACTIVE, CLOSED"
:project	has_param	"projectno, name, sdate, endate, status, type"
:empno	has_param	"empno, name"
:cost	has_param	"costno, billing projectno, revenue, realization, ..."
:allocations	has_param	"allocno, projectno, empno, sdate, endate, ..."

Example - Rules

```
{?x type WON} => {?x has_client " "}.
{x type SWON} => {?x has_corporate_sponsor " "}.
{x role TM ?z role owner ?x projectno ?y ?z projectno ?y} => {?x has_supervisor ?z}.
{x role TM ?x projectno ?y ?x empno ?z} => {?z is_in_group ?y}.
{x role TM ?z role GL ?x projectno ?y ?z projectno ?y} => {?x has_manager ?z}.
```

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Components of Task Manager



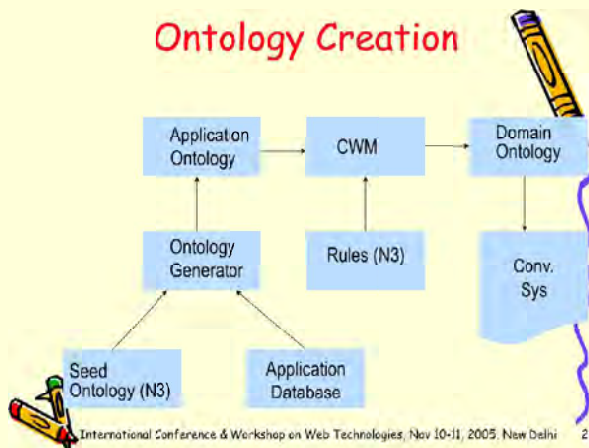
Reasoning: N3, CWM

RDF file generated

```
<rdf:Description rdf:about="http://www.tcs.com/nl-project/conv-sys/natas#1000">
  <aid rdf:resource="http://www.tcs.com/nl-project/conv-sys/natas#2"/>
  <allocno rdf:resource="http://www.tcs.com/nl-project/conv-sys/natas#1000"/>
  <empno rdf:resource="http://www.tcs.com/nl-project/conv-sys/natas#Allocations"/>
  <empno rdf:resource="http://www.tcs.com/nl-project/conv-sys/natas#108367"/>
  <endate rdf:resource="http://www.tcs.com/nl-project/conv-sys/natas#01-10-05"/>
  <has_supervisor rdf:resource="http://www.tcs.com/nl-project/conv-sys/natas#4000"/>
  <percentage rdf:resource="http://www.tcs.com/nl-project/conv-sys/natas#50"/>
  <projectno rdf:resource="http://www.tcs.com/nl-project/conv-sys/natas#100582"/>
  <role rdf:resource="http://www.tcs.com/nl-project/conv-sys/natas#TM"/>
  <sdate rdf:resource="http://www.tcs.com/nl-project/conv-sys/natas#01-01-05"/>
</rdf:Description>
```

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Ontology Creation



Multi-modal reasoning on data intensive domains

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Multi-modal reasoning

Surveillance and Assessment tasks are complex

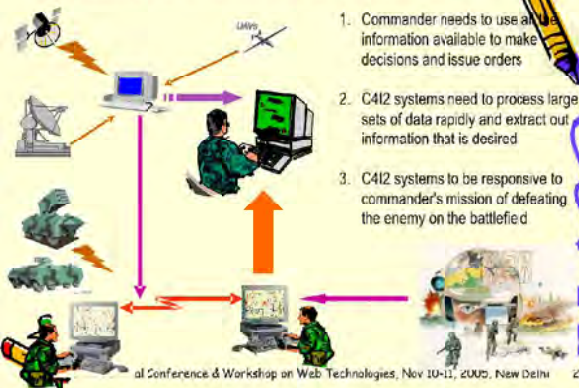
- Very large amounts of Data - mostly time-stamped data
- Need to analyze that data quickly and determine what is going on
- Want to predict before event / disaster occurs
- Has various interwoven knowledge / expertise
- Different possible courses of action

Surveillance Stock Market, Battlefield

Assessment Situation, Threat assessments

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Processing and Reasoning in C4I2 domain



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Aspects of Assessment

Stock market surveillance

- Create vital intelligence by analyzing data for fraudulent activities through evaluation of transactions and assessment of possible situations

- Help plan countermeasures to prevent frauds

Battlefield surveillance

- Create a wider and more global picture (scenario) of enemy activities
- Detect deeper patterns in terms of enemy objects, groups, nets, formations, etc.
- Identify possible enemy activities such as buildups, movements, plans and goals
- Identification, evaluation, prioritization of threats
- Have ability to retrieve information intelligently

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Framework for handling large numeric data

- Mechanism to specify patterns over data
Patterns can be approximate and time dependent
Fuzzy Temporal logic extensions to Prolog

- Detect if specified pattern is present in data
Parts of data that almost meets the pattern



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Framework for handling large numeric data

- Rules analyze situations identified by pattern-evaluator / work together with pattern evaluator

- If Double Top Pattern is present Then Alert (It may indicate Trend Reversal.)
- If Rounding Bottom Pattern is present Then Alert (Long consolidation period.)
- If Head & Shoulder is present Then Alert (Major trend Reversal may take place.)

Cases provide solutions to specific scenarios

- Capture experience of previous instances and reason new ones

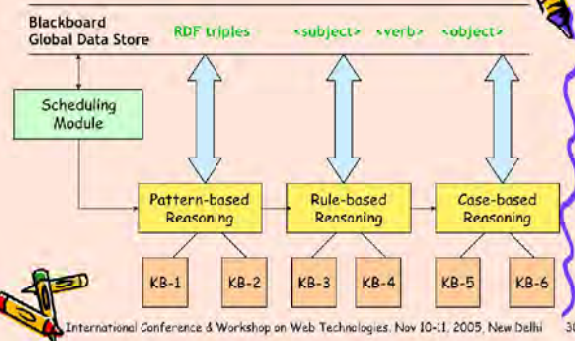
- Need to work in sync

- Partial solutions occur and need to work on these actively

- Decision support to evaluate alternate solutions to get maximum payoff

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Blackboard Architecture



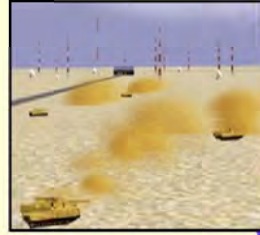
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REPORT

2RAJ-COMPO-TECH unit was asked to provide support by containing EW communications in Sector 63. All enemy EW units were jammed from 12:00 to 14:30 Hrs on 13 June 2004. This restricted enemy surveillance while our operations was on.

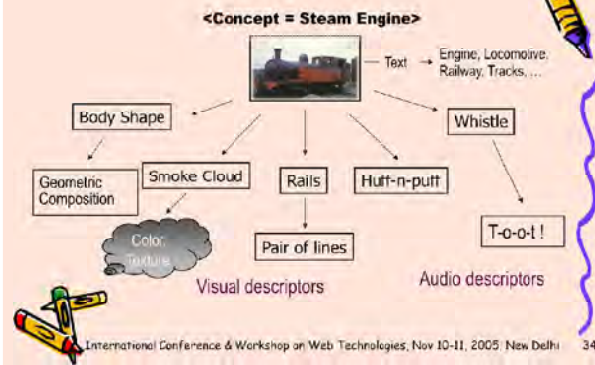
EXTRACTED INFORMATION

WHO 2RAJ-COMPO-TECH
WHAT Contain all enemy EW unit communications Jamming
WHEN 12:00 to 14:30 Hrs
 13 June 2004
WHY Restrict enemy surveillance while operations are on
 Sector 63



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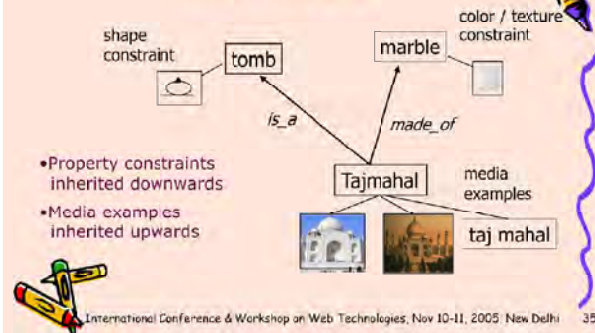
Observation Model



M-OWL Multimedia OWL TCS (Tata Infotech)

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Property Inheritance in Multimedia



M-OWL Multimedia Ontology Language

- Content based multimedia retrieval requires semantic interpretation of media features.
- Current ontology languages, e.g. OWL, do not support description of media events/objects in terms of media features
- Crisp Description Logic based reasoning in OWL is not suitable for reasoning in multimedia domain.

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M-OWL Characteristics

- Syntactically, extension to OWL
- New constructs for
 - Representing Media based description of a media object / event ... motivated by MPEG-7
 - Formal definition of spatial and temporal relations, like top, bottom, after, together, etc.
 - Classification of properties to support media property propagation rules
 - Representation of uncertainties (probabilities)
- reasoning scheme for property propagation
- Bayesian reasoning for concept recognition

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Thank you !