ODM and Rules - Semantic Enabled Complex Event Processing

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■ TIBCO Software
  • Largest independent software integration company
  • 3,000 customers in 40 countries using SOA, BPM and Business Optimization
  • Complex Event Processing one of the fast growing trends
Agenda

1. Complex Event Processing
   What is it and where does it fit in the IT and semantics worlds?

2. Semantic Processing and Real-time Event Processing
   How can semantics assist in real-world, real-time event processing?
Real-world Events

Customer Logon
Base Rate Increase
Ordered Item Arrives in Store
Customer Checks “Close Account” Web Page
New Liability Added
Mobile Call from CT @11.13
Rental Car Crashed
New Order
Rental Car Returned
Contract Submitted
Contract Returned thru EDI
Customer Logon

Base Rate Increase

Ordered Item Arrives in Store

New Liability Added

Rental Car Crashed

Customer Checks

Close Account

Web Page

New Order

Mobile Call from CT @11.13

Contract Submitted

Contract Returned thru EDI

Rental Car Returned
Where is the information?
The Event Cloud

- What **meaning** can we derive from the increasing “cloud of events”?

- Can we **infer** important business events by correlating events automatically + earlier, regardless of source / type?
Complex Event Processing

Sense and Respond

Track and Trace

Situation Awareness

Underlying Applications and Infrastructure
What Does CEP Solve?

- Potential Business Value
- Business Event
- Resulting Complex Event Measured
- Root Cause / Correlation
- Corrective Decision Made
- Action Taken
- Action time

- Warnings precede threats
- CEP provides quicker response to complex events
Implementing Complex Event Processing

Events

- Access and Monitor the “Event Cloud”
- Define complex events across events and existing data

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<td>Inference Rules</td>
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<td>Sets and Queries</td>
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Processors

- Continuously process events using procedural and declarative event processing elements

Information

- Stored Events and Data
- Event Storage

Access and Monitor via JMS, RV, MQ, TCP/IP, etc...
Sample “IT Models” used in CEP

- Event Model and Concept Model for static event and concept relationships
- State Model for dynamic, time-based concept lifecycles
- Query Model for sets and windows of events and concepts
- Rule Model for patterns of events and concepts
- Decision Model for managed decision tables

OMG MDA and Class/Object/Data Models

Computation Independent Models (CIM)

- SBVR: Semantics for Business Vocabularies and Rules
- ODM: Ontology Definition Metamodel

Platform Independent Models (PIM)

- UML2: Class Models

Platform Specific Models (PSM)

- SUN Java
- SQL
- MS .NET
- W3C WSDL
- W3C XML
- W3C RDF

OMG

W3C

OWL: Web Ontology Language

With platform-specific extensions
OMG MDA and Rule Models

Computation Independent Models (CIM)
- SBVR (Semantics for Business Vocabularies and Rules)

Platform Independent Models (PIM)
- OCL (Object Constraint Language)
- PRR (Production Rule Representation)

Platform Specific Models (PSM)
- OWL (Web Ontology Language)
- RIF (Rule Interchange Format)

Tools:
- TIBCO
- Pega
- JESS
- DROOLS
- ILOG
- Blaze

Formal UML model for production rules
- Defined in UML
- Extends UML so production rules are 1st class citizens alongside objects

Vendor-neutral UML-friendly rule representation
- Rules specified via tools, not manually!

2 rule “semantics” (types):
1. Forward chaining inference rules (e.g. Rete-model)
2. Sequentially processed procedural rules (e.g. scripts)

Import/export for rule modeling
- XMI between UML tools and BREs
PPR metamodel

- **Ruleset** = collection of Rule
- **Rule** is (for RuleVariables) if <Condition> then <Actions>
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Assumptions (1)

- **Most IT processing uses conventional, “fixed” IT models**
  - Knowledge mapped to structured object-oriented structures that run in JVM etc efficiently: changes require recompilation
  - Moving to knowledge-based models (e.g. RDF data) for existing applications is too expensive (abstraction, runtime, performance)
  - New IT management capabilities sometimes use RDF/OWL to support dynamic enterprise views & reduce application change time
Assumptions (2)

- Knowledge-based solutions may be most valuable when dealing with change / changeable entities / discovery or where flexibility is essential
  - Business intelligence / discovery activities
  - Complex cross-domain / cross-organizational information-based service delivery
  - Software system development and maintenance
Assumptions (3)

- Mitigated today in conventional IT systems through techniques like
  - Declarative production rules
  - BPM
  - Event driven architecture (type of SOA)
Assumptions (4)

- Semantics help in the “software system – person” boundaries, to augment conventional approaches, increase scalability of rule sets, or where reuse potential is high
Definitions

An **ontology** specifies a rich, updatable and verifiable description of the

- Terminology, **concepts**, nomenclature
- **Properties** explicitly defining concepts
- **Relations** among concepts (hierarchical and lattice)
- **Rules** to distinguish concepts, refining definitions and relations (constraints, restrictions, regular expressions)

relevant to a particular domain or area of interest.
Ontologies versus IT Models

Formal Ontology

UML

Catalog
Terms/Glossary
Thesauri "Narrower Term" Relation
Informal Is-a
Formal Is-a
Frames (Properties)
Disjointness, Inverse, Part-of...

General Logical Constraints

ODM

State
Class
Event
PRR
Query

IT levels of ontology support

*Based on "Choosing the Right Ontology Language" by Grimm, D., van Steen, A., Coull, D., Casado, C., McGuinness, Welty, Ushold, Gruninger, Lehmann
Ontologies driving CEP (1)

- Event Model and Concept Model for static event and concept relationships
- State Model for dynamic, time-based concept lifecycles
- Query Model for sets and windows of events and concepts
- Rule Model for patterns of events and concepts
- Decision Model for managed decision tables

Formal Ontologies

- UML: Class, Event, State
- ODM: Knowledge of object and event, inheritance, containment, & reference
- OWL: Knowledge of classification changes over time
- PRR: Knowledge of constrained sets, collection definitions; May change over time
- Formal Ontology: Knowledge of filtered behaviors across sets, including dynamic classifications
Ontologies driving CEP (2)

Event Model and Concept Model for static event and concept relationships

State Model for dynamic, time-based concept lifecycles

Query Model for sets and windows of events and concepts

Rule Model for patterns of events and concepts

Decision Model for managed decision tables

Formal Ontology

Semantic processing of event information, leading to:
- new event subtypes,
- new classifications,
- updated / new set definitions,
- updated / new production rules,
- updated / new decisions
Semantic CEP Architecture example

Event Sources → Event Bus → Event History → Semantic Agent

Semantic Agent contains:
- Event Reclassification & Re-aggregation
- Trend Analysis & Machine Learning
- Update Logic

Semantic Agent outputs to:
- Trend KB
- CEP

CEP contains:
- State Model
- Rulebase
- Queries

CEP processes:
- State Engine
- Inference Rule Engine
- Query Engine

Business Event Meta-Patterns KB

Event Consumers
Example Semantic CEP roles

- Update object model and associated metadata
  (time to live, history depth, etc)

- Update rule parameters
  (new / revised classes and subclasses to look for, attribute ranges that are significant, etc)

- Update state model
  (transition rule values, wait times for missing events, new conditions, eliminate invalidated states, etc)
Example Semantic CEP Use Cases

- Call Center / CRM Operations to identify conflicting Client Advisories
- Intelligence Analysis supporting research operations
- Semantically enhanced Fraud Detection and Financial Regulation
- IP Content Publication & Management for Media
Summary

- **Complex Event Processing**
  - a “new kid” on the IT block
  - using high-performance IT capabilities to provide a continuous event/data aggregation architecture

- **Semantic Extensions**
  - new approaches to bridging the semantic / KR and conventional IT / model-driven worlds
  - convergence with modern IT solutions like CEP