The Role of Rules in CEP
and Rule Standards

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- Business Rules and Complex Event Processing specialist
- Contributor to relevant standards (OMG PRR, W3C RIF) and industry consortia (EPTS)

**TIBCO Software**
- Provides enterprise software that helps companies achieve service-oriented architecture (SOA) and business process management (BPM) success
- Over 3,000 customers and offices in 40 countries
- 3 main technology areas: SOA, BPM and Business Optimization
  - CEP: TIBCO BusinessEvents
  - CEP Customers: Telco, Finance, Manufacturing/RFID, Transport/Logistics
- Contributor to / member of OMG, OASIS, W3C, etc
Complex Event Processing

Continuous Event Processing

Complex Patterns of Events

(Lots of Events)

Event Store

Business Processes: BPM & Workflow Processes

IT Services: SOA & traditional Data Processing

Persistence Services

Sense and Respond
Track and Trace
Situational Awareness

New Order
New Order
New Order
(Lots of Events)
Complex Event Processing

Processing type:
Decision Processing
Event Processing
Complex Business Problems

- **Fraud / Theft**
  - Thousands-to-millions of high-value small-size product items or transactions
  - How do you identify known patterns of “suspicious” behavior?

- **Logistics / Scheduling**
  - Raw material, production & delivery scheduling and resources are complex and prone to change
  - How do we reallocate resources to handle business and production changes?

- **Activity Monitoring**
  - Complex production and supply process with multiple actors
  - How to measure and action Key Performance Indicators?
Associated Events

- **Positive Events**
  - Product item X arrives at Production station S from Store T
  - Production worker Y arrives at Production station S
  - Production contract for item Z by time T is posted

- **Negative Events**
  - Product item X has been in transit to Store T for >15 minutes
  - Subcomponent Y hasn’t arrived at the Production station by the ETA
  - Delivery of contract Z has not taken place

- **Sets of Events**
  - 5+ items of Product item type Y failed to arrive at destination
  - Supplier Y was 5 mins late for 1 delivery, but made it early to the next
  - Return rate on component Z exceeds SLA %
Significant features of these Events

- **Time Sensitivity**
  - A thief may leave the building at the same time as stolen product
  - A product should take 40 minutes to travel a given production line segment

- **Distributed Event Sources**
  - A series of produced items fails at various QA stages, and their common attribute was a storage location
  - Multiple suppliers for a subcomponent are reporting delivery delays
CEP Technologies are diverse

- CEP applies pattern detection (including filtration) to the event cloud / streams / history thereof
- Multiple modelling + execution paradigms available for pattern detection
- No single standard likely to suffice
“Requirements for CEP Technology”

- **Access and Monitor the “Event Cloud”**
  - JMS, RV, MQ, TCP/IP, etc…
  - Timers to detect lack of events
  - Determine event state changes

- **Match Patterns, Apply Business Logic**
  - Detect events
  - Detect event patterns
  - Maintain State and Facts over time
  - Update Detection algorithms as events change

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**Event Bus or Source**
- Low-latency reliable message delivery

**Event and Data Model**
- for information modeling

**Temporal Model**
- for determining time-dependent info

**Pattern Detection Model**
- for recognizing patterns, defining actions
CEP Problem Characteristics

- Processing complexity per event
- Events throughput per second

Problem A

Problem B
Different CEP Implementations

Event Sources

Event Cache

Event Bus

Event Consumers

Rule-Driven CEP
- State Engine
- State Model
- Inference Rule Engine
- Rulebase

Neural Net CEP
- Neural Net
- Network

Event Stream Processing CEP
- ProcessFlow of queries
- Stream Queries

Event Services
Cache
Types of CEP Agents / Processes
CEP and Other Architectures

Event Sources

Event Bus

Event Consumers

Distributed Event Cache

Complex Event Processing Agent (1)

CEP (2)

CEP (3)

CEP (4)

Business Process Management

SOA Services

Data Services

Helper Processes and Services
Example Related Standards

- **Event Bus or Source**
  - Low-latency reliable message delivery

- **Event and Data Model**
  - for information modeling

- **Temporal Model**
  - for determining time-dependent info

- **Pattern Detection Model**
  - for recognizing patterns, defining actions

- **History and Cache**

- **JMS**

- **OMG EMP**
  - (RFP in progress)

- **OMG UML2**
  - Class Models

- **OMG UML2**
  - State Models
Rule-oriented view of CEP Patterns

- Event Bus or Source
  - Low-latency reliable message delivery

- Event and Data Model
  - For information modeling

- Temporal Model
  - For determining time-dependent info

- Pattern Detection Model
  - For recognizing patterns, defining actions

- History and Cache

(Lots of Events) -> Complex Patterns

Rule

Reaction
Rule Representation options

**Complex Patterns**

**Rule**

**Reaction**

**Common representations:**
- Script languages
- Java-based languages

**Common execution semantics:**
- Orchestration/ordering of queries
- Rete-based inferencing

**Continuous Query Languages**
**Production Rule Conditions**
Rule types for CEP

Rule classification per Gerd Wagner, RuleML
Current Standards for Rules (per OMG MDA)

Model Driven Architecture (MDA)

Computation Independent Models (CIM)
- Business Models

Platform Independent Models (PIM)
- UML Models

Platform Specific Models (PSM)
- UML Models - platform specific

Top-down analysis and development

Semantics for Business Vocabulary and Rules (SBVR)

Production Rule Representation (PRR)

Rule Interchange Format (RIF)

JSR-94

Code / Execution
OMG MDA and Class/Object/Data Models

OMG

Platform Independent Models (PIM)

Computation Independent Models (CIM)

SBVR
Semantics for Business Vocabularies and Rules

OWL
Web Ontology Language

ODM
Ontology Definition Metamodel

UML2
Class Models

With platform-specific extensions

Platform Specific Models (PSM)

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

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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)
- TIBCO
- Pega
- JESS
- DROOLS
- ILOG
- Blaze

OMG
- OWL: Web Ontology Language

W3C
- RIF: Rule Interchange Format
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>`
Rule Interchange Format proposed as a cross-vendor and cross-rule-type rule interchange representation

Consortium of developers and researchers from the
- rule vendor community (TIBCO, Fair Isaac, Ilog, Oracle, etc)
- research community (RuleML.org, DERI, REWERSE, IBM R&D, etc)
- end-user community (MISMO, Betfair, MITRE, etc)
- CEP members include TIBCO, Prova
RIF = Superset rule language

- **A format (but actually a language itself)**
  - Allows rules written for one application to be published, shared, and re-used in other applications and other rule engines.
  - Part of W3C's larger mission of enabling the sharing of information in forms suited to machine processing
  - Includes semantic web rule languages as well as commercial tools

![Diagram](image_url)
Equivalences in PRR and RIF

OMG modeling stack

PRR v1

PRR v2 using RIF expr lang

Shared metamodel

W3C technology stack

RIF Dialect for logic rules

RIF Dialect for PR (PRD)

Shared expression language

Equivalent semantics + Simple Translation

Modeling: design time

Interchange: run time
Timeline for Rule Stds

Organizations

- RuleML.org
- W3C
- OMG
- Java Community Process
- RIF WG
- Business Rules Working Group
- Business Modeling and Integration BMI
- JSR-94 Rule Engine API
- RuleML schema
- common community
- JSR-94
- PRR RFP
- BMM
- SBVR
- RIF

Standards
Summary

- Rules are a relevant pattern for CEP modeling + implementation
- Rule standards now in development by a large, active community
  - CEP members include: TIBCO, Prova
  - Vendors involved who have other groups doing CEP: Oracle, IBM
  - Standardization process improves communication among vendors, academics ➞ better understanding of rules and rule uses
- PRR and RIF PRD kept in sync by common membership
- Timescale: PRR1.0 finalization, PRD Draft in 2008
OMG = [http://www.omg.org](http://www.omg.org)
  includes the Business Rules Working Group (PRR and SBVR standards)
  as well as BPMI (BPMN standard)
- OMG PRR details [OMG only] =
  [http://www.omg.org/techprocess/meetings/schedule/Prod._Rule_Representation_RFP.html](http://www.omg.org/techprocess/meetings/schedule/Prod._Rule_Representation_RFP.html)

W3C = [http://www.w3.org](http://www.w3.org)
- W3C RIF = [http://www.w3.org/2005/rules/wg](http://www.w3.org/2005/rules/wg)


Academic Community
- Related EU projects: [http://rewerse.net/](http://rewerse.net/)