

The New Rules of Business: Semantic Web as Disruptive Innovation

Benjamin Grosf

Assistant Professor of IT, MIT Sloan School of Management
As of July 1 2007: Sr. Research Program Manager, Vulcan Inc.

<http://ebusiness.mit.edu/bgrosf>



*Invited Keynote Presentation (50-min.) at the
6th European Business Rules Conference (EBRC-2007)
Dusseldorf, Germany, June 19, 2007*

Quickie Bio of Presenter Benjamin Grosf

- MIT Sloan professor 2000 since 2000
- 12 years at IBM T.J. Watson Research; 2 years at startups
- PhD Comp Sci, Stanford; BA Applied Math Econ/Mgmt, Harvard
- Semantic technology as main research area:
 - Rules as core technology; on web; in combination with ontologies
 - Business Applications, Implications, Strategy, Market Evolution
- Overall: knowledge representation, e-commerce, agents
- **News:** Will join Vulcan Inc. in July 2007, working for Paul G. Allen (co-founder of Microsoft)
 - leading a new research program; and working closely with the VC arm
 - also continuing part-time consulting practice (part of arrangement with

Vulcan)
6/19/2007

Copyright 2007 by Benjamin Grosf. All Rights Reserved

Outline

- I. Semantic Rules – Overview [*will SKIM*]
 - what, where, why, when
 - history, context, relationship to Web
 - recent developments
 - research breakthroughs → initial steps of commercial adoption; standards
 - roadmapping technology, applications, business value
- II. Strategic Analysis of Market Evolution
 - Pattern of disruption in the business rules market
- III. What to do about it
 - What players like you can/should do

Resources

- Author's website (<http://ebusiness.mit.edu/bgrosf>)
 - ... see especially there:
 - Recent talks
 - this one soon, at [.../#EBRC2007Talk](#)
 - WWW-2006 Tutorial slideset “Semantic Web Rules with Ontologies, and their E-Services Applications”
 - Recent papers
 - examples of policy application scenarios
 - SweetRules toolset (<http://sweetrules.projects.semwebcentral.org>)

Outline

- I. Semantic Rules – Overview [*will SKIM much of*]
 - what, where, why, when
 - history, context, relationship to Web
 - recent developments
 - research breakthroughs → initial steps of commercial adoption; standards
 - roadmapping technology, applications, business value
- II. Strategic Analysis of Market Evolution
 - Pattern of disruption in the business rules market
- III. What to do about it
 - What players like you can/should do

The following Part I slides, largely skimmed here, are mostly from the talk slidesets for:

1. “Semantic Rules for Policies and Services on the Web: Techniques, Business Applications, and Standards”

by Benjamin Grosf

<http://ebusiness.mit.edu/bgrosf/#SemRules1205Talk>

2. “Commercializing Semantic Web: Rules, Services, and Roadmapping”

by Benjamin Grosf

<http://ebusiness.mit.edu/bgrosf/#ESTC2007Talk>

Flavors of Rules Commercially Most Important today in E-Business

E.g., in OO app's, DB's, workflows.

1. Relational databases, SQL: Views, queries, facts are all rules.
 - XQuery, SPARQL emerging. SQL99 even has recursive rules.
2. Production rules (OPS5 heritage): e.g.,
 - Fair Isaac, ILOG, Haley, etc.: rule-based Java/C++ objects.
3. Event-Condition-Action rules (loose family similar to PR), cf.:
 - business process automation / workflow tools.
 - active databases; publish-subscribe.
4. Prolog. *“logic programs” as a full programming language.*
5. *(Lesser: other knowledge-based systems.)*

“*Semantic*”

- “Semantic” in “semantic rules” and “semantic web” means:
 - 1. Knowledge-based
 - ... and ...
 - 2. Having meaning independent of algorithm and implementation
 - I.e., equipped with an interoperable conceptual abstraction
 - ... based on declarative knowledge representation (KR)
 - (vs. procedural, dependent on inferencing control strategy, inferencing engine)

Exploding Research Interest in SW

Since 2002: ...

- International Semantic Web Conference (ISWC) formed
 - Grown to 400+ researchers
- Became 2nd largest topic area of the International Conference on the World Wide Web (WWW)
 - (1st is Search, i.e., Google etc.)
- Specialized conferences formed: e.g., RuleML
- Major Research Programs in US and EU
- Professional Societies Chapters formed: e.g., AIS SIG
- Journals formed: e.g., J. Web Semantics
- Several industry standards efforts (some done)

Exploding Commercial Interest in SW and Semantic Technology

- 3rd SemTech (Semantic Technology) Conference in Silicon Valley held May 2007
 - ~700+ participants
- 1st European Semantic Technology Conference held June 2007
 - ~225 participants
- Numerous startups – esp. in US, EU
- Standards activities with strong participation, e.g., W3C
 - Large, medium, and small companies
- VC's seriously interested (since ~fall 2006)
- Front page article NY Times (Nov. 2006)
- US DoD/national-intelligence a strong customer

New Fundamental Rule KR Theory that enables Key Technical Requirements for SWS

In 1985-94:

- Prolog interoperable with relational DB; LP extends core-SQL [many]
- Richer logical connectives, quantifiers [Lloyd & Topor]
- “Well Founded” Semantics for Negation-As-Failure [Van Gelder et al; Przymusinski]
- Hilog quasi-higher order expressiveness, meta-syntax flexibility [Kifer et al.]
- Frame syntax cf. F-Logic [Kifer et al.]

In 1995-2004:

- **Courteous LP: prioritized conflict handling** [Groszof]
 - Robust, tractable, modular merging & updating
- **Situated LP: hook rules up to services** [Groszof]
- **Description LP: combine Description Logic ontologies** [Groszof et al.]
- **Courteous Inheritance: combine OO default ontologies** [Groszof et al.]
- **Production Rules as LP: interoperate** [Groszof et al.]
 - Declarative LP as interoperable core between commercial families [Groszof et al.]
- **Hypermonotonic Reasoning: combine with FOL** [Groszof (in-progress)]

Semantic Rules: Use Cases from our research

- Contracts/negotiation, advertising/discovery
 - E-procurement, E-selling
 - Pricing, terms & conditions, supplier qualification, ...
- Monitoring:
 - Exception handling, e.g., of contract violations
 - Late delivery, refunds, cancellation, notifications
 - Notifications, personal messaging, and other workflow
- Trust Policies: authorization, confidentiality & privacy, security, access control
 - E.g., financial services, health care
 - *Extensive analysis of business case/value*
- Semantic mediation: rule-based ontology translation, context-based information integration

Concept of Knowledge Representation (KR)

- A knowledge representation S is defined as a triple $(LP, LC, |=)$, where:
 - LP is a formal language of sets of premises (i.e., premise expressions)
 - LC is a formal language of sets of conclusions (i.e., conclusion expressions)
 - $|=$ is the entailment relation.
 - $Conc(P,S)$ stands for the set of conclusions that are entailed in KR S by a set of premises P
 - We assume here that $|=$ is a functional relation.
- **Heritage of KR concept:** **AI, DB** areas of comp sci; earlier: logic from math, phil.; programming languages foundations

Example of Entailment: Mortality

- In First-Order Logic (FOL) KR:
 - Let P be the premises:
 - $\forall ?X. \text{human}(?X) \Rightarrow \text{mortal}(?X).$
 - $\text{human}(\text{Socrates}).$
 -
 - In FOL, P entails (among others) the conclusion:
 - $\text{mortal}(\text{Socrates}).$
 - Notation:
 - “ \forall ” means “for all”.
 - “?” Prefixes a logical variable.

Example of Entailment: Sunday Stroll

- In Bayesian Probability KR:
 - Let P be the premises:
 - $\text{prob}(\text{rainySunday}) = 0.4.$
 - $\text{prob}(\text{funSunday} \mid \text{rainySunday}) = 0.3.$
 - $\text{prob}(\text{funSunday} \mid \neg\text{rainySunday}) = 0.9.$
 -
 - In this KR, P entails (among others) the conclusion:
 - $\text{prob}(\text{funSunday}) = 0.66.$

Example of Entailment: Discounting

- In the **Courteous Logic Programs KR** (e.g., **RuleML**):
Let P be the premises:
 - {loyald} discount(?cust, RamadaHotel, 10percent)
 ← memberOf(?cust, AAA).
 - {seniord} discount(?cust, RamadaHotel, 25percent)
 ← age(?cust, ?x) and greaterThan(?x, 64).
 - overrides(seniord, loyald).
 - \perp ← discount(?c, ?h, ?y) and discount(?c, ?h, ?z) | (?y \neq ?z).
 - memberOf(Faisal, AAA).
 - age(Faisal, 72).
- In this KR, P entails (among others) the conclusion:
 discount(Faisal, RamadaHotel, 25percent).

Example of Discounting, cont.'d

In the more general **Production Logic Programs KR**:

Suppose one adds the rule:

- @emailCouponAd(?cust, RamadaHotel, ?x)
 ← discount(?cust, RamadaHotel, ?x).

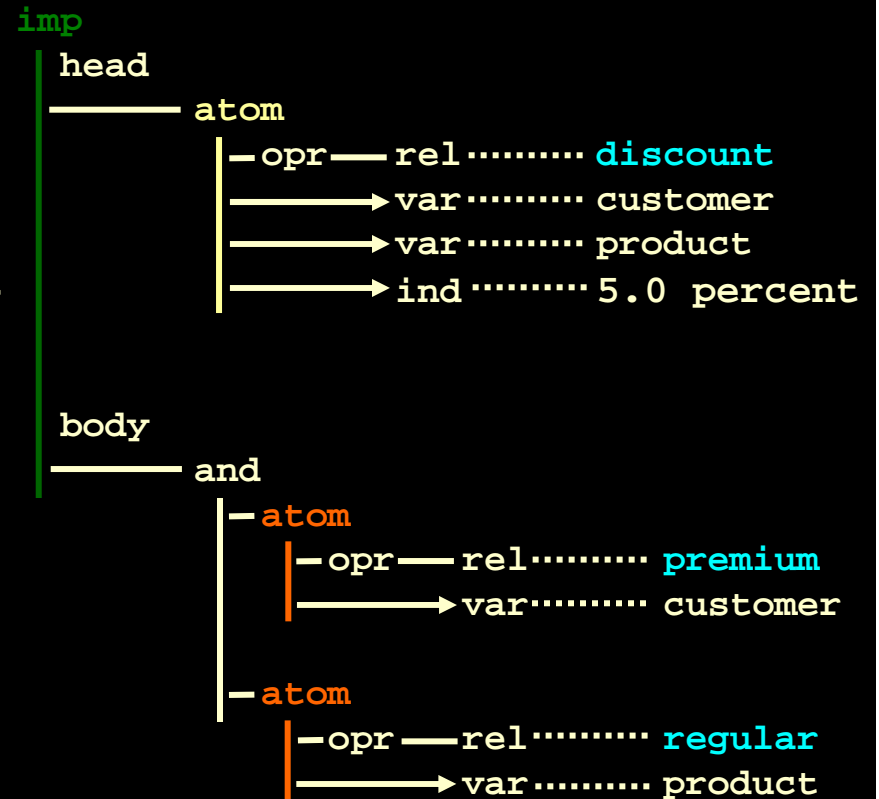
Then P entails the action (i.e., sanctions a call to an attached procedure):

@emailCouponAd(Faisal, RamadaHotel, 25percent).

RuleML Example: Markup and Tree

'The **discount** for a *customer* buying a *product* is **5.0 percent** if the *customer* is **premium** and the *product* is **regular**.'
discount(?customer,?product,"5.0 percent") ← premium(?customer) ∧ regular(?product);

```
<imp>
  <head>
    <atom>
      <opr><rel>discount</rel></opr>
      <tup><var>customer</var>
        <var>product</var>
        <ind>5.0 percent</ind></tup>
    </atom>
  </head>
  <body>
    <and>
      <atom>
        <opr><rel>premium</rel></opr>
        <tup><var>customer</var></tup>
      </atom>
      <atom>
        <opr><rel>regular</rel></opr>
        <tup><var>product</var></tup>
      </atom>
    </and>
  </body>
</imp>
```



tup is an ordered tuple.

XML
XPath
XSLT
XQuery
XForms

KR: What's the Game?

Desiderata

- Expressiveness: what can be said
 - useful, natural, complex enough
- Syntax: encoding data format -- e.g., in XML
 - easy enough to edit and communicate, by computers and by humans
- Semantics: principles of sanctioned inference, independent of reasoning algorithms:
 - clear, useful, natural, and understandable enough
- Computational Tractability (esp. worst-case): scale up in a manner qualitatively similar to relational databases: computation cycles go up as a polynomial function of input size
- Reasoning algorithms (compute the entailed conclusions):
 - sound (correct), complete, efficient, clear, and simple enough to engineer

Semantic Rules: Differences from Rules in the 1980's / Expert Systems Era

- Get the KR right (knowledge representation)
 - More mature research understanding
 - Semantics independent of algorithm/implementation
 - Cleaner; avoid general programming/scripting language capabilities
 - Highly scalable performance; better algorithms; choice from interoperability
 - Highly modular wrt updating; use prioritization
 - → Highly dynamic, scalable rulebase authoring: distributed, integration, partnering
- Leverage Web, esp. XML
 - Interoperable syntax
 - Merge knowledge bases
- Embeddable
 - Into mainstream software development environments (Java, C++, C#); not its own programming language/system (cf. Prolog)
- Knowledge Sharing: intra- or inter- enterprise
- Broader set of Applications

Semantic Rules News

News recently:

- Fundamental theory and technique breakthroughs, e.g.:
 - **Declarative logic programs** (LP) basis for interoperability, then webized → **RuleML** standards design (2001-)
 - **Courteous** LP prioritized defaults, robust modular merging
 - **Description** LP ontology integration
 - **Production** LP interoperability+semantics for production rules, declarative procedural attachments for actions and queries
 - **SweetRules** V2 open source toolset platform (2004-)
- Large US, EU research projects (**DAML**, **WSMO**) focus on rules
(DARPA Agent Markup Language; Web Service Mediation Ontology)

Semantic Rules News (cont. 'd)

News recently:

- **W3C** forms Rule Interchange Format WG, full standards effort, after holding a Workshop (2005)
- **OMG** forms standards efforts on production rules, rule management, SBVR (semantic business vocabulary and rules)
- Java JSR-94 for rule management
- **Semantic Web Services Framework** design (2005) focuses on rules
- Rule-based Policy area heats up in web services, semantic web, incl. at **Oasis**. Oasis forms Semantic Execution Env. standards effort (2005).
- Semantic web rules workshop series becomes full research **conference** (RuleML-2005) colocated with ISWC
- **Forrester, Gartner**, etc. reports on rules sector

SKIMMED SLIDES
BEGIN

Talk Mode: the MIT Firehose



Shortened from a 90-minute talk
⇒ Some skimmed

6/19/2007

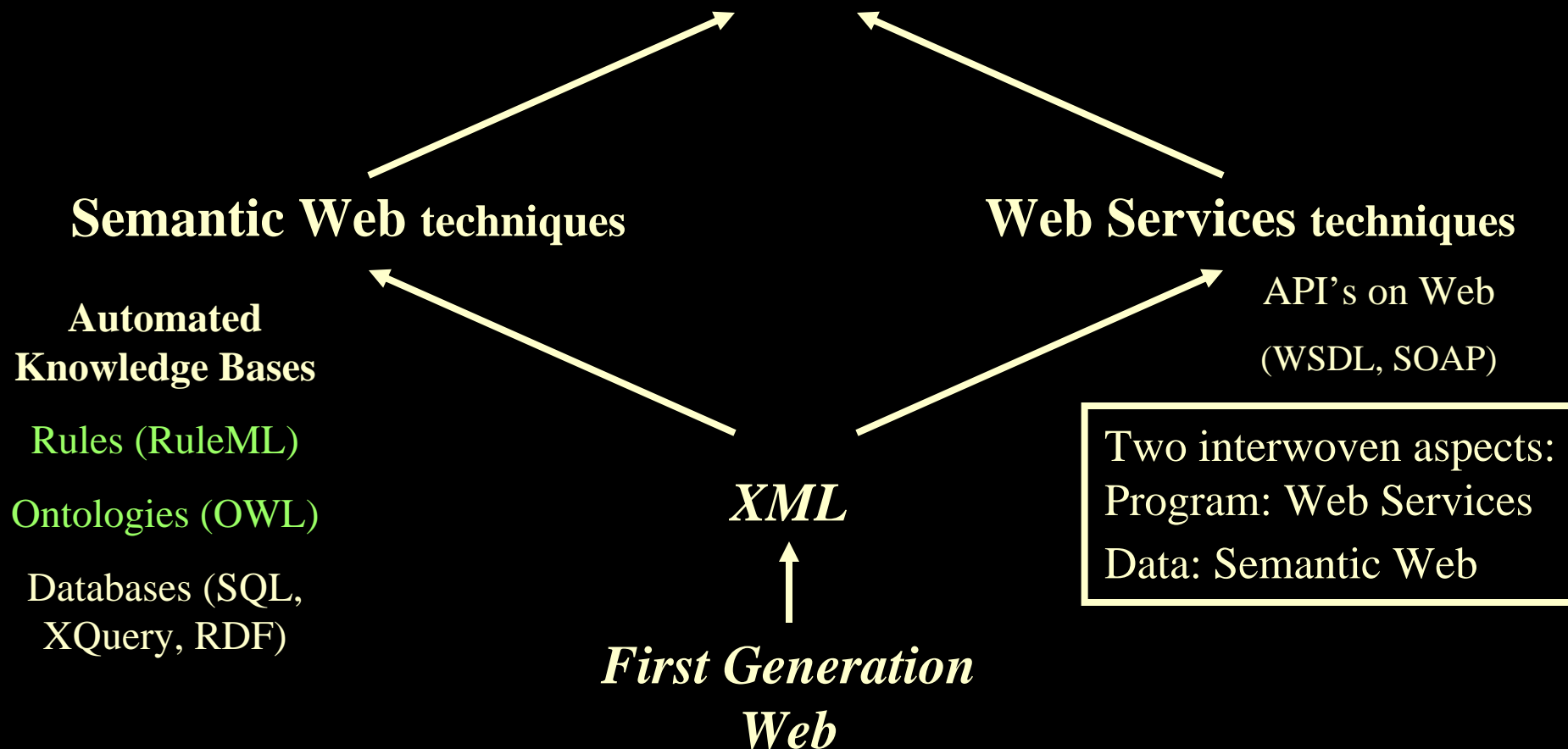
Copyright 2007 by Benjamin Grosf. All Rights Reserved

Semantic Rules Standards Design (historically)

- Forerunners from R&D: pure Prolog, KIF, CommonRules, EECOMS, RuleML early, SWSL, WSML, ...
 - Description Logic Programs
 - Logic Programs to/from Production Rules
- RuleML, JSR-94, SBVR, PRR, ISO CommonRules, W3C RIF, SPARQL

Next Generation Web

Semantic Web **Services**



Semantic Web: concept, approach, pieces

- Shared semantics when interchange data \therefore knowledge
- **Knowledge Representation** (cf. AI, DB) as approach to semantics
 - Standardize KR syntax, with KR theory/techniques as backing
- **Web-exposed Databases**: SQL; XQuery (XML-data DB's)
 - Challenge: share DB schemas via meta-data
 - **RDF**: “Resource Description Framework” W3C standard
 - Meta-data low-level mechanics: unordered directed graphs (vs. ordered trees)
 - RDF-Schema extension: simple class/property hierarchy, domains/ranges
- **Ontology** = formally defined vocabulary & class hierarchy
 - **OWL**: “Ontologies Working Language” W3C standard
 - Subsumes RDF-Schema and Entity-Relationship models
 - Based on Description Logic (DL) KR \sim subset of First-Order Logic (FOL))
- **Rules** = if-then logical implications, facts \sim subsumes SQL DB's
 - **RuleML**: “Rule Markup Language” emerging standard
 - Based on Logic Programs (LP) KR \sim extension of Horn FOL
 - Also provide FOL KR

Beware Narrow Usage of “Semantic Web”

- *Some people* use “semantic web” to mean *only*:
stuff that uses RDF and OWL.

... E.g., often W3C does this.

- We use the broader sense, as does the overall SW R&D community.

Our Research Aspects/Questions about the Semantic Web

- **Core technologies:** Requirements, concepts, theory, algorithms, standards?
 - Rules in combination with ontologies; probabilistic, decision-/game-theoretic
- **Business applications and implications:** concepts, requirements analysis, techniques, scenarios, prototypes; strategies, business models, market-level evolution?
 - End-to-end e-contracting, finance, trust; ...

Vision: Uses of Rules in E-Business

- Rules as an important aspect of coming world of Internet e-business: rule-based business policies & business processes, for B2B & B2C.
 - represent seller's offerings of products & services, capabilities, bids; map offerings from multiple suppliers to common catalog.
 - represent buyer's requests, interests, bids; → matchmaking.
 - represent sales help, customer help, procurement, authorization/trust, brokering, workflow.
- Known advantages of rules vs. general code
 - separable business logic, more reusable across app.'s, life cycle
 - good for loose coupling cf. workflow
 - good for representing contingent behavior of services/processes.
 - high level of conceptual abstraction; easier for non-programmers to understand, specify, dynamically modify & merge.
 - executable but can treat as data, separate from code
 - potentially ubiquitous; already wide: e.g., SQL views, queries.
- Rules in communicating applications, e.g., embedded intelligent agents.

SWS and Rules Summary

*** SWS Tasks Form 2 Distinct Clusters,
each with associated Central Kind of Service-description
Knowledge and Main KR*

1. Security/Trust, Monitoring, Contracts, Advertising/Discovery, Ontology-mapping Mediation

- Central Kind of Knowledge: Policies
- Main KR: Nonmon LP (rules + ontologies)

2. Composition, Verification, Enactment

- Central Kind of Knowledge: Process Models
- Main KR: FOL (axioms + ontologies)
 - + Nonmon LP for ramifications (e.g., cf. Golog)
- Thus RuleML & SWSF specify both Rules, FOL
 - Fundamental KR Challenge: “Bridging” Nonmon LP with FOL
 - SWSF experimental approach based on hypermon. [Grosf & Martin]

Production Logic Programs: *A New Fundamental Rule KR Approach*

In 2005:

- Production extension of LP:
 - actions and tests appear directly within rules (procedural attachments)
 - Generalizes Situated LP a bit, and reformulates it more familiarly
- Theory & algorithms achieving semantic interoperability of {core Production Rules} \leftrightarrow declarative LP
 - Handles negation correctly, by stratifying PR agenda control strategy
 - 1st declarative semantics for Production Rules
- Combines with all the other features: Courteous, ...
- \rightarrow “**Production LP**” as umbrella LP KR approach

Some Answers to:
“Why does SW Matter to Business?”

- 1. “Death. Taxes. Integration.” - They’re always with us.
- 2. “Business processes require communication between organizations / applications.” - Data and programs cross org./app. boundaries, both intra- and inter- enterprise.
- 3. “It’s the *automated knowledge* economy, stupid!”
 - The world is moving towards a knowledge economy. And it’s moving towards deeper and broader automation of business processes. The first step is automating the use of structured knowledge.
 - Theme: *reuse* of knowledge across multiple tasks/app’s/org’s

EECOMS Example of SCM Policy Rules: Ordering Lead Time

- Vendor's rules that prescribe how buyer must place or modify an order:
 - A) 14 days ahead if the buyer is a qualified customer.
 - B) 30 days ahead if the ordered item is a minor part.
 - C) 2 days ahead if the ordered item's item-type is backlogged at the vendor, the order is a modification to reduce the quantity of the item, and the buyer is a qualified customer.
- Suppose more than one of the above applies to the current order?
Conflict!
- Helpful Approach: **precedence** between the rules. Often only *partial* order of precedence is justified. E.g., $C > A$.

Courteous LP's: Ordering Lead Time Example

```
{leadTimeRule1} orderModificationNotice(?Order,14days)
    ← preferredCustomerOf(?Buyer,?Seller) ∧
       purchaseOrder(?Order,?Buyer,?Seller) .

{leadTimeRule2} orderModificationNotice(?Order,30days)
    ← minorPart(?Buyer,?Seller,?Order) ∧
       purchaseOrder(?Order,?Buyer,?Seller) .

{leadTimeRule3} orderModificationNotice(?Order,2days)
    ← preferredCustomerOf(?Buyer,?Seller) ∧
       orderModificationType(?Order,reduce) ∧
       orderItemIsInBacklog(?Order) ∧
       purchaseOrder(?Order,?Buyer,?Seller) .

overrides(leadTimeRule3 , leadTimeRule1) .

⊥ ← orderModificationNotice(?Order,?X) ∧
    orderModificationNotice(?Order,?Y) | (?X ≠?Y) .
```



PRESS ROOM

EVENTS

CONTACT

WHAT IS XBRL

NEWS ABOUT XBRL

THE SHOWCASE

XBRL IN ACTION

XBRL AND BUSINESS

TECHNICAL INFORMATION

EDUCATION AND TRAINING

ABOUT THE ORGANISATION

HOW TO JOIN

MEMBERS' AREA

NEWS FOR MEMBERS

TECHNICAL DEVELOPMENT

WORKING GROUPS

SUPPLY CHAINS

Welcome to XBRL International



Financial Reporting Goes Global - XBRL and IFRS Working Together

For more information, please visit the [Conference Website](#) [register today](#).

XBRL is a language for the electronic communication of business financial data which is set to revolutionise business reporting around the world. It provides major benefits in the preparation, analysis and communication of business information. It offers cost savings, greater efficiency and improved accuracy and reliability to all those involved in supplying or using financial data.

XBRL stands for eXtensible Business Reporting Language. It is one of a family of "XML" languages which is becoming a standard means of communicating information between businesses and on the internet.

XBRL is being developed by an international non-profit consortium of approximately 250 major companies, organisations and governmental agencies. **It is an open standard, free of licence fees.** It is already being put to practical use in a number of countries and implementations of XBRL are growing rapidly around the world.

This site provides information about the nature, uses and benefits of XBRL. It explains how individuals and companies can join the effort to move forward and make use of the language.

Equational Ontological Conflicts

Key Concepts

Gross Profit = Net Sales – Cost of Goods

Gross Profit = Net Sales – Cost of Goods – Depreciation

Price = Nominal Price + Shipping

Price = Nominal Price + Shipping + Tax

“ heterogeneity in the way data items are *calculated* from other data items *in terms of definitional equations*”

End-to-End E-Contracting Tasks

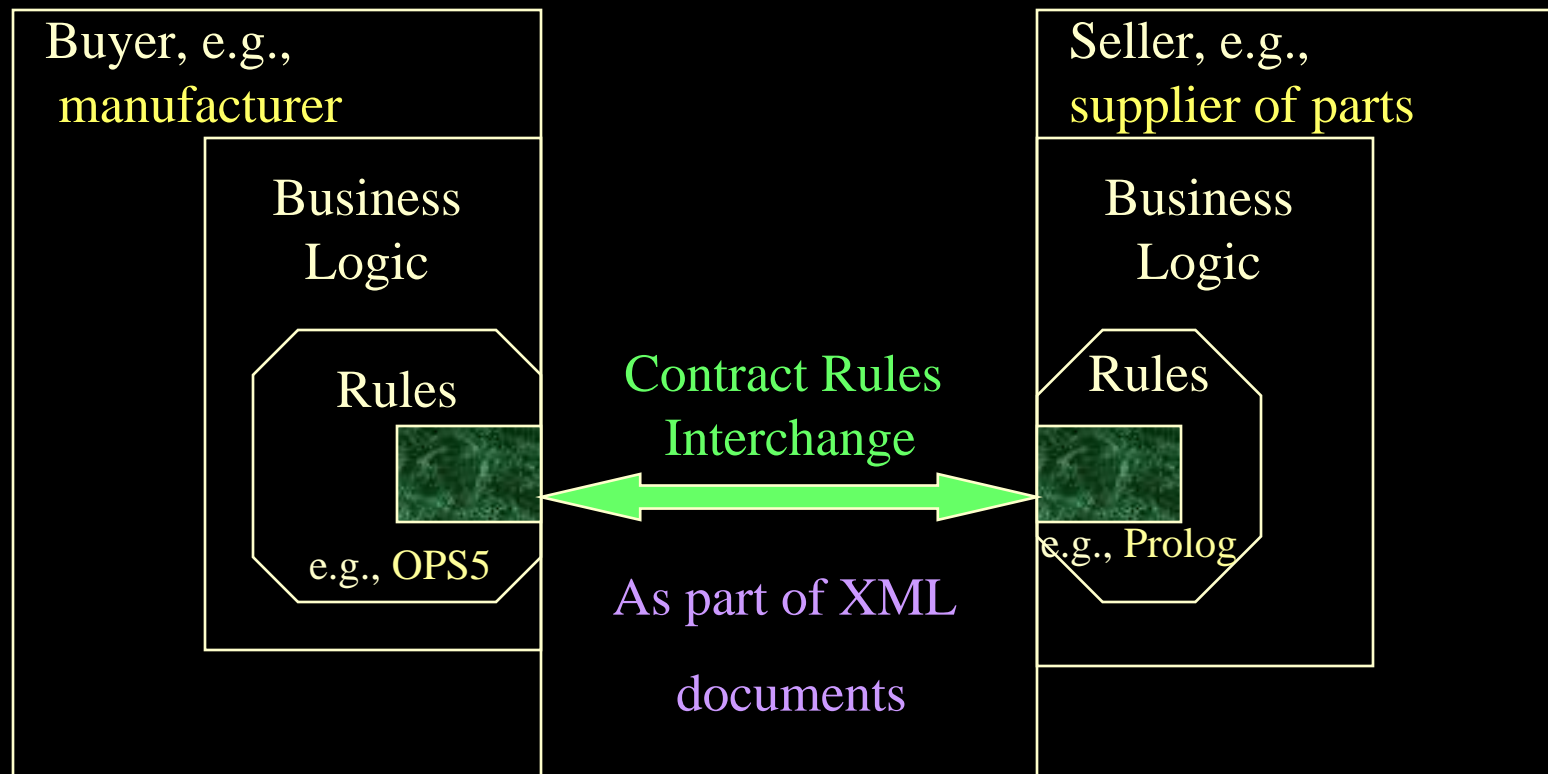
- Discovery, advertising, matchmaking
 - Search, sourcing, qualification/credit checking
- Negotiation, bargaining, auctions, selection, forming agreements, committing
 - Hypothetical reasoning, what-if'ing, valuation
- Performance/execution of agreement
 - Delivery, payment, shipping, receiving, notification
- Problem Resolution, Monitoring
 - Exception handling

SweetDeal Approach:

Rule-based Contracts for E-commerce

- Rules as way to specify (part of) business processes, policies, products: as (part of) contract terms.
- Complete or partial contract.
 - As **default rules**. **Update**, e.g., in negotiation.
- Rules provide high level of conceptual abstraction.
 - **easier for non-programmers** to understand, specify, **dynamically modify & merge**. E.g.,
 - by multiple authors, cross-enterprise, cross-application.
- Executable. Integrate with other rule-based business processes.

Contract Rules during Negotiation

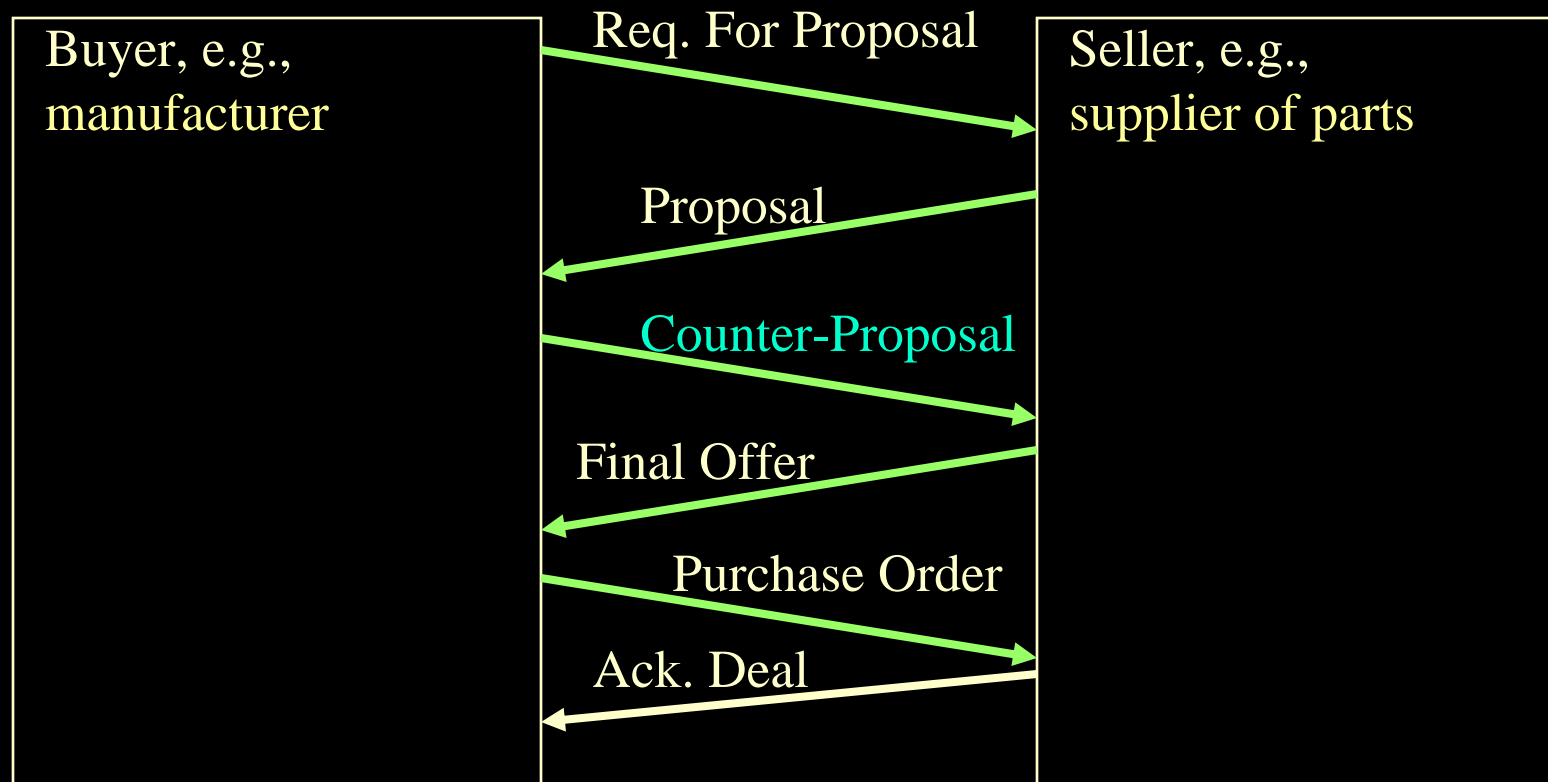


Contracting parties NEGOTIATE via shared rules.

Examples of Contract Provisions Well-Represented by Rules in Automated Deal Making

- Product descriptions
 - Product catalogs: properties, conditional on other properties.
- Pricing dependent upon: delivery-date, quantity, group memberships, umbrella contract provisions
- Terms & conditions: refund/cancellation timelines/deposits, lateness/quality penalties, ordering lead time, shipping, creditworthiness, biz-partner qualification, service provisions
- Trust
 - Creditworthiness, authorization, required signatures
- *Buyer Requirements (RFQ, RFP) wrt the above*
- *Seller Capabilities (Sourcing, Qualification) wrt the above*

Exchange of Rules Content during Negotiation: example



Example: E-Contract Proposal from supplierCo to manufCo

- ...
{usualPrice} price(per_unit, ?PO, \$60) ←
 - purchaseOrder(?PO, supplierCo, ?AnyBuyer) ∧
 - quantity_ordered(?PO, ?Q) ∧ (?Q ≥ 5) ∧ (?Q ≤ 1000) ∧
 - shipping_date(?PO, ?D) ∧ (?D ≥ 24Apr00) ∧ (?D ≤ 12May00).
- {volumeDiscount} price(per_unit, ?PO, \$51) ←
 - purchaseOrder(?PO, supplierCo, ?AnyBuyer) ∧
 - quantity_ordered(?PO, ?Q) ∧ (?Q ≥ 100) ∧ (?Q ≤ 1000) ∧
 - shipping_date(?PO, ?D) ∧ (?D ≥ 28Apr00) ∧ (?D ≤ 12May00) .
- overrides(volumeDiscount , usualPrice) .
- \perp ← price(per_unit, ?PO, ?X) ∧ price(per_unit, ?PO, ?Y) GIVEN (?X ≠ ?Y).
- ...

Negotiation Ex. Doc. Rules:

Counter-Proposal from *manufCo* to *supplierCo*

- ...
- {usualPrice} price(per_unit, ?PO, \$60) ← ...
- {volumeDiscount} price(per_unit, ?PO, \$51) ←
- purchaseOrder(?PO, supplierCo, ?AnyBuyer) ∧
- quantity_ordered(?PO, ?Q) ∧ (?Q ≥ 5) ∧ (?Q ≤ 1000) ∧
- shipping_date(?PO, ?D) ∧ (?D ≥ 28Apr00) ∧ (?D ≤ 12May00) .
- overrides(volumeDiscount , usualPrice) .
- ⊥ ← price(per_unit, ?PO, ?X) ∧ price(per_unit, ?PO, ?Y) GIVEN (?X ≠ ?Y).
- {aSpecialDeal} price(per_unit, ?PO, \$48) ←
- purchaseOrder(?PO, supplierCo, **manufCo**) ∧
- quantity_ordered(?PO, ?Q) ∧ (?Q ≥ **400**) ∧ (?Q ≤ 1000) ∧
- shipping_date(?PO, ?D) ∧ (?D ≥ **02May00**) ∧ (?D ≤ 12May00) .
- overrides(aSpecialDeal, volumeDiscount) .
- overrides(aSpecialDeal , usualPrice) .
- ...

**Simply
added
rules!**

XML Encoding of Rules in RuleML

- `<rulebase>`
- `<imp>`
- `<rlab>usualPrice</_rlab>`
- `<head>`
- `<atom>`
- `<opr><rel>price</rel></_opr>`
- `<ind>per_unit</ind>`
- `<var>PO</var>`
- `<ind>$60</ind>`
- `</atom>`
- `</head>`
- `<body> ... (see next page) </_body>`
- `</imp>`
- ...
- `</rulebase>`

Advantages of Standardized SW Rules for Policies, e.g., Authorization/Security

- Easier Integration: with rest of business policies and applications, business partners, mergers & acquisitions
 - Enterprise integration, B2B
- Familiarity, training
- Easier to understand and modify by humans.
- Quality and Transparency of implementation in enforcement
 - Provable guarantees of behavior of implementation
 - Scalability; consistency, completeness, correctness
- Reduced Vendor Lock-in
- Expressive power
 - Principled handling of conflict, negation, priorities
- ⇒ **Agility, change management** ↑

Advantages of SW Rules, cont'd:

Loci of Business Value in Policy Management

- Reduced system dev./maint./training costs
- Better/faster/cheaper policy admin.
- Interoperability, flexibility and re-use benefits
- Greater visibility into enterprise policy implementation ⇒ better compliance
- Centralized ownership and improved governance by Senior Management
- Rich, expressive policy management language allows better conflict handling in policy-driven decisions
- Strategic agility, incl. wrt business model

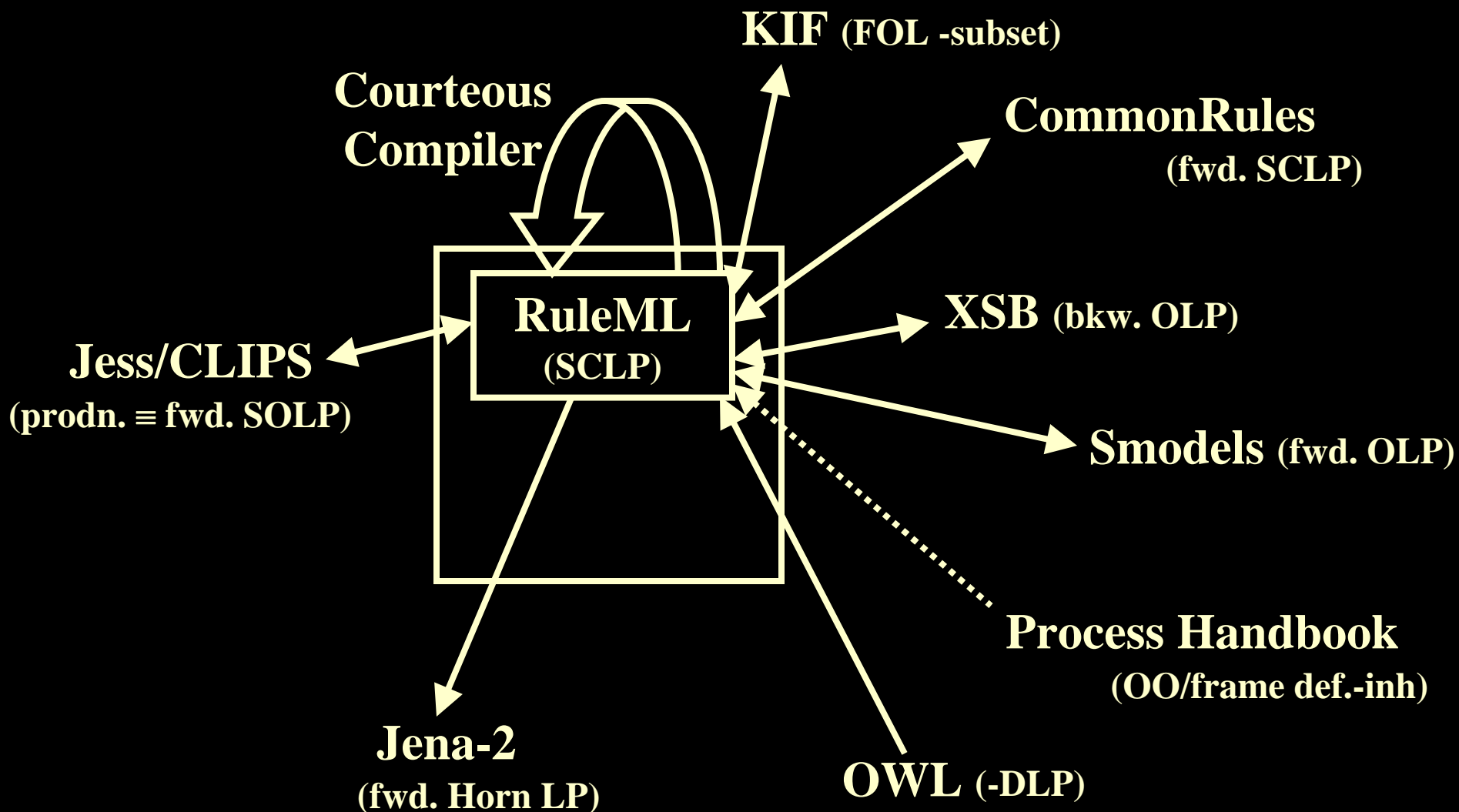
SweetRules *Context and Players*

- Part of SWEET = “Semantic Web Enabling Tools” (2001 –)
 - Other parts: ... these use SweetRules ...
 - SweetDeal for e-contracting
 - SweetPH for Process Handbook ontologies
- Cross-institutional. Collaborators invited!
 - Originated and coordinated by MIT Sloan since 2001
 - Code base: Java, XSLT; convenience shell scripts (for testing drivers)
 - Code by MIT, UMBC, BBN, Stanford, U. Zurich
 - Cooperating other institutions: U. Karlsruhe, IBM, NRC/UNB, SUNY Stonybrook, HP, Sandia Natl. Labs; RuleML Initiative
 - Collaboration on design of code by Stanford, U. Karlsruhe
 - Uses code by IBM, SUNY Stonybrook, Sandia Natl. Labs, HP, Stanford, Helsinki
 - Many more are good targets: subsets of Flora-2, cwm, KAON, JTP, SWI Prolog, Hoolet, Triple, DRS, ROWL, ...

SweetRules V2.0 Fundamental KR

- **Fundamental KR: Situated Courteous Logic Programs (SCLP)** KR = Knowledge Representation
 - Horn
 - + **Negation-As-Failure (NAF)** = Ordinary LP
 - + Courteous prioritized conflict handling
 - overrides relation on rule labels, classical negation, mutex integrity constraints
 - + Situated sensing & effecting
 - Invoke external procedural attachments
 - Sensing = tests/queries; e.g., built-ins
 - Effecting = side-effectful actions, triggered by conclusions

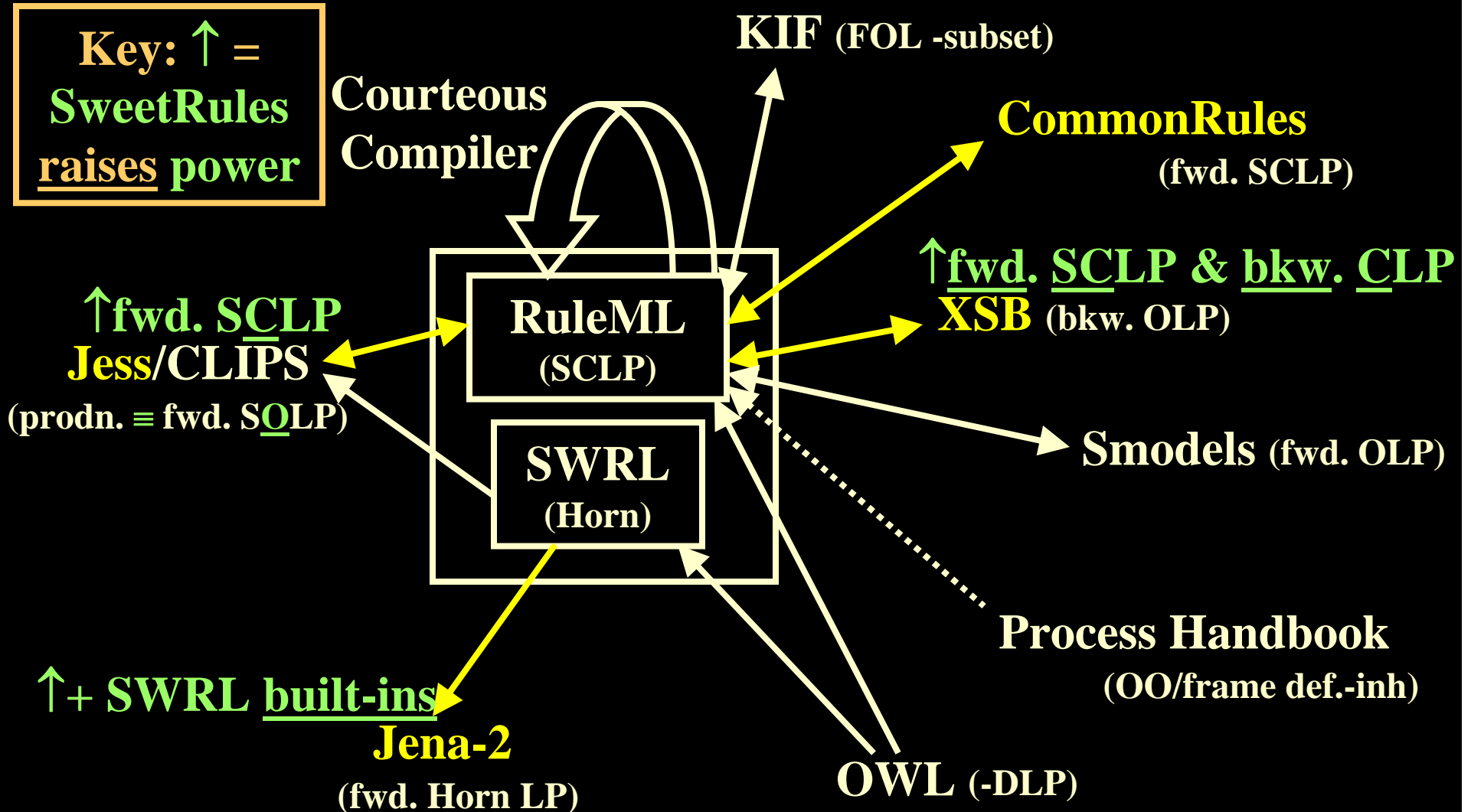
SweetRules V2.0 Translators Graph



SweetRules Inferencing Capabilities: Overview

- **Inferencing engines in RuleML/SWRL via translation:**
 - Indirect inferencing:
 1. translate to another rule system, e.g., {XSB, Jess, CommonRules, or Jena}
 2. run inferencing in that system's engine
 3. translate back
 - Can use composite translators

SweetRules V2.0+: Indirect Inferencing Engines



Novel Capabilities of SweetRules I

- 1st Semantic interoperability between **Production Rules** and **declarative LP**
 - 1st semantic treatment of Production Rules
- 1st for several particular kinds of **semantic interoperability** between heterogeneous commercially important kinds of rules -- and ontologies too, e.g. ...
- 1st: **Production Rules**,
- + **Prolog** (and thus essentially core SQL),
- + **OWL/RDF** (via Description LP approach)
- 1st: **Via** an emerging standards design for semantic rules on web: **RuleML**
- 1st: Supports **WSDL actions** in semantic rules – a true rule-based semantic web service system

Novel Capabilities of SweetRules II

- 1st: tool set **platform** for semantic rules on web
 - & in **open source**
- 1st: Based on **Production LP KR** approach, overall
- **1st: Inclusion merging** for heterogeneous rulebases and ontology KBs, via such interchange language
- **1st: Indirect inferencing**: design pattern and detailed design/implement.
- **1st: Dozens of particular translators**, e.g., Jess, XSB, OW/RDF, CommonRules, Jena, KIF, Process Handbook
 - **Pluggable and automatically composed**
- 1st: Supports **expressively powerful RuleML-based** interoperability and inferencing
 - **Courteous prioritized conflict handling**
 - **+ Situated procedural attachments** for actions and tests/queries -- cf. PR, + generalized
- **1st wrt several nonmon algorithms & capabilities**:
 - Courteous + unrestricted non-stratified negation
 - Stratified negation in production rules
 - Non-stratified negation via production rules
 - Courteous extension of Prolog, Production Rules
- **1st wrt several procedural attachment algorithms & capabilities**:
 - Actions extension of Prolog-based engine

Summary of SweetRules

- **SweetRules V2: tool set platform**
 - Supports **expressively powerful RuleML-based** interoperability and inferencing
 - and also **SWRL**. Basis: **declarative Logic Programs KR** at heart, + some FOL
 - **Description LP** technique for merging restricted OWL-DL into LP
 - **Courteous LP** prioritized conflict handling
 - Unrestricted (scoped) default negation
 - **Production LP** / Situated LP procedural attachments for actions and tests/queries cf. PR
 - has generalization to permit unbound such queries
 - Indirect inferencing: translate, infer in another rule system, translate back
 - **1st interoperability between Production Rules and declarative LP**
 - Based on **Production LP KR** approach, overall
 - Translation/inferencing in Jess, XSB, OWL/RDF, CommonRules, Jena, KIF, more
 - Inclusion merging of heterogeneous rulebases and ontology knowledge bases
 - Dozens of translators, pluggable and automatically composed
 - Supports **WSDL actions** – a true rule-based semantic web service system

Rules Roadmap I

- Relatively recent research breakthroughs in rule KR theory and techniques
- Several of these are now rapidly moving into commercial adoption, and are helping drive standardization in semantic rules
 - Declarative LP with: well integrated ontologies; actions; defaults; and more
 - Interoperable between Prolog, RDBMS/SQL, Production Rules / ECA Rules – both backward and forward inferencing
 - Highly scalable; complexity qualitatively similar to RDBMS
 - Prioritized conflict handling enables: modularity; robustness in face of inconsistency

Rules Roadmap II

- Driving applications in a number of areas:
 - policy, e.g.:
 - trust, contracting (shopping, ads, discovery, exceptions), services lifecycle
 - information integration and mediation
 - social networking; combining structured and unstructured for search/navigation
 - business process communications and integration
 - verticals: financial, biomedical, military intelligence, mobile/personal communications
 - event-driven architecture, and dynamic knowledge management

Rules Roadmap III

- Prospects for near-term technical progress are bright, if development investment is incented, in both:
 - back-end
 - expressiveness -- from recent KR advances
 - performance -- via compilation and distributed computation
 - front-end ease of authoring and testing/validation, particularly by business users -- from:
 - improved expressive convenience/power
 - controlled natural language
 - decision tables and structured templates/forms
 - graphical and conversational interfaces
 - cheaper processing & storage
 - collaboration/communication infrastructure

Rules Roadmap IV

- Effectual standardization of rules must provide application builders the actually required KR expressiveness.
- Most current and potential applications need features such as default negation, actions, etc., that go well beyond RIF phase 1.
- RIF has been moving slowly.
- The design approach embodied in Production LP and RuleML points the way towards where the next phase/successor of RIF should go.
- RDBMS can
 - SKMS
 - (“Structured Knowledge Management System”)
 - with semantic rules + ontologies (+ databases)
 - It’s a straight incremental extension expressively
 - *the* successor to the relational model?!?

Rules Roadmap V

- Relevant further R&D agenda for rules includes:
 - authoring/testing UI
 - integration/polishing of the KR advances
 - incremental reasoning, event-driven, justification/provenance/explanation
 - deeper KR integration of FOL vs. LP with nonmon and actions – needs more theory
 - exploring highly distributed, dynamic, expressive KB's & reasoning – in part, needs more theory
 - Fulfilling much of the Web Services and SOA story considerably depends on equipping services with rule-based semantic descriptions functionality, e.g., for discovery, contracting, authorization, and monitoring.
 - Plenty more to do there

SKIMMED SLIDES
END

Outline

- I. Semantic Rules – Overview
 - what, where, why, when
 - history, context, relationship to Web
 - recent developments
 - research breakthroughs → initial steps of commercial adoption; standards
 - roadmapping technology, applications, business value
- II. Strategic Analysis of Market Evolution
 - Pattern of disruption in the business rules market
- III. What to do about it
 - What players like you can/should do

Preface

- “Prediction is hard, especially of the future” ☺
- Deliberately provocative
- Gartner hype curve for significant innovations: (generic)
 - Initial hype boom and then bust
 - Disappointment that horizon to impact is not shorter
 - Longer-term, actual impact is higher than early expectations



Status Quo Ante

Current commercially important rule systems

- KR relatively little changed in ~25 years
- fragmented market
- customer silo'ing/lock-in
- high prices
- high lifecycle costs for customers, particularly from KB authoring/testing

Business Rules Market Evolution

Roadmapping analysis hypotheses in steps

- 1. standardization will happen

→ interoperability

→ 2. undo* silo'ing/lock-in

* well, greatly reduce

undo* silo'ing/lock-in

→ 3a. major upside for customers

3b. but grave threat to vendor price margins

major upside for customers, but grave threat to vendor price margins

→ 4a. higher volume

4b. but classic market disruption pattern for the vendors

higher volume but classic market disruption pattern for
the vendors

→ 5. shake-out (among vendors)

shake-out (among vendors)

→ 6. best-of-breed differentiation and
complementarity (among vendor offerings)

-- e.g., back-end (engine) vs. front-end (authoring)

best-of-breed shakeout, differentiation,
complementarity,

+ lower prices, and customer upside

→ 7. opportunities for vendor entrants
and for customer entrants

best-of-breed shakeout, differentiation,
complementarity,
+ higher volume

→ 8. pressure for composition & partnering
in tools & solutions

... and ? re-consolidation ?

... ? e.g., via M&A ?

Disruption: “Waterfall” Summary

- Rule market roadmapping analysis hypothesis:
standardization
 - interoperability
 - undo silo'ing/lock-in
 - major upside for customers, but grave threat to vendor price margins
 - higher volume but classic market disruption pattern for the vendors
 - shake-out
 - best-of-breed differentiation and complementarity, e.g., back-end (engine) vs. front-end (authoring)
 - & opportunities for both vendor and customer entrants
 - & pressure for solution partnering.

Outline

- I. Semantic Rules – Overview
 - what, where, why, when
 - history, context, relationship to Web
 - recent developments
 - research breakthroughs → initial steps of commercial adoption; standards
 - roadmapping technology, applications, business value
- II. Strategic Analysis of Market Evolution
 - Pattern of disruption in the business rules market
- III. What to do about it
 - What players like you can/should do

What you can/should do I

- Players:
 - Customers
 - Services providers – notably consultants
 - (sometimes one arm of a vendor)
 - Vendors (of products)
- All players: It's about the Lifecycle
 - Recognize when you have a challenge in managing:
 - Business users
 - Change
 - Complexity

What you can/should do II

- Customers:

Since effort to develop the rulebases is precious:

- invest sooner rather than later in standards-based specification/development of rulebases
 - reduce costs over lifecycle
 - increase ROI, flexibility
 - get familiar with new techniques, tools, vendors
- use the corresponding expressive subset of existing rule engines/tools/systems
 - restrict expressiveness to what's has-been/will-be standardized
 - i.e., stay semantic

What you can/should do III

- Services providers -- notably consultants:
 - get familiar with new/emerging methodologies
 - provide transition services
 - (from old techniques/tools/systems to new semantic/standards-based)
- Both Customers and Service providers:
 - transition prototyping
 - use open source / academic ware / smaller vendors to get feet wet
 - ... during the shorter-term/interim while more established/high-support vendors move to

What you can/should do IV

- Vendors:
 - pick niche, be best of breed, e.g.:
 - high performance engine
 - great UI for business users
 - advanced expressive features
 - ... [your imagination goes here ☺]
 - focus focus
 - partner to serve customers
 - "resistance is futile" -- the Borg, in Star Trek: the Next Generation
 - “The river goes around the rock”

What you can/should do V

- All players:
 - seize growth opportunities
 - *Since costs ↑ (prices ↓, cost of use ↓), capabilities ↑ (cheaper, faster, better) → net value ↑*
 - new application areas: biomed, mobile, search/navigation, social networking, ...
 - compose best of breed
 - look for partnered solutions

What you can/should do VI

- All players:
 - "May you live in interesting times" – traditional Chinese curse
 - "War is the health of the state" -- von Clausewitz (19th century)
 - "Confusion is the health of the consultant"
 - track timing/evolution of features/capabilities in the market
 - think hard about time horizon of your investments

Outline

- I. Semantic Rules – Overview
 - what, where, why, when
 - history, context, relationship to Web
 - recent developments
 - research breakthroughs → initial steps of commercial adoption; standards
 - roadmapping technology, applications, business value
- II. Strategic Analysis of Market Evolution
 - Pattern of disruption in the business rules market
- III. What to do about it
 - What players like you can/should do

Q&A

- Thanks for your attention 😊
- Questions Invited!