ODM and Rules - Semantic Enabled Complex Event Processing

Paul Vincent, Business Optimization Group, TIBCO Software
Paul Vincent

- CTO, Business Rules and Complex Event Processing
- Contributor to standards (OMG PRR Co-Chair, W3C RIF)
- Contributor to Event Processing research
  - EPTS Reference Architecture Working Group co-chair
  - EPTS Metamodelling Working Group co-chair
- Co-author http://tibcoblogs.com/cep/

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
- New Liability Added
- Rental Car Crashed
- Customer Checks “Close Account” Web Page
- Mobile Call from CT @11.13
- New Order
- Contract Submitted
- Rental Car Returned
- Contract Returned thru EDI
- Rental Car Crashed
- New Liability Added

Where is the information?

Fraud Risk!

Risk of Customer Defection

Customer CrossSell Opportunity

Change in Product Sales Trend

Stock Capacity trending to limit

Compliance Limit Approached

Cell phone fraud alert

Contract Validated

Customer now rated Gold

Rental Contract Complete

Contract Valid
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
What Does CEP Solve?

Warnings precede threats

CEP provides quicker response to complex events

Potential Business Value

Resulting Complex Event Measured

Root Cause / Correlation

Corrective Decision Made

Action Taken

Action time
Implementing Complex Event Processing

Access and Monitor the “Event Cloud”

Define complex events across events and existing data

Events
- Event and Data Structures
- States and Transitions
- Inference Rules
- Sets and Queries

via JMS, RV, MQ, TCP/IP, etc...

Information
- Stored Events and Data

Event Storage

Continuously process events using procedural and declarative event processing elements
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

UML Class
UML Event
UML State
UML PRR
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
  - With platform-specific extensions

Platform Specific Models (PSM)
- SUN Java
- SQL
- MS .NET
- W3C WSDL
- W3C XML
- W3C RDF

OMG
- W3C

• 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
PRR metamodel

- **Ruleset** = collection of Rule
- **Rule** is (for RuleVariables) if **Condition** then **Actions**
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?
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
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.

---

*Based On AaaI '99 Ontologies Panel - Mcguinness, Welty, Usbhol, Gruninger, Lehmann*
Ontologies versus IT Models

Formal Ontology

UML ODM

IT levels of ontology support

UML Class
UML Event
UML PRR
UML State
Queries

Catalog

Thesauri “Narrower Term” Relation
Formal Is-a
Frames (Properties)
Disjointness, Inverse, Part-of...

Terms/Glossary
Informal Is-a
Formal Instance
Value Restrictions
General Logical Constraints

*Based on: Gruninger, Welty, Ushold, Gruninger, Lehmann
Ontologies driving CEP (1)

**Formal Ontology**
- Object and event, inheritance, containment, & reference
- Knowledge of classification changes over time

**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

Knowledge of constrained sets, collection definitions; May change over time

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

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
- Business Event Meta-Patterns KB
- Event History
- Event Reclassification & Re-aggregation
- Trend KB
- Trend Analysis & Machine Learning
- Update Logic
- Event Consumers
- CEP
- State Engine
- Rulebase
- Inference Rule Engine
- Query Engine
- Queries
- State Model

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