E-Services Knowledge Management on the New Generation Web: Rules, E-Contracting, and Business Process Automation

Benjamin Grosof

MIT Sloan School of Management

Information Technologies group

http://ebusiness.mit.edu/bgrosof

Presentation at IBM T.J. Watson Research Center,

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Hosts: Hoi Chan and Richard Goodwin

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Quickie Bio of Presenter Benjamin Grosof

- MIT Sloan professor 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 web services is main research area:
  - Rules as core technology
  - Business Applications, Implications, Strategy:
    - e-contracting/supply-chain; finance; trust; …
  - Overall knowledge representation, e-commerce, intelligent agents

- Co-Founder, Rule Markup Language Initiative – the leading emerging standards body in semantic web rules (http://www.ruleml.org)
  - Co-Lead, DAML Rules
  - Co-Lead on Rules, Joint US-EU ad hoc Agent Markup Language Committee
- Core participant in Semantic Web Services Initiative – which coordinates world-wide SWS research and early standards (http://www.swsi.org)
  - Area Editor for Contracts & Negotiation, Language Committee
  - Co-Chair, Industrial Partners program (SWSIP)

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Outline of Talk

- Intro; Semantic Web Services (SWS) Concept & Vision
- Semantic Web Rules
  - Rule KR & Theory
  - RuleML Emerging Standard
  - SweetRules V2 Toolset
- E-Business Applications of Rule-based SWS
  - SweetDeal Approach to End-to-End E-Contracting;
  - Trust Policies; … with Business Value Analysis
- Creating Service Ontologies
  - Process Handbook; SweetPH; Leveraging Legacy OO
- Roadmapping E-Services Knowledge Management & SWS
  - Reusable Service Ontologies and Contracts; Open-Source KB's
  - SWS Initiative & its SWS Language Approach
  - SWS Market Evolution & Prospective Early Adoption

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Overall Approach

- Use Semantic Web Rules with Ontologies
  - Situated Courteous Logic Programs (SCLP) as Rules KR
  - Priorities; Procedural Attachments for Actions, Tests/Queries
  - Ontologies from legacy or new OO, in SCLP or FOL/DL
  - Webized in RuleML + OWL
- Build and use Open-source KB's
  - Service Ontologies
    - Early step: Process Handbook in RuleML
      - SweetPH translation using Courteous Inheritance approach
      - Open Process Handbook Initiative (OPHI)
    - Early step: SWSL Core Service Ontologies
      - Build on NIST PSL, OWL-S service profiles
    - Other near-term steps:
      - look at WSDL, WSBPEL, WS Choreography

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Concept & Style of Talk

- Overview of several areas of research
  - Condensed several previous talks
  - Not as much depth on any one area
  - Skim more slides
  - Transitions sometimes jumpier

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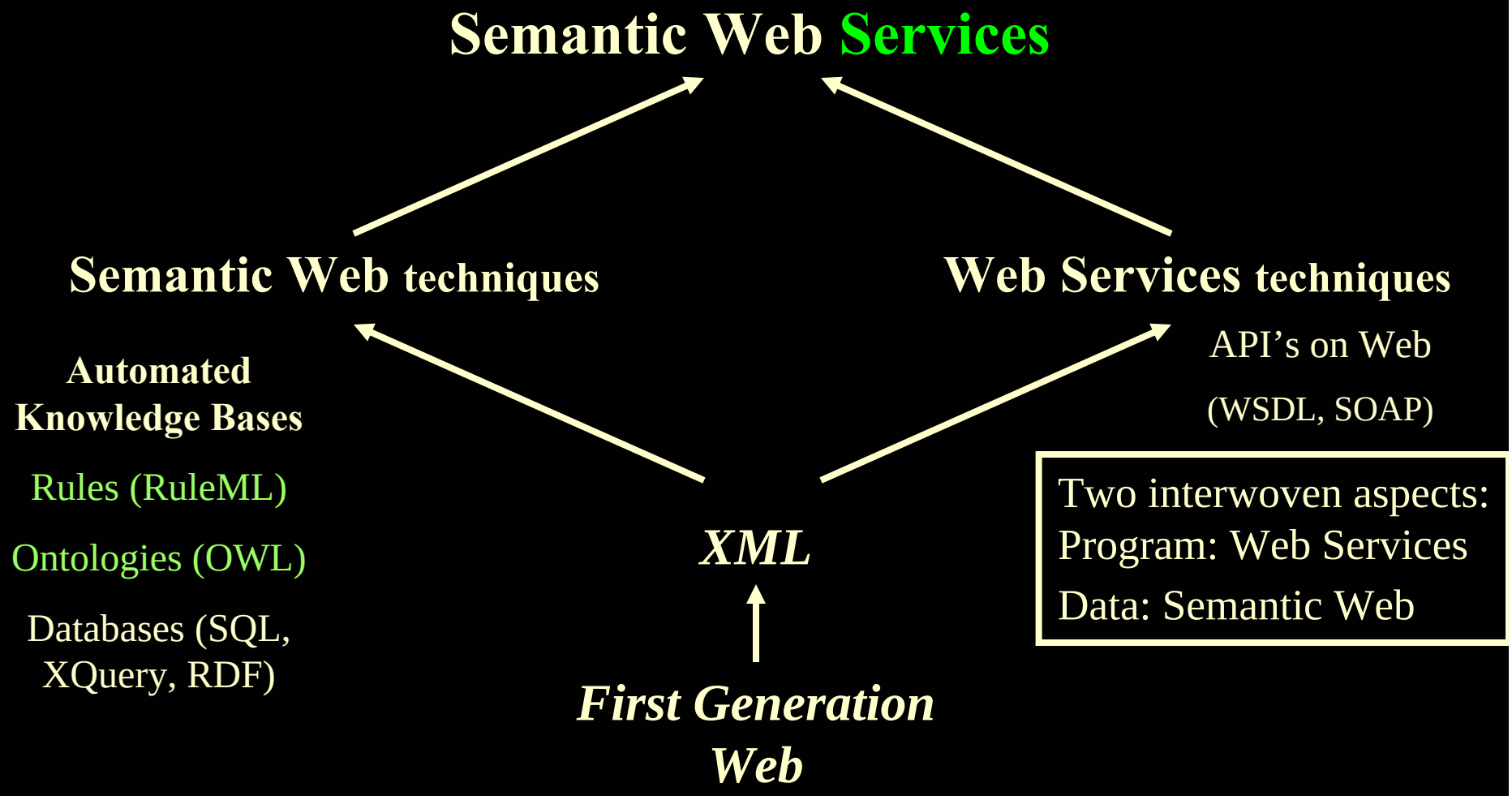
Next Generation Web



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Semantic Web Services

- Convergence of Semantic Web and Web Services
- Consensus definition and conceptualization still forming
- Semantic (Web Services):
  - Knowledge-based service descriptions, deals
    - Discovery/search, invocation, negotiation, selection, composition, execution, monitoring, verification
    - Advantage: **reuse** of knowledge across app's, these tasks
  - Integrated knowledge
- (Semantic Web) Services: e.g., infrastructural
  - Knowledge/info/DB integration
  - Inferencing and translation

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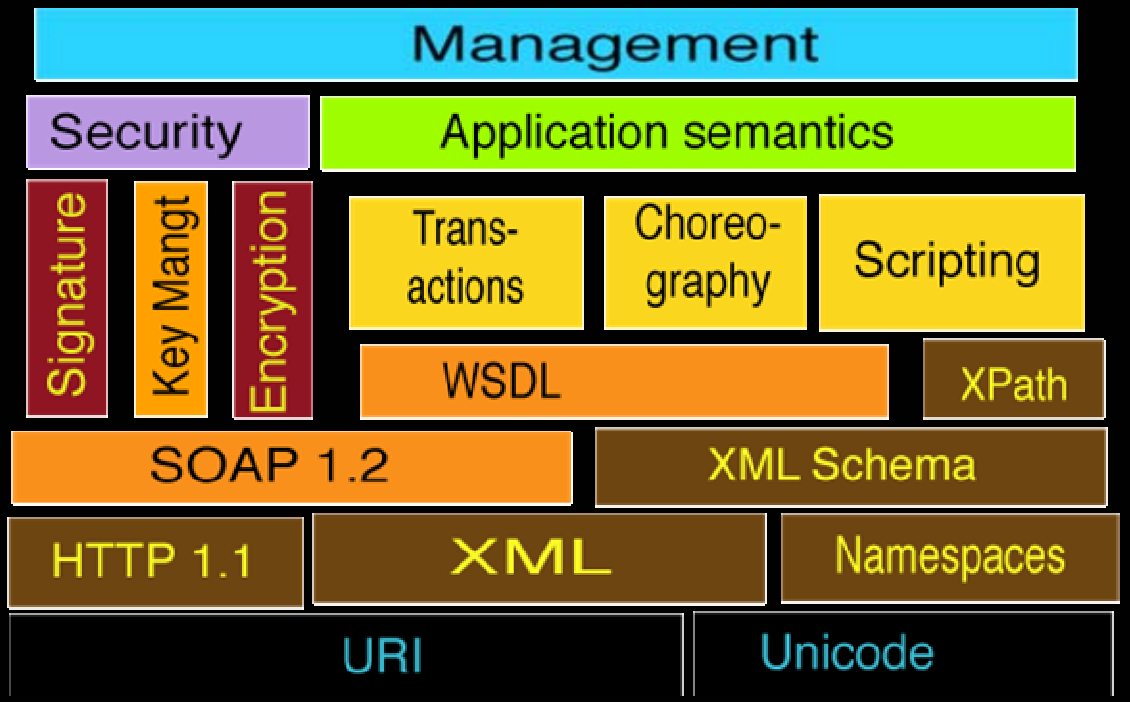
Web Services Stack outline



NOTES:

WSDL is a Modular Interface spec
SOAP is Messaging and Runtime
Also:
- UDDI is for Discovery
- BPEL4WS, WSCI, …
  are for transactions
- Routing, concurrency, …

Diagram courtesy Tim Berners-Lee: http://www.w3.org/2004/Talks/0309-ws-sw-tbl/slide6-0.html

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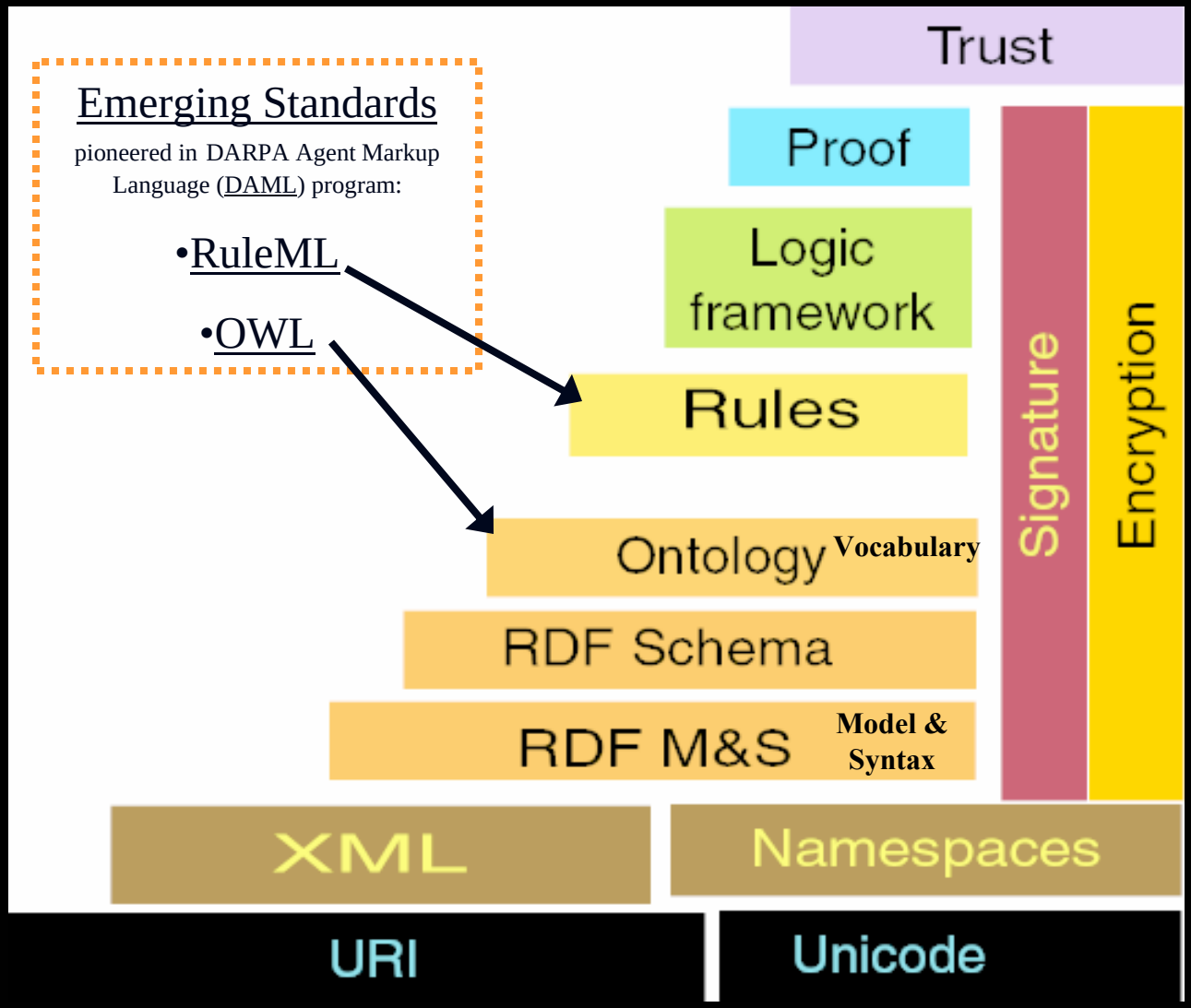
W3C Semantic Web "Stack": Standardization Steps



[Diagram http://www.w3.org/DesignIssues/diagrams/sw-stack-2002.png is courtesy Tim Berners-Lee]

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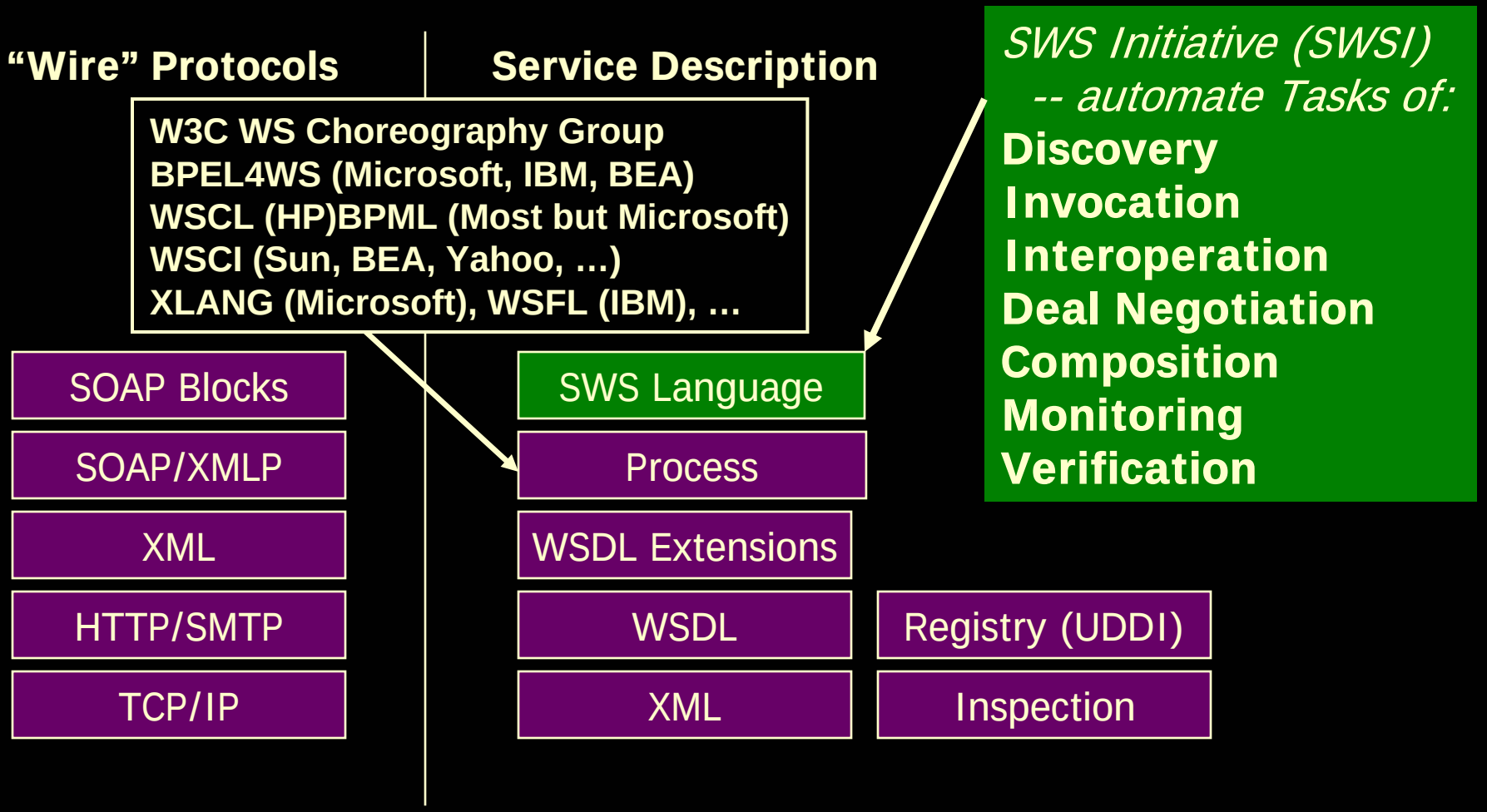
SWS Language effort, on top of Current WS Standards Stack



[Slide authors: Benjamin Grosof (MIT Sloan), Sheila McIlraith (Stanford) , David Martin (SRI International), James Snell (IBM)]

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Big Questions
about the New Generation Web

- What are the critical features/aspects of the new technology?
- What business problems does it help solve?
- What are the likely innovation evolution paths, and associated entrepreneurial opportunities?

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More Research Aspects/Questions about the New Generation 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; …

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Some Answers to: "Why does SWS 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

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Semantic Web: concept, approach, pieces

- Shared semantics when interchange data ∴ 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 lower-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 ~subset of First-Order Logic (FOL))
- Rules = if-then logical implications, facts ~subsumes SQL DB's
  - RuleML: "Rule Markup Language" emerging standard
    - Based on Logic Programs (LP) KR ~extension of Horn FOL
    - Also provide FOL KR

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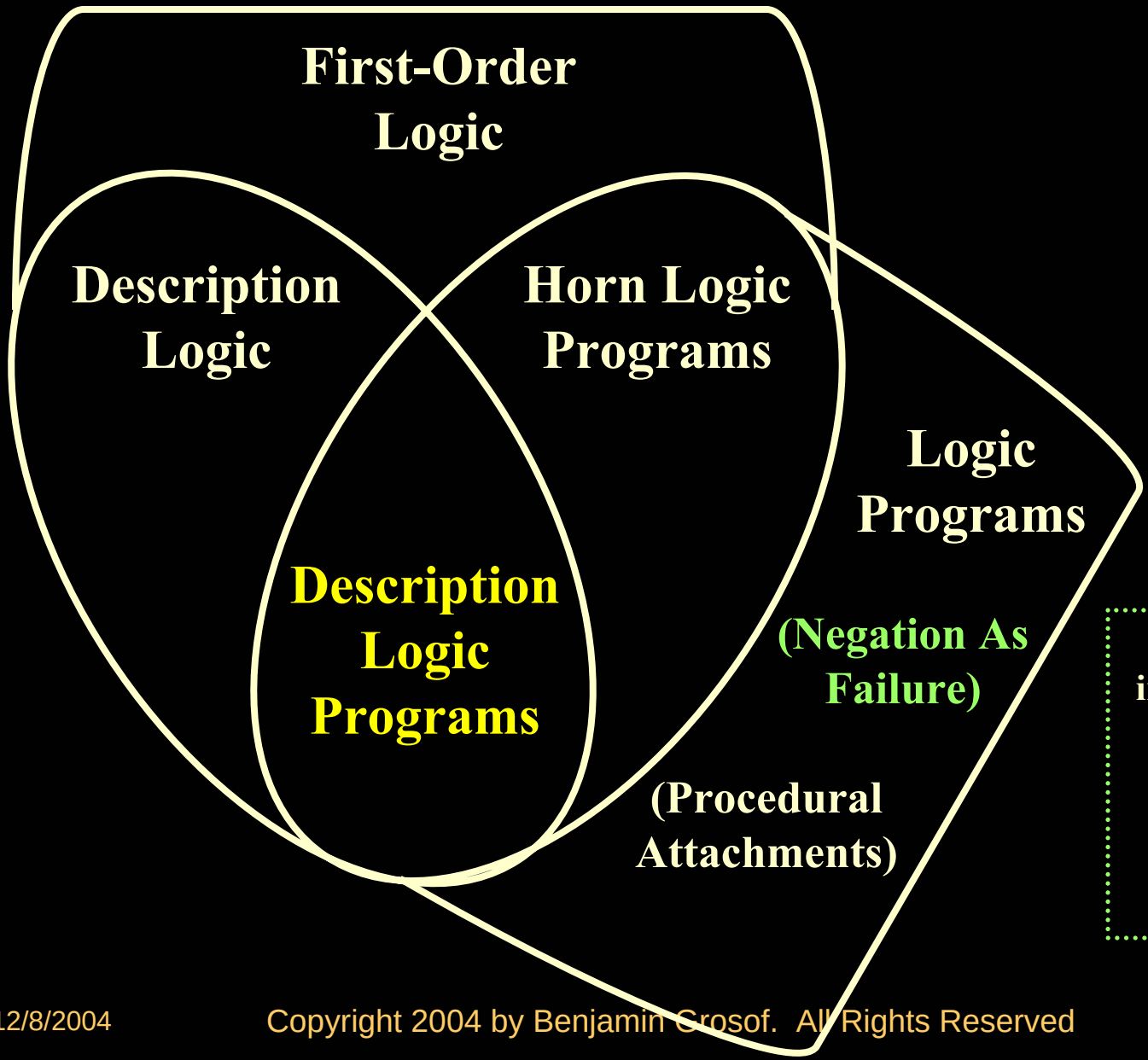
Venn Diagram: Expressive Overlaps among KR's



NB: Nonmon LP, including Courteous, relies on NAF as fundamental underlying KR expressive mechanism

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New Analysis: Key Technical Requirements for SWS

- 1. Combine rules with ontologies, from many web sources, with:
  - Rules on top of ontologies
  - Interoperability of heterogeneous rule and ontology systems
  - Power in inferencing
  - Consistency wrt inferencing
  - Scaleability of inferencing

- 2. Hook rules (with ontologies) up to web services
  - Ex. web services: enterprise applications, databases
  - Rules use services, e.g., to query, message, act with side-effects
  - Rules constitute services executably, e.g., workflow-y business processes
  - Rules describe services non-executably, e.g., for discovery, deal negotiation
  - On top of web service process models, coherently despite evolving messiness

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

- 1. Courteous Logic Programs: [Grosof]
  KR to combine rules from many sources, with:
  - Prioritized conflict handling to enable consistency, modularity; scaleably
  - Interoperable syntax and semantics
- 2. Situated Logic Programs: [Grosof]
  KR to hook rules (with ontologies) up to (web) services
  - Rules use services, e.g., to query, message, act with side-effects
  - Rules constitute services executably, e.g., workflow-y business processes
- 3. Reference Ontologies from Rules Via URI Names [Grosof]
- 4. Description Logic Programs: [Grosof, Horrocks, Volz, & Decker]
  KR to combine LP (RuleML) rules on top of DL (OWL) ontologies, with:
  - Power in inferencing (including for consistency)
  - Scaleability of inferencing

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

- 5. Courteous Inheritance: [Grosof & Bernstein]
  - OO default inheritance as Courteous LP
- 6. Production Rules as LP: [Grosof]
  - OPS5-heritage production rules as Situated Courteous LP
  - Find and fix fundamental weakness in chaining through negation in Rete-based inferencing
- 7. Hypermonotonic Reasoning: [Grosof (in-progress)]
  - Unify Nonmon LP KR with FOL KR
  - Nonmon LP as sound & incomplete wrt FOL

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Overview of RuleML Today I

- RuleML Initiative (2000--)
  - Dozens of institutions (~35), researchers; esp. in US+Canada, EU
  - Mission priorities:
    1. Enable semantic exchange of rules/facts between most commercially important rule systems
    2. Synergize with RDF, OWL (& other relevant web standards as arrive)
    3. Enable rule-based semantic web services, e.g., policies
  - Standards specification: current version V0.8+
    - 1st version 2001; basic now fairly stable
  - A number of tools (~40 engines, translators, editors), demo applications

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Overview of RuleML Today II

- Annual RuleML Workshop at ISWC since 2002 on RuleML & SW Rules
- Has now a "home" institutionally in DAML and Joint Committee
- Discussions well underway to launch Oasis, W3C efforts.
- Cooperating with OMG – providing markup and semantics for production rules meta-model.
- Collaborating with Semantic Web Services Initiative (SWSL)
- Close relationship with REWERSE (EU Network of Excellence on SW Rules)
- Collaborating with WSMO (early phase) in EU

• Initial Core: Horn Logic Programs KR

…Webized (in markup)… and with expressive extensions

URI's, XML, RDF, … *non-mon, actions, …*

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Overview of RuleML Today III

- Fully Declarative KR (not simply Prolog!)
  - Well-established logic with model theory
  - Available algorithms, implementations
  - Close connection to relational DB's
    - core SQL is Datalog Horn LP
- Abstract graph syntax
  - 1st encoded in XML…
  - … then RDF
- Expressive Extensions incrementally, esp. already:
  - Non-monotonicity: Negation as failure; Courteous priorities
  - Procedural Attachments: Situated actions/effecting, tests/sensing
  - *In-progress:*
    - Hilog, frame syntax, reification cf. F-Logic Programs, SWSL
    - Events cf. Event-Condition-Action

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Slide also by Harold Boley (NRC)

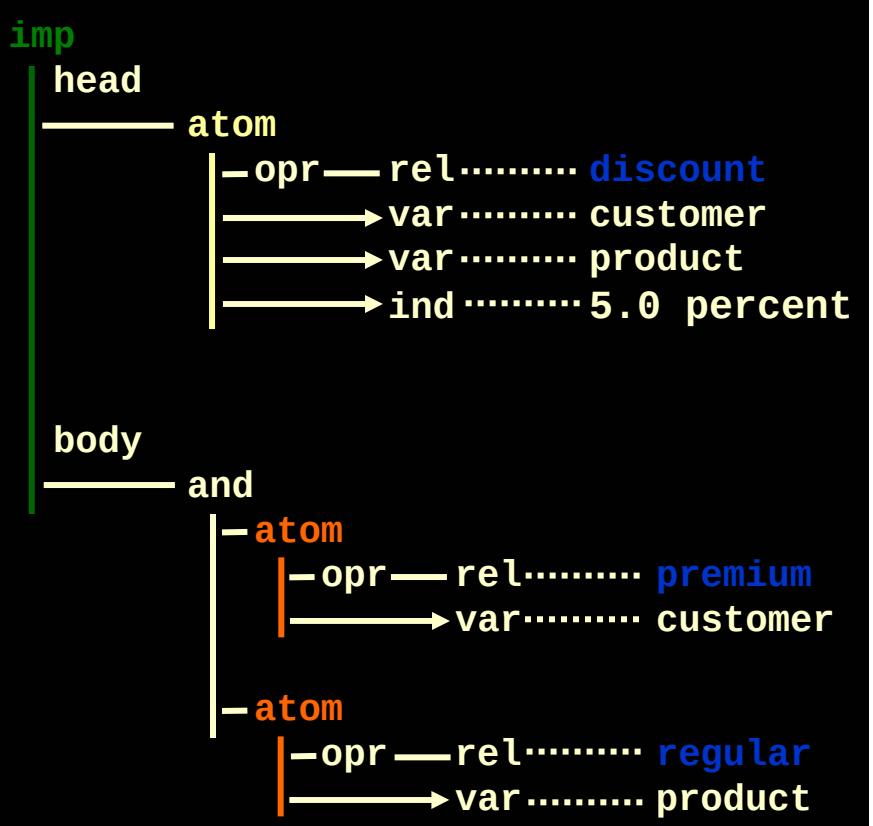
RuleML Example: Markup and Tree

'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);

Markup Syntax

```
<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.

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SweetRules Concept and Architecture

- Concept and Architecture: Tools suite for Rules and RuleML
  - Translation and interoperability between heterogeneous rule systems (forward- and backward-chaining) and their rule languages/representations
  - Inferencing including via translation between rule systems
  - Authoring, Analysis, and testing of rulebases
  - Open, lightweight, extensible, pluggable architecture overall

  - Merge knowledge bases
    - Combine rules with ontologies, incl. OWL
  - SWRL rules as special case of RuleML
  - Focus on kinds of rule systems that are commercially important

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SweetRules Website

- See http://sweetrules.projects.semwebcentral.org
  - Downloadable
  - Open-source code
  - Documentation
    - Javadoc
    - ISWC-2004 Tutorial on Rules+Ontologies+Ebiz
    - Overview, README, Rule Formats, ...

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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, ...

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SweetRules V2.0 Fundamental KR

- Fundamental KR: Situated Courteous Logic Programs (SCLP)
  - 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

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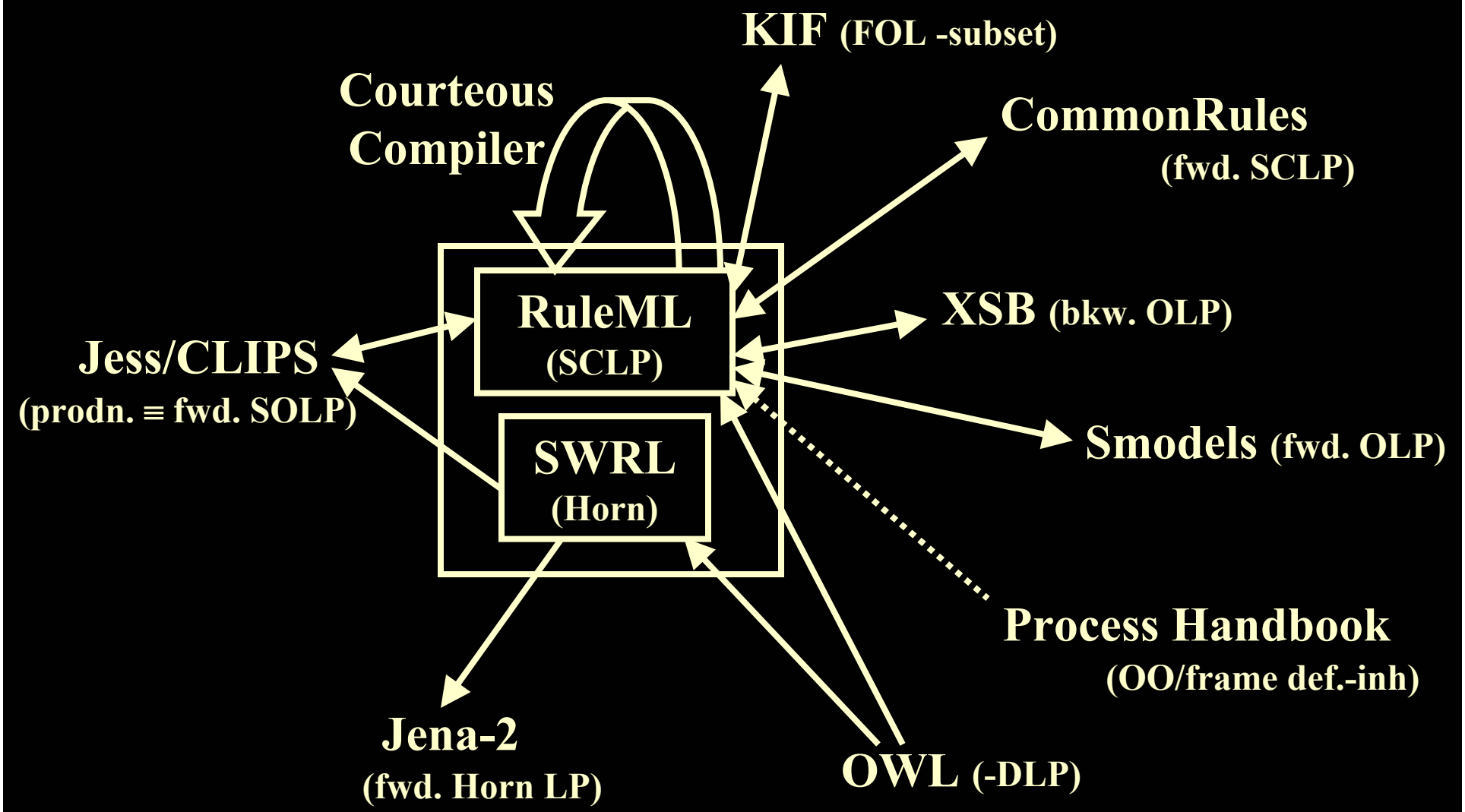
SweetRules V2.0 Translators Graph



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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

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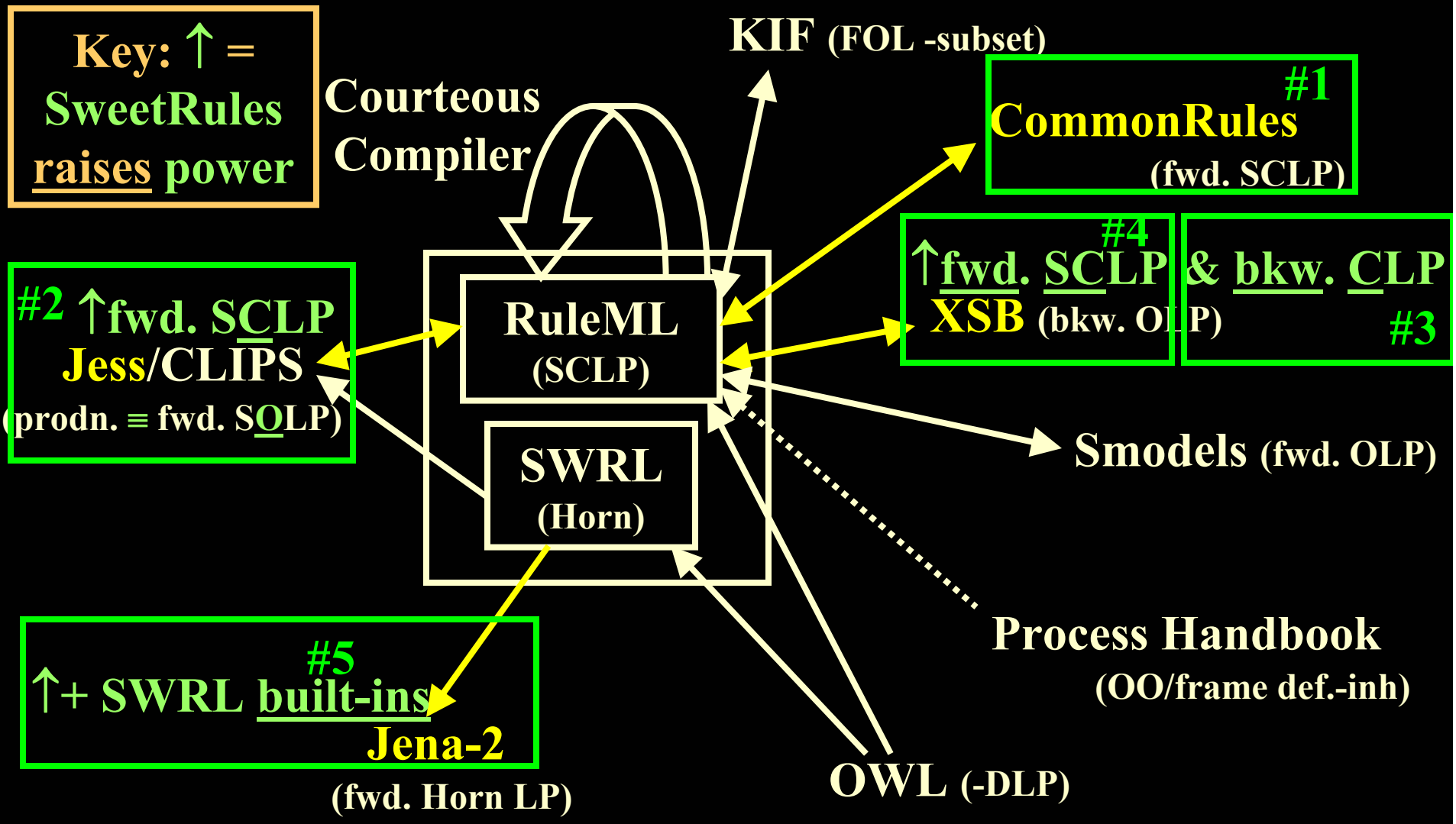
SweetRules V2.0 New Inferencing Engines



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SweetRules: Use Cases Overview

- Trust Policies: authorization, 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
- Contracts/negotiation, advertising/discovery
  - E-procurement, E-selling
  - Pricing, terms & conditions, supply chain, …
- Monitoring:
  - Exception handling, e.g., of contract violations
    - Late delivery, refunds, cancellation, notifications
  - Personal messaging and workflow

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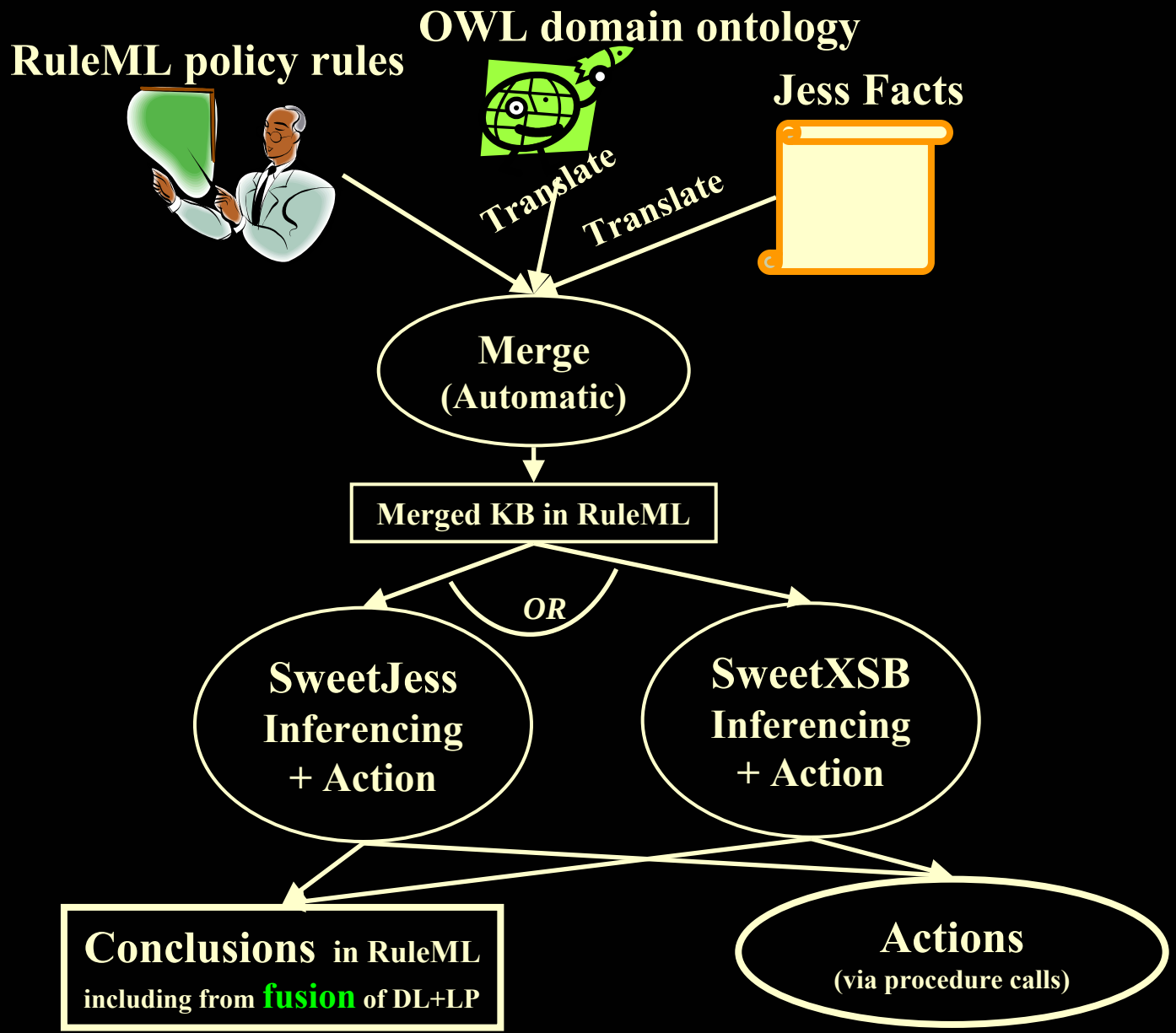
OrderingLeadTime Example Demo Flow

In SweetRules V2.0



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SweetDeal V2 Demo Outline

- SweetDeal E-Contracting Application using SweetRules (supply chain)
  - SCLP RuleML that include DLP OWL ontologies
  - Contract proposals/final-agreements are SCLP RuleML rulebases that reference/include OWL ontologies
  - Humans edit & communicate, supported by automated agents
  - Proposal evaluation supported by inferencing
  - Agreed business process is executable via inferencing+action

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SweetDeal V2 Demo: Novelty Highlights

1. SweetDeal is the first e-contracting application scenario, and first real e-business application scenario, combining RuleML with OWL. It uses DLP-fusion combining the OWL with RuleML to do combined hybrid inferencing. It combines contract rulesets in RuleML with business process/contract ontologies in OWL.
2. Moreover, SweetDeal is the first to have such contracts contain rules that employ procedural attachments to perform actions (side-effectful) as part of the business processes that the contracts specify.
3. SweetDeal is the first previous application to be refitted to use SweetRules V2 – and the first to be refitted to use DLP-fusion.

- Deltas wrt the previous SweetDeal V1 prototype (of 2002):
  - Uses OWL (previous DAML+OIL); DLP-fusion; procedural attachments for actions; SweetRules as infrastructure

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ISWC-2004 Tutorial: Outline of Part C.

C. Applications -- Policies, Services, and Semantic Integration

1. Ontology Translation and Semantic Integration
   - SWRL uses, ECOIN, financial services
2. End-to-End E-Contracting and Business Process Automation
   - supply chain, e-tailing, auctions, SweetDeal, Process Handbook
3. Business Policies including Trust
   - credit, health, RBAC, XACML, P3P, justifications
4. Semantic Web Services
   - SWSL tasks
5. Prospective Early Adopter areas, strategy, and market evolution
6. Windup and Discussion

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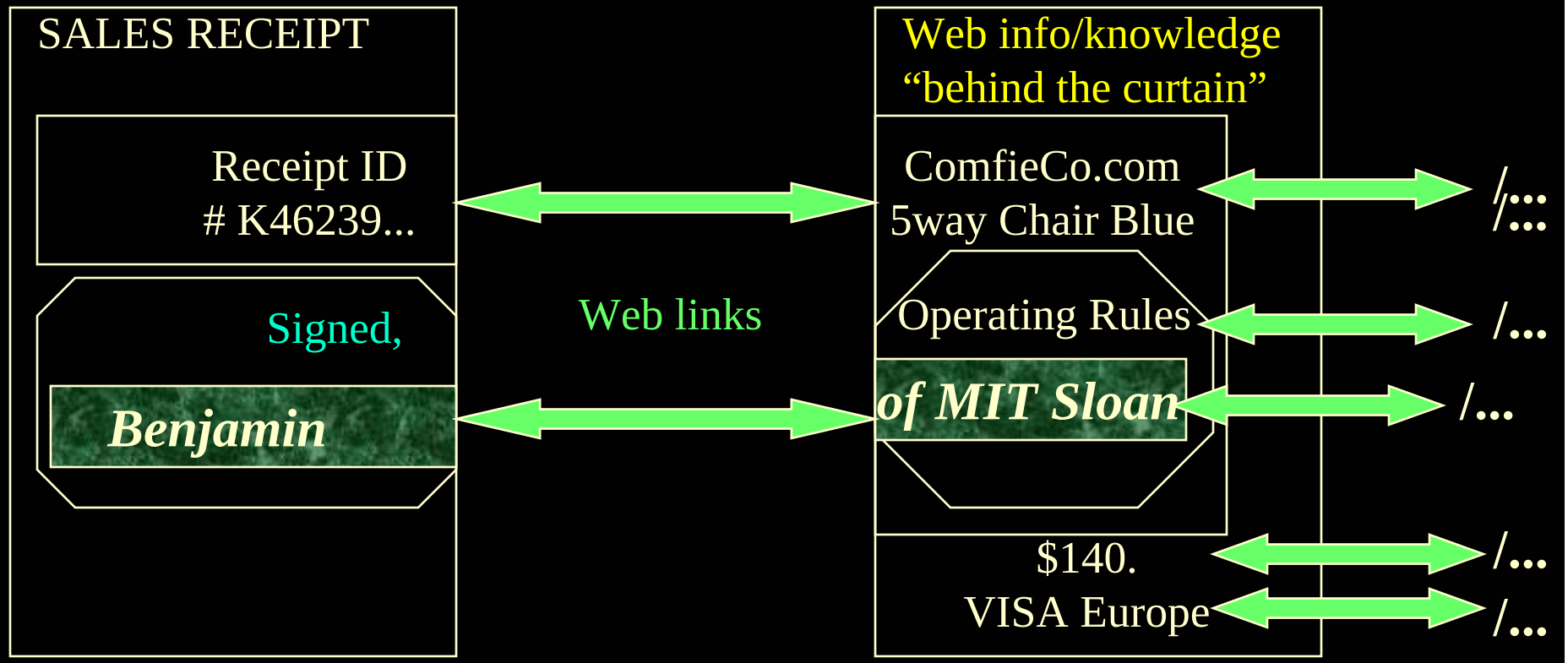
Looks Simple To Start... then Gets Interestingly Precise

A Vision/Approach of what Web & Agents enable



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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

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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.

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SweetDeal Approach

[Grosof , Labrou, & Chan EC-99; Wellman, Reeves, & Grosof Computational Intelligence 2002; Grosof & Poon Intl. J. of Electronic Commerce 2004]

- SWEET = Semantic WEb Enabling Technology
  - software components, theory, approach
  - pilot application scenarios, incl. contracting (SweetDeal)
- Uses/contributes *emerging standards* for XML and knowledge representation:
  - RuleML semantic web rules
  - OWL ontologies (W3C)
- Uses *repositories* of business processes and contracts
  - MIT Process Handbook (Sloan IT)
  - legal/regulatory sources: law firms, ABA, CommonAccord, … *Suggestions welcome!!*

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What Can Be Done with the Rules in contracting, & negotiation, based on our SweetDeal approach to rule representation

- Communicate: with deep shared semantics
  - via RuleML, inter-operable with same sanctioned inferences
  - ⇔ heterogeneous rule/DB systems / rule-based applications (“agents”)
- Execute contract provisions:
  - infer; ebiz actions; authorize; ...
- Modify easily: contingent provisions
  - default rules; modularity; exceptions, overriding
- Reason about the contract/proposal
  - hypotheticals, test, evaluate; tractably
  - *(also need “solo” decision making/support by each agent)*

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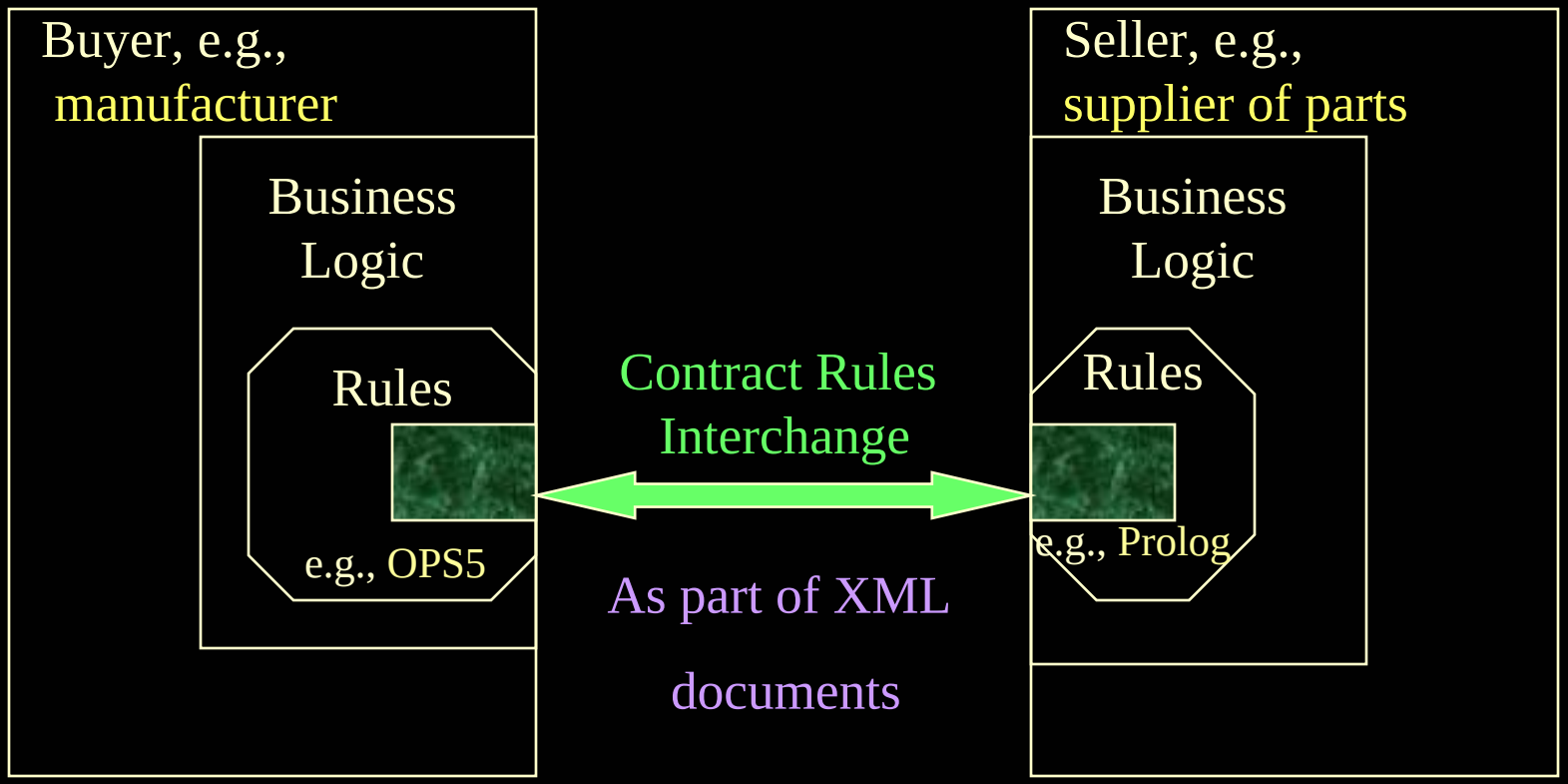
Contract Rules during Negotiation



Contracting parties NEGOTIATE via shared rules.

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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*

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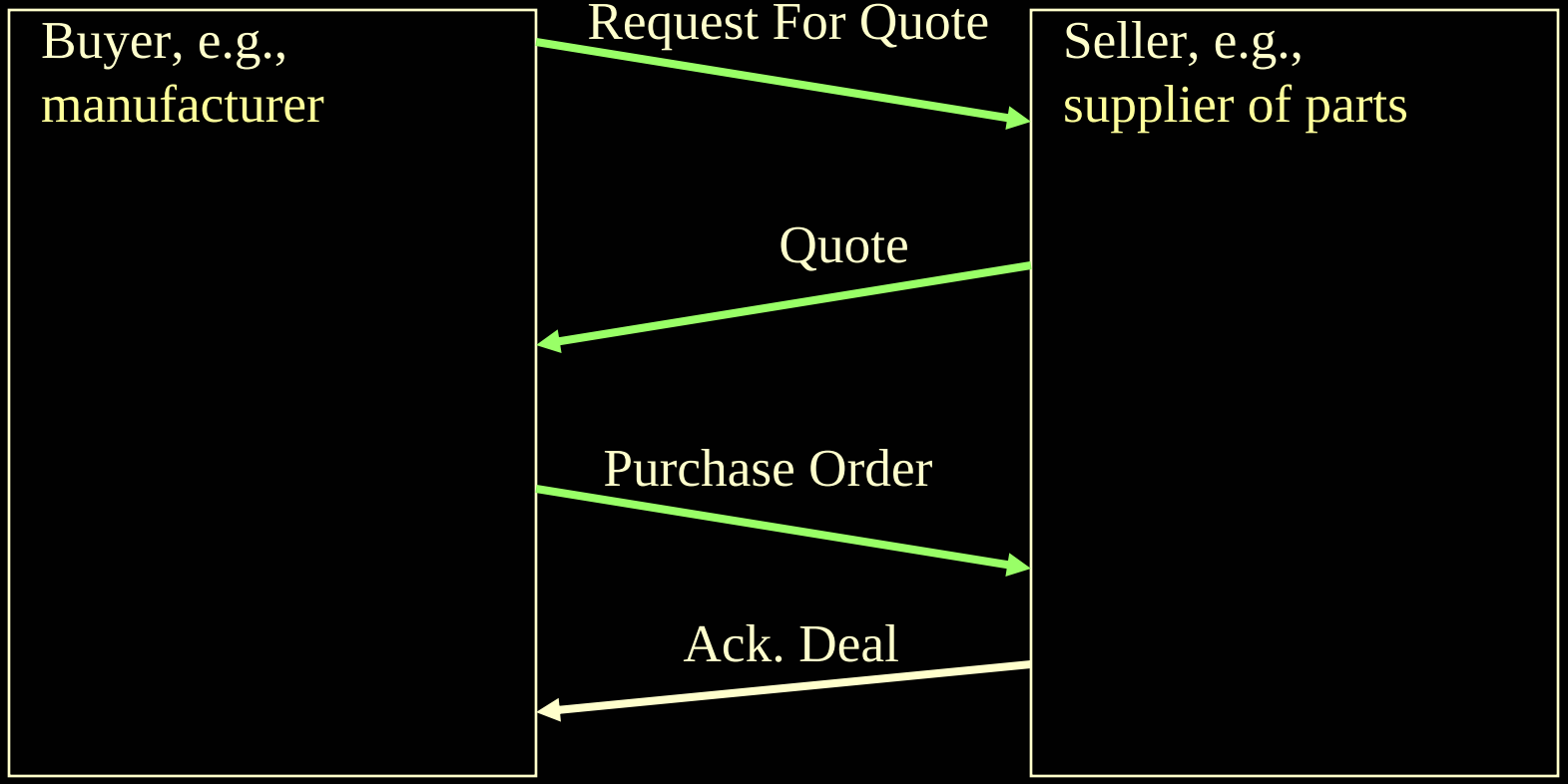
Exchange of Rules Content during Negotiation: example



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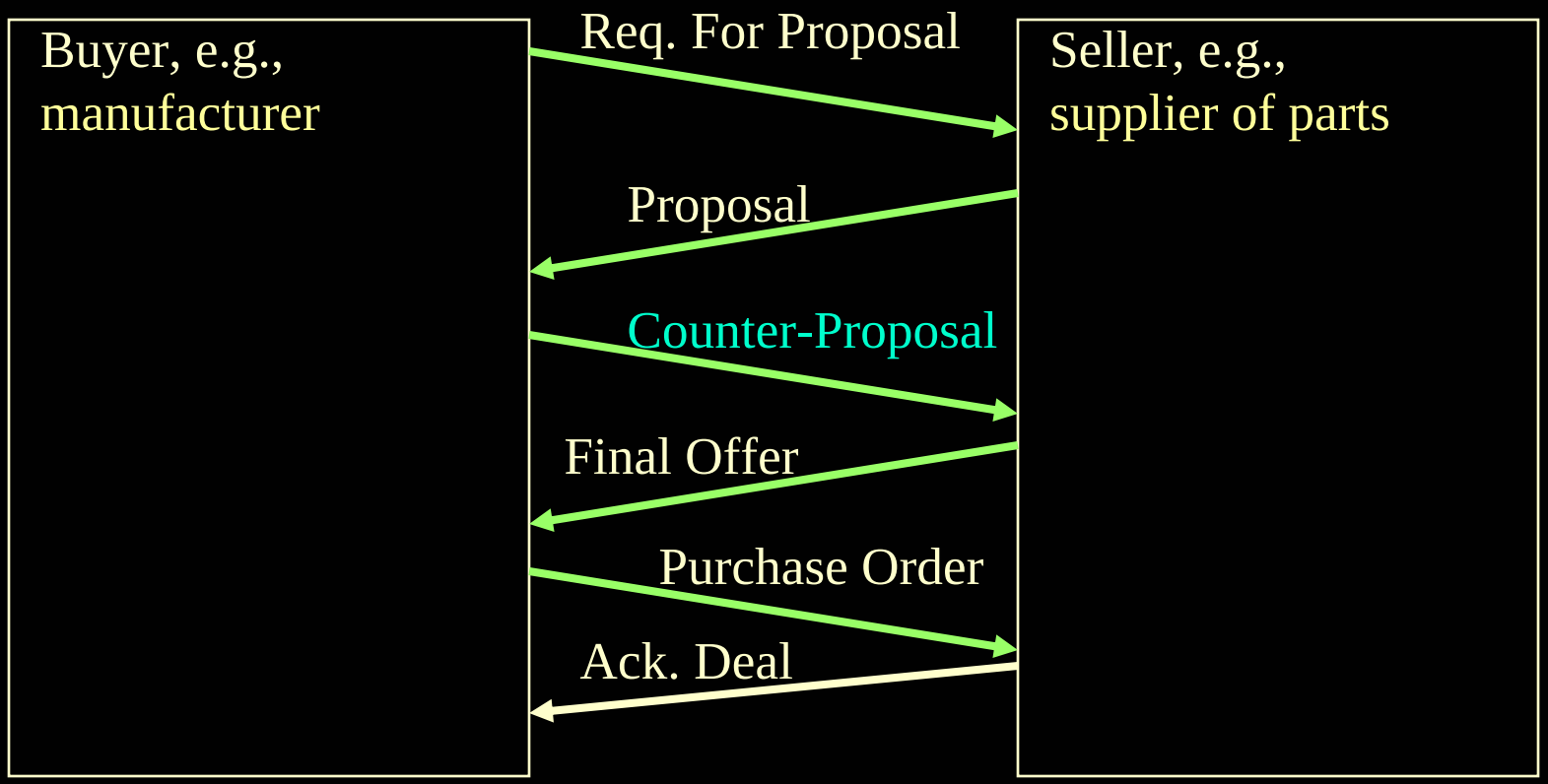
Exchange of Rules Content during Negotiation: example



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Negotiation Example XML Document: Proposal from supplierCo to manufCo

```
<negotiation_message>
 <message_header>
    <proposal/>
    <from> supplierCo </from>
    <to> ManufCo </to>
  </message_header>
  <rules_content>
        …[see next slide]
  </rules_content>
  …
</negotiation_message>
```

- Example of similar message document format:
- FIPA Agent Communication Markup Language (draft industry standard).

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Courteous LP 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) .
- ⊥ ← price(per_unit, ?PO, ?X) ∧ price(per_unit, ?PO, ?Y) GIVEN (?X ≠ ?Y).
- ...

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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!

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Negotiation Example --

XML Encoding of Rules in RuleML

```
<rulebase>
 <imp>
  <_rlab>usualPrice</_rlab>
  <_head>
   <cslit>
    <_opr><rel>price</rel></_opr>
     <ind>per_unit</ind>
     <var>PO</var>
     <ind>$60</ind>
   </cslit>
  </_head>
  <_body>     …  (see next page)    </_body>
 </imp>
…
</rulebase>
```


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Negotiation Example -- XML Encoding of Rules in RuleML, Continued

```
<_body>
 <andb>
  <fclit>
   <_opr><rel>purchaseOrder</rel></_opr>
    <var>PO</var>
    <ind>supplierCo</ind>
    <var>AnyBuyer</var>
  </fclit>
  <fclit>
  …
  </fclit>
  ...
 </andb>
</_body>
```


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URI Ontological Reference Approach Example, in RuleML

```
payment(?R,base,?Payment) <-
http://xmlcontracting.org/sd.owl#result(co123,?R) AND
price(co123,?P) AND quantity(co123,?Q) AND
multiply(?P,?Q,?Payment) ;
```

SCLP TextFile Format for RuleML

```
<imp>
  <_head> <atom>
     <_opr><rel>payment</_opr></rel>    <tup>
     <var>R</var> <ind>base</ind> <var>Payment</var>
  </tup></atom> </_head>
  <_body>
   <andb>
     <atom> <_opr>
       <rel href= "http://xmlcontracting.org/sd.owl#result"/>
         </_opr> <tup>
           <ind>co123</ind> <var>Cust</var>
          </tup> </atom>

... </andb> </_body>  </imp>
```


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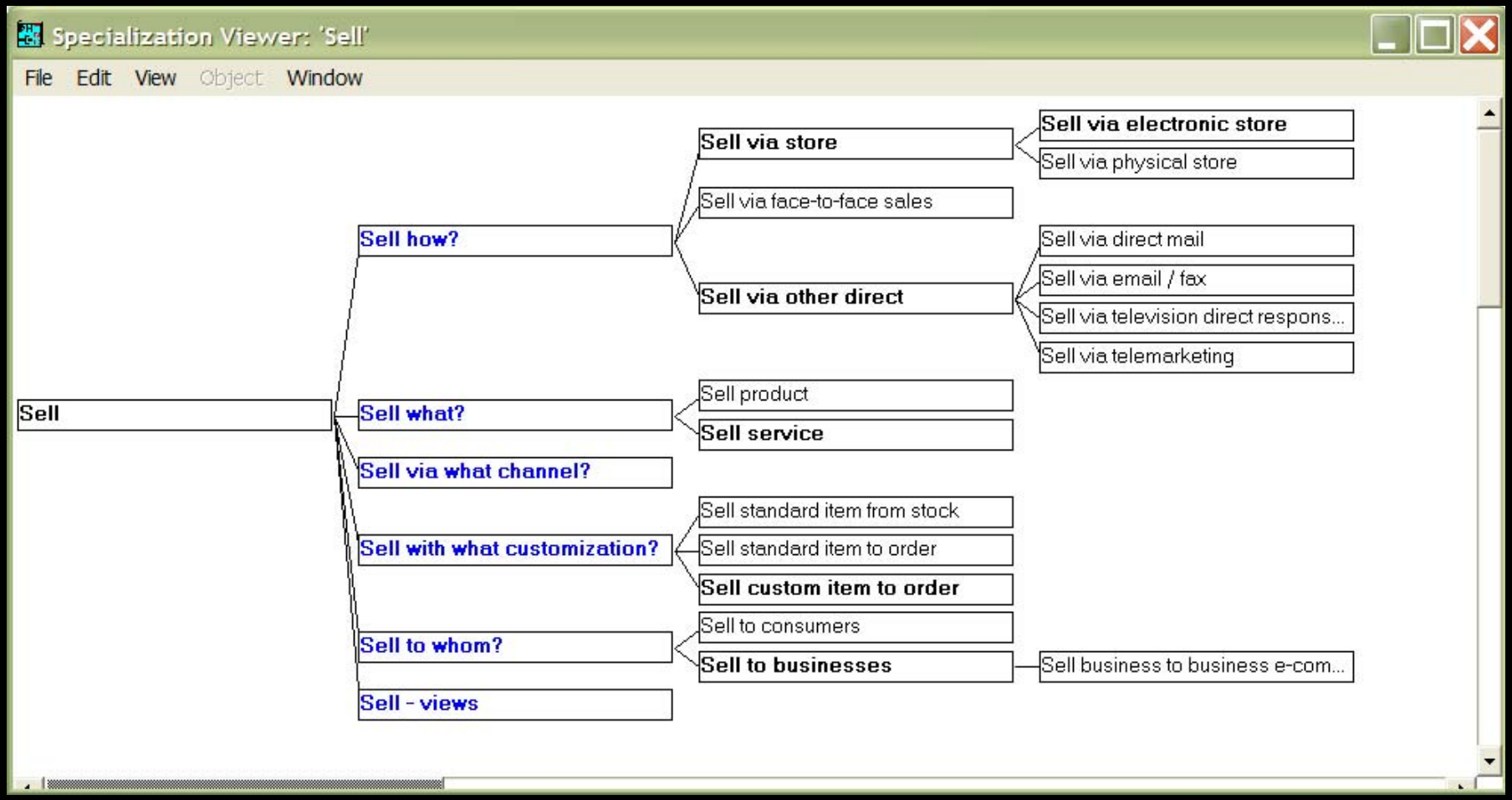
Some Specializations of "Sell" in the MIT Process Handbook (PH)



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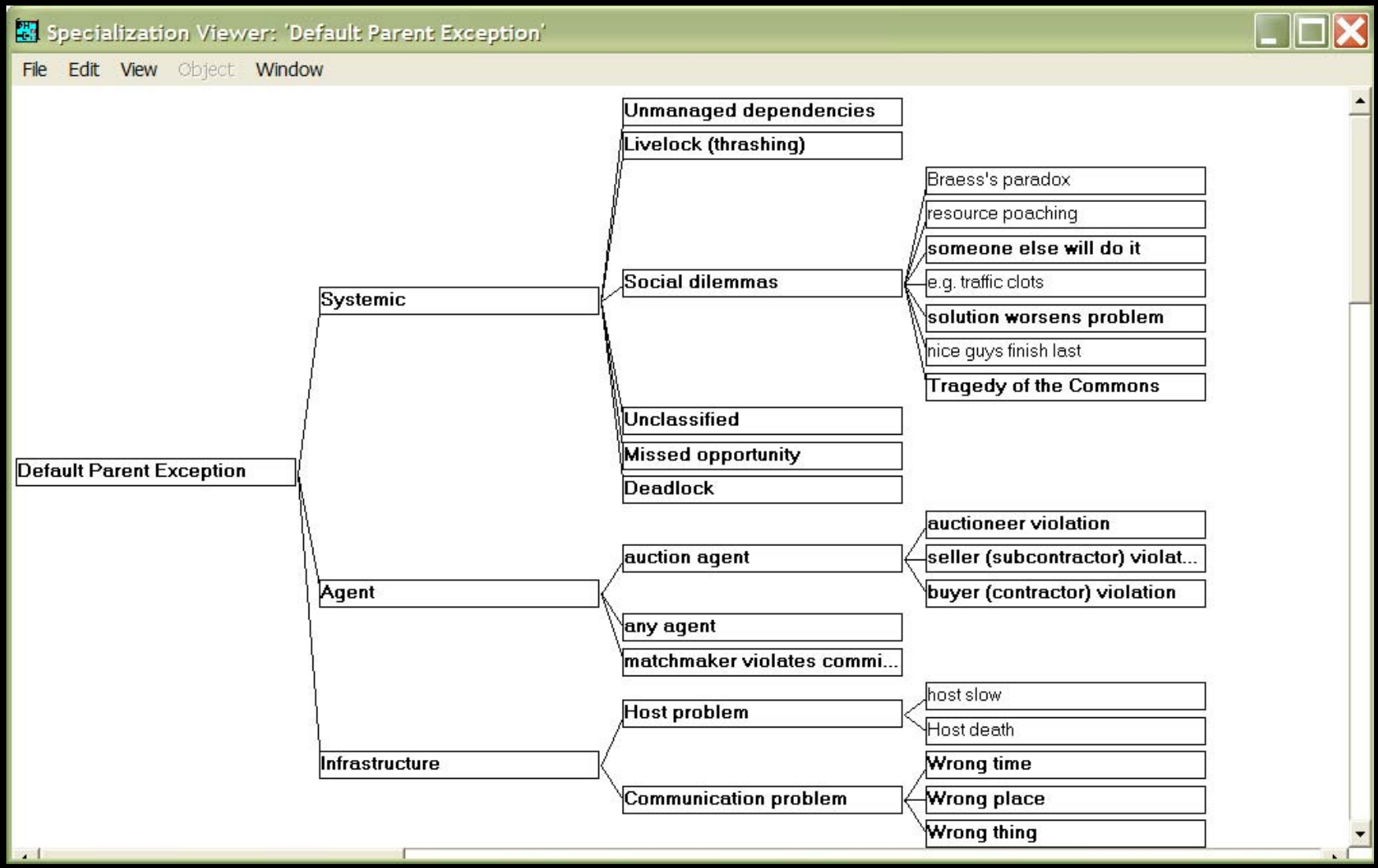
Some Exceptions in the MIT Process Handbook



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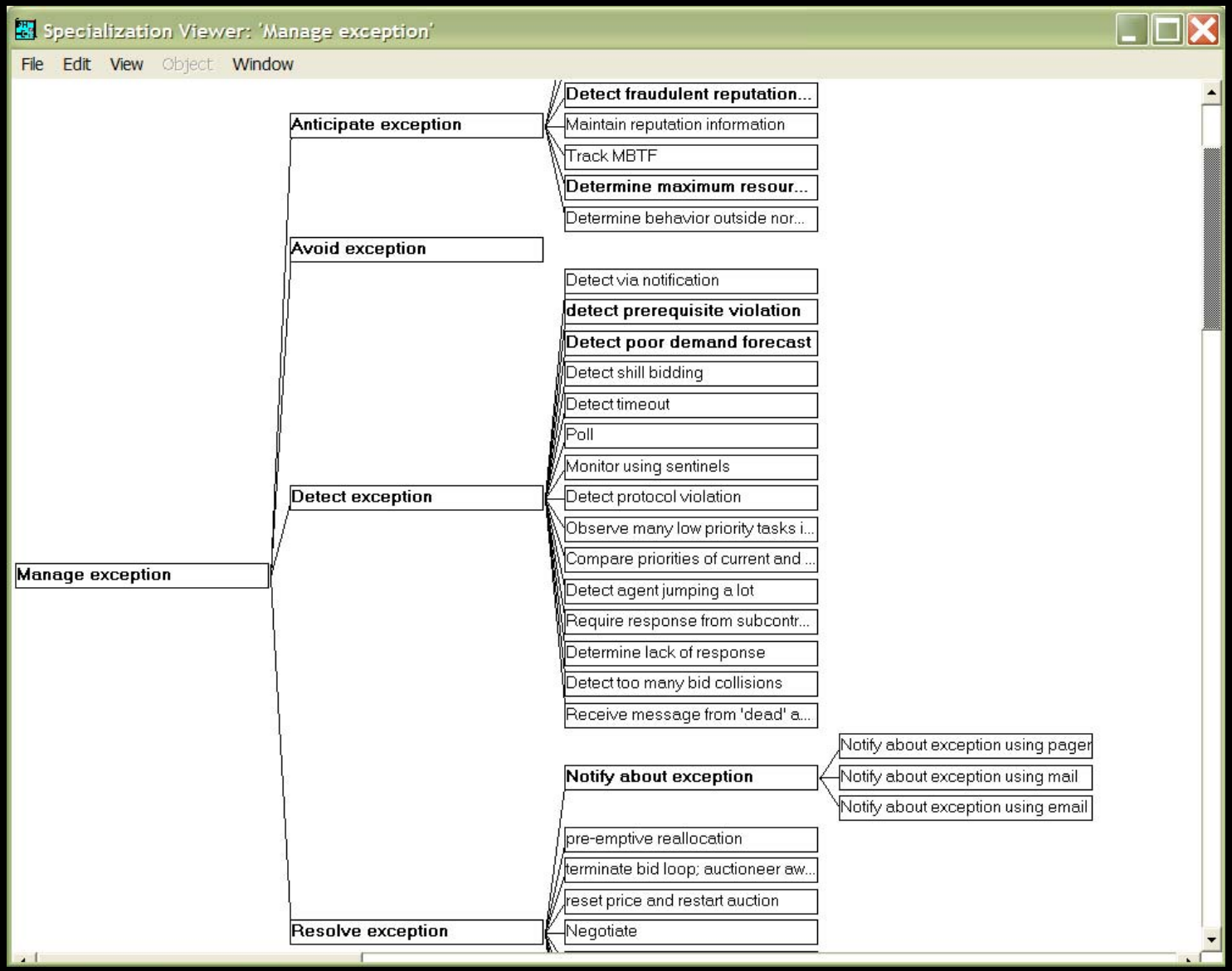
Some exception handlers in the MIT Process Handbook



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Example Contract Proposal with Rule-based Exception Provisions

- Buyer adds rule modules to the contract proposal to specify:
  - 1. detection of an exception
    - LateDelivery as a potential exception of the contract's process
    - detectLateDelivery as exception handler: recognize occurrence
  - 2. avoidance of an exception (and perhaps also resolution of the exception)
    - lateDeliveryPenalty as exception handler: penalize per day

- Rule module = a nameable ruleset → a subset of overall rulebase
  - can be included directly and/or imported via link; nestable
    - similar to legal contracts' "incorporation by reference"
  - an extension to RuleML; in spirit of "Webizing"

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Example Contract Counter-Proposal with Rule-based Exception Provisions

- Seller modifies the draft contract (it's a *negotiation*!)
- Simply adds* another rule module to specify:
  - lateDeliveryRiskPayment as exception handler
    - lump-sum in advance, based on average lateness
      - instead of proportional to actual lateness
  - higher-priority for that module than for the previous proposal, e.g., higher than lateDeliveryPenalty's rule module

- Courteous LP's prioritized conflict handling feature is used
- *NO *change* to previous proposal's rules needed!
  - similar to legal contracts' accumulation of provisions

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  - SweetDeal Approach to End-to-End E-Contracting;
  - Trust Policies; … with Business Value Analysis
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  - SWS Initiative & its SWS Language Approach
  - SWS Market Evolution & Prospective Early Adoption

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ISWC-2004 Tutorial: Outline of Part C.

C. Applications -- Policies, Services, and Semantic Integration

1. Ontology Translation and Semantic Integration
   - SWRL uses, ECOIN, financial services
2. End-to-End E-Contracting and Business Process Automation
   - supply chain, e-tailing, auctions, SweetDeal, Process Handbook
3. Business Policies including Trust
   - credit, health, RBAC, XACML, P3P, justifications
4. Semantic Web Services
   - SWSL tasks
5. Prospective Early Adopter areas, strategy, and market evolution
6. Windup and Discussion

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Opportunity for Process Handbook in SWS

- Need for Shared Knowledge Bases about Web Services / Business Processes
  - For Semantic Web Services, etc.
- Want to leverage legacy process knowledge content
  - Go where the knowledge already is
- Process Handbook (PH) as candidate nucleus for shared business process ontology for SWS
  - 5000+ business processes, + associated class/property concepts, as structured knowledge (http://ccs.mit.edu/ph)
  - E.g., used in SweetDeal E-Contracting prototype
- Concept: Use Semantic Web KR and standards to represent Object-Oriented framework knowledge:
  - class hierarchy, types, generalization-specialization, domain & range, properties/methods' association with classes

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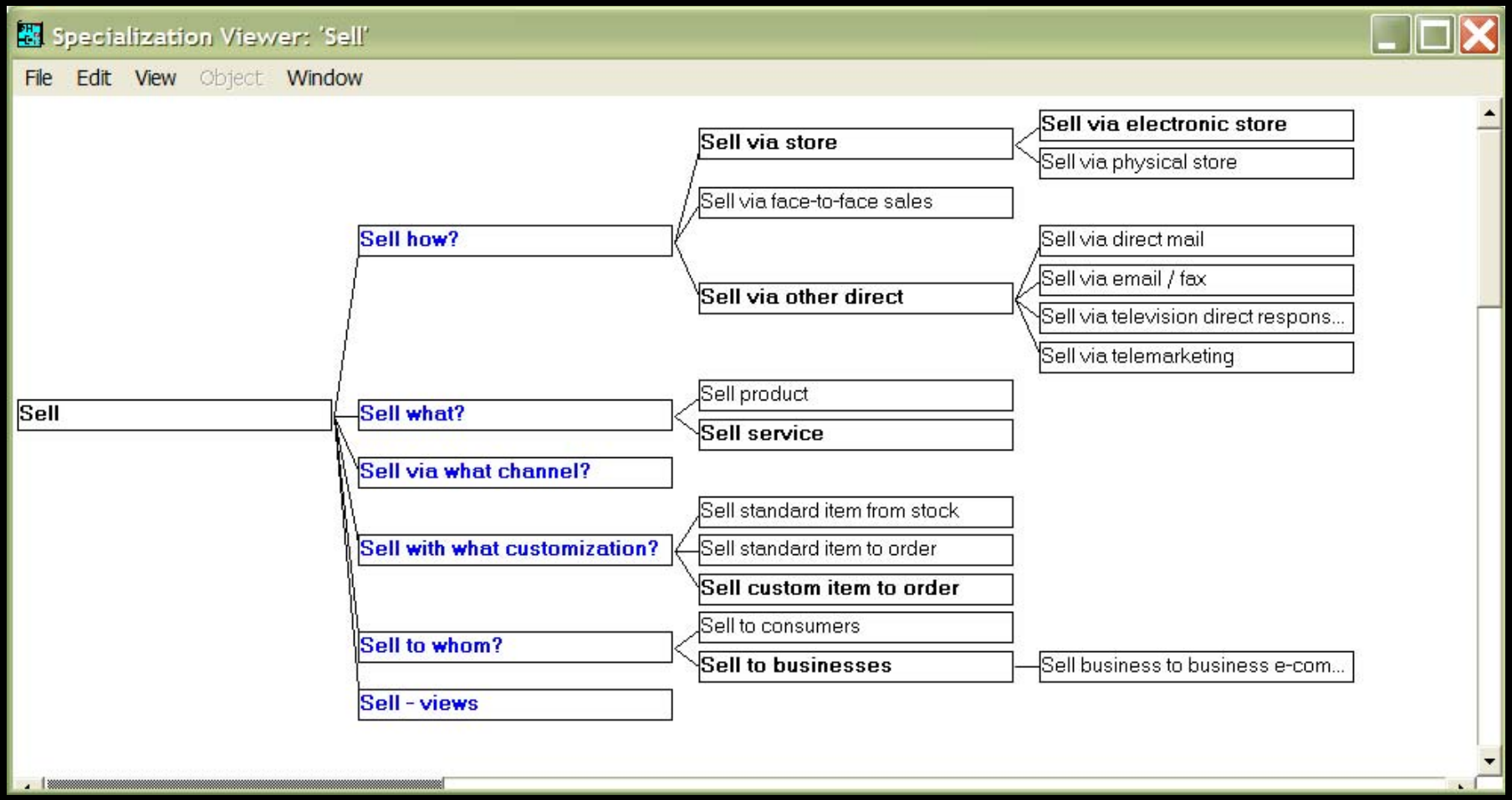

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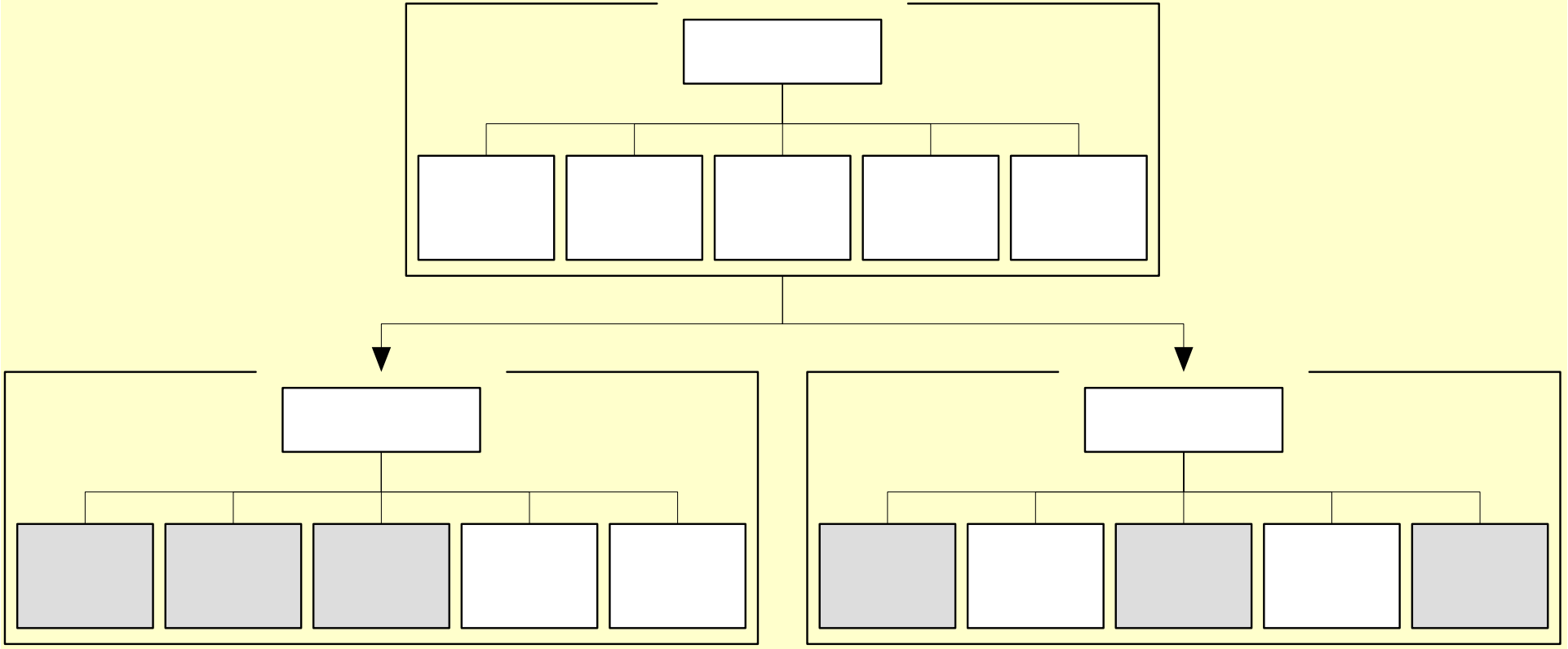
PH Example: Selling Processes



An activity (e.g., SellProduct) has sub-activities (steps).

Its specializations (e.g., SellByMailOrder) inherit its sub-activities by default.

Key: gray = modified (overridden). X = deleted (canceled).

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SweetPH's New Technical Approach: Courteous Inheritance for PH & OO

- Surprise: use SW *rule* language not the main SW *ontology* language! I.e., use (SCLP) RuleML not OWL.
  - OO inheritance is *default* ⇒ more reuse in ontologies
  - OWL/FOL cannot represent default inheritance
  - RuleML/nonmon-LP can
- Courteous Inheritance approach translates PH to SCLP KR
  - A few dozen background axioms. Linear-size translation. Inferencing is tractable computationally.
- PH becomes a SWS OO process ontology repository
- *In progress: open source version of PH content*
- *In progress: extend approach to OO ontologies generally*

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Challenge: Capturing Semantics around Policies

- Deep challenge is to capture the semantics of data and processes, so that can:
  - Represent, monitor, and enforce policies – e.g., trust and contracts
  - Map between definitions of policy entities, e.g., in financial reporting
  - Integrate policy-relevant information powerfully

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Policies for Compliance and Trust Mgmt.: Role for Semantic Web Rules

- Trust Policies usually well represented as rules
  - Enforcement of policies via rule inferencing engine
  - E.g., Role-based Access Control
    - This is the most frequent kind of trust policy in practical deployment today.
  - W3C P3P privacy standard, Oasis XACML XML access control emerging standard, …

- Ditto for Many Business Policies beyond trust arena, too
  - "Gray" areas about whether a policy is about trust vs. not: compliance, regulation, risk management, contracts, governance, pricing, CRM, SCM, etc.
  - Often, authorization/trust policy is really a part of overall contract or business policy, at application-level. Unlike authentication.
  - Valuable to reuse policy infrastructure

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Advantages of Standardized SW Rules

- Easier Integration: with rest of business policies and applications, business partners, mergers & acquisitions
- Familiarity, training
- Easier to understand and modify by humans
- Quality and Transparency of implementation in enforcement
  - Provable guarantees of behavior of implementation
- Reduced Vendor Lock-in
- Expressive power
  - Principled handling of conflict, negation, priorities

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Advantages of SW Rules, cont'd:
Loci of Business Value

- 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 trust management language allows better conflict handling in policy-driven decisions

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Delegation Logic (D1LP) Example: accessing medical records

[N. Li, B. Grosof, J. Feigenbaum ACM TISSEC 2003]

- Problem: Hospital HM to decide: requester Alice authorized for patient Peter?
- Policies: HM will authorize only the patient's physician. HM trusts any hospital it knows to certify the physician relationship. Two hospitals together can vouch for a 3rd hospital.
  - HM says authorized(?X, read(medRec(?Y))) if HM says inRole(?X, physic(?Y)).
  - HM delegates inRole(?X, physic(?Y))^1 to threshold(1,?Z, HM says inRole(?Z,hosp)).
  - HM delegates inRole(?H,hosp)^1 to threshold(2 , ?Z, HM says inRole(?Z,hosp)).
- Facts: HC certifies Alice is Peter's physician. HM knows two hospitals HA and HB. HA and HB each certify HC as a hospital.
  - HC says inRole(Alice, physic(Peter)). HA says inRole(Joe, physic(Sue)).
  - HM says inRole(HA,hosp). HM says inRole(HB, hosp).
  - HA says inRole(HC,hosp). HB says inRole(HC, hosp).
- Conclusion: HM says authorized(Alice, read(medRec(Peter))). *Joe NOT authorized.*

Slide also by Ninghui Li and Joan Feigenbaum

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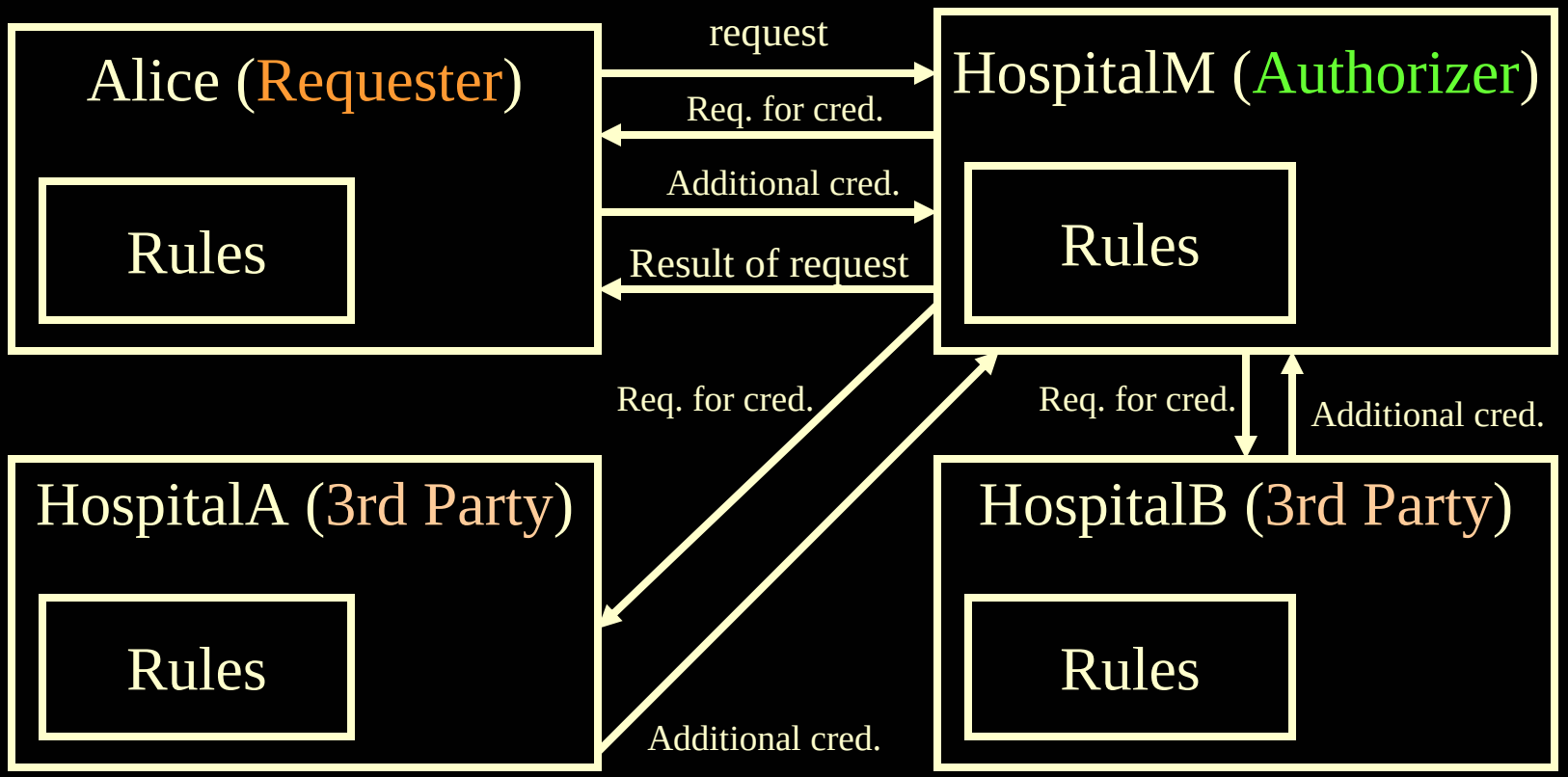
Example Scenario Information Flow



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Trust Policies and Compliance in US Financial Industry Today

- Ubiquitous high-stakes Regulatory Compliance requirements
  - Sarbanes Oxley, SEC (also in medical domain: HIPAA), etc.
- Internal company policies about access, confidentiality, transactions
  - For security, risk management, business processes, governance
- Complexities guiding who can do what on certain business data
- Often implemented using rule techniques

- Often misunderstood or poorly implemented leading to vulnerabilities
- Typically embedded redundantly in legacy silo applications, requiring high maintenance
- Policy/Rule engines lack interoperability

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Example Financial Authorization Rules

Classification	Application	Rule
Merchant	**Purchase Approval**	If credit card has fraud reported on it, or is over limit, do not approve.
Mutual Funds	**Rep trading**	*Blue Sky*: State restrictions for rep's customers.
Mortgage Company	**Credit Application**	TRW upon receiving credit application must have a way of securely identifying the request.
Brokerage	**Margin trading**	Must compute current balances and margin rules before allowing trade.
Insurance	**File Claims**	Policy States and Policy type must match for claims to be processed.
Bank	**Online Banking**	User can look at own account.
All	**House holding**	For purposes of silo (e.g., statements or discounts), aggregate accounts of all family members.

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Example I – Credit Card Verification System

- Typical for eCommerce websites accepting credit cards – Visa, MC, Discover, Amex
- Rules for transaction authorization
  - Bank performs account limit, expiration, address and card code verification
  - A fraud alert service may flag a card
  - Service provider may blacklist customer
- Overrides, e.g., alert service > bank rules

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Example II – Brokerage Access Control

- Need protection of customer accounts of retail (own) and many client correspondents from unauthorized access by traders (reps)
- Many Complex Rules for access control
  - Retail reps can look at any retail account but not correspondent accounts
  - A correspondent user may look at accounts for their organization but…
  - Only from those branches over which rep's branch has fiduciary responsibility
  - For certain branches, customer accounts are explicitly owned by certain reps and cannot be divulged even to his partner!
- More rules, with several overrides

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CommonRules Implementation for Credit Card Verification Example

Sample Rule Listing

```
<bankResp>
  if checkTran(?Requester)
  then
    transactionValid(self,?Requester);
<cardRules2>
    if      checkCardDet(?Requester, ?accountLimit, ?exp_flag, ?cardholderAddr,
    ?cardholderCVC) and
    checkTranDet(?Requester, ?tranAddr, ?tranCVC) and
    notEquals(?tranCVC, ?cardholderCVC)
    then
    CNEG transactionValid(self,?Requester);
…
overrides(cardRules2, bankResp);
checkTran(Joe);
checkCardDet(Joe, 50, "false", 13, 702);
checkTranDet(Joe, 13, 702);
cardGood(Fraudscreen.net,Joe,good);
customerRating(Amazon.com, Joe, good);
```

CommonRules translates straightforwardly ↔ RuleML.

We show its human-oriented syntax as a presentation syntax for RuleML.

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Runtime Results for Credit Card Verification

Sample Output

SCLPEngine: Adorned Derived Conclusions:

CNEG transactionValid_c_3(self, Mary);
transactionValid_c_2(self, Joe);
transactionValid_c_2(self, Mary);
transactionValid_r_2(self, Mary);
transactionValid_u(self, Joe);
CNEG transactionValid_u(self, Mary);

transactionValid(self, Joe);
CNEG transactionValid(self, Mary);

Adorned **conclusions represent intermediate phases of prioritized conflict handling in Courteous Logic Programs**

CNEG **= limited classical negation (which is permitted in Courteous LP)**

CNEG p means p is (believed to be) false

Self **= the agent making the authorization decision, i.e., the viewpoint of this local rulebase.**

(This is as usual in trust management.)

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Slide also by Chitravanu Neogy

XBRL®
eXtensible Business Reporting Language

Welcome to XBRL International

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

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

XBRL is being developed by an international non-profit consortiu approximately 250 major companies, organisations and governm 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 benefit XBRL. It explains how individuals and companies can join the effo move forward and make use of the language.

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More Strategic Opportunities in Compliance

- XBRL (eXtensible Business Reporting Language):
  - SWS rules + ontologies can reduce degree of industry consensus required to enable interoperability
    - Difficult to get agreement on single definition of “earnings”; easier to agree on “long-term capital gains realized from sale of real estate assets”.
    - Translate between different use contexts’ ontologies
- SEC and other regulatory agencies:
  - They can accelerate compliance
    - via providing automated SWS specifications of regulations and reporting forms (+ the instructions)
      - e.g., RuleML regulatory rulebases accessible via Web Services interfaces

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eXtensible Access Control Markup Language (XACML)

- Oasis XACML is leading technical standard for access control policies in XML
  - Access to XML info
  - Policies in XML
- Uses a rule-based approach
  - Including for prioritized combination of policies
- Status: Emerging
- Needs a formal semantics -- and a more principled and standardized approach to rules KR, generally.
  - Research opportunity!

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Platform for Privacy Preferences (P3P)

- W3C P3P is leading technical standard for privacy policies representation and enforcement
- Client privacy policies specified in a simple rule language (APPEL, part of P3P)
- Has not achieved great usage yet
  - Microsoft dominance of browsers a strategic issue
- Needs a formal semantics -- and a more principled and standardized approach to rules KR, generally.
  - Research opportunity!

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Web Services Trust Policy Management

- Web Services (WS) area is evolving quickly
- Emerging hot area: WS policy management, including for security/trust -- which includes privacy
  - Defined as next-phase agenda in standards efforts, major vendor white papers/proposals (e.g., Microsoft, IBM)
  - Semantic Web Services research in this is growing, e.g., DAML-Security effort, Rei, SWSL
- Research opportunity!

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Other Aspects and Approaches: Web Trust and Policies

- Rei rule-based policy language [L. Kagal *et al*]
  - Builds upon SCLP, OWL, Delegation Logic approach
- DAML-Security effort [Denker *et al*]
- PeerTrust rule-based trust negotation [Nejdl *et al*]
  - Builds upon OLP, Delegation Logic approach; protocols

- Justifications and proofs on the Semantic Web:
  - InferenceWeb approach [D. McGuinness *et al]*

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SWS Initiative (SWSI)

- >50 participating institutions
- Two active committees: Language (SWSL), Architecture (SWSA)
- Industrial partners program (~40)
- Created Dec. 2002 with US, EU, & global partners
- Coordinate research and early standards
- http://www.swsi.org
- Requirements 2003
- Design drafts 2004
- Design reports early 2005

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New Analysis of SWS

Adopted by

SWS Initiative's

SWS Language Committee

http:/www.swsi.org

SWS Tasks Form 2 Distinct Clusters, each with:

a. Central Kind of Service-description Knowledge

b. Main KR

1. Security/Trust, Monitoring, Contracts, Advertising/Discovery, Ontology-mapping Mediation
   a. Central Kind of Knowledge: Policies
   b. Main KR: Nonmon LP (rules + ontologies)
2. Composition, Verification, Enactment
   a. Central Kind of Knowledge: Process Models
   b. Main KR: FOL (axioms + ontologies)

      + Nonmon LP for ramifications (e.g., cf. Golog)

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SW Approach to Service Descriptions

Adopted by SWSL

- Use Nonmon LP and/or FOL KR, in standardized semantic web form
  - RuleML the only serious candidate for Nonmon LP; also covers FOL
  - Simplified Common Logic (successor to KIF) is another candidate for FOL, but its webizing is not as mature
- Use ontologies
  - In OWL Description Logic, FOL, and/or LP
- SWSL provides spec. of core ontologies, based initially on:
  - NIST Process Specification Lang. (PSL)
  - OWL-S service Profiles
- *Wanted: Detailed Service Ontology KB's*
  - E.g., SW version of MIT Process Handbook

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Overall Approach

- Use Semantic Web Rules with Ontologies
  - Situated Courteous Logic Programs (SCLP) as Rules KR
  - Priorities; Procedural Attachments for Actions, Tests/Queries
  - Ontologies from legacy or new OO, in SCLP or FOL/DL
  - Webized in RuleML + OWL
- Build and use Open-source KB's
  - Service Ontologies
    - Early step: Process Handbook in RuleML
      - SweetPH translation using Courteous Inheritance approach
      - Open Process Handbook Initiative (OPHI)
    - Early step: SWSL Core Service Ontologies
      - Build on NIST PSL, OWL-S service profiles
    - Other near-term steps:
      - look at WSDL, WSBPEL, WS Choreography

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Outline of Talk

- Intro; Semantic Web Services (SWS) Concept & Vision
- Semantic Web Rules
  - Rule KR & Theory
  - RuleML Emerging Standard
  - SweetRules V2 Toolset
- E-Business Applications of Rule-based SWS
  - SweetDeal Approach to End-to-End E-Contracting;
  - Trust Policies; … with Business Value Analysis
- Creating Service Ontologies
  - Process Handbook; SweetPH; Leveraging Legacy OO
- Roadmapping E-Services Knowledge Management & SWS
  - Reusable Service Ontologies and Contracts; Open-Source KB's
  - SWS Initiative & its SWS Language Approach
  - SWS Market Evolution & Prospective Early Adoption

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Rules in Semantic Web Services: SWSL Strategic Requirements Analysis I

[Grosof, Kifer, Martin et al – SWSI Language Committee May 2004]

- The opportunity for near-term impact of SWS is mostly: …
- Use of LP Rules in: the "SCAMP" group of tasks:
  - SCAMP = Security, Contracts, Advertising, access, authorization, mappings/mediation for semantic interoperability, Monitoring, privacy, and Policies

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B2B Tasks: Communication for Business Processes with Partners

- B2B business processes involving significant Communication with customers/suppliers/other-partners is overall a natural locus for future first impact of SWS.
- Customer Relationship Management (CRM)
  - sales leads and status
  - customer service info and support
- Supply Chain Management (SCM):
  - source selection
  - inventories and forecasts
  - problem resolution
  - transportation and shipping, distribution and logistics
- orders; payments, bill presentation

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Some B2B Tasks (continued)

- bids, quotes, pricing, CONTRACTING; AUCTIONS; procurement
- authorization (vs. authentication) for credit or trust
- database-y: e.g.,
  - catalogs & their merging
  - policies
- inquiries and answers; live feedback
- notifications
- trails of biz processes and interactions
- ratings, 3rd party reviews, recommendations
- knowledge management with partners/mkt/society

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SWS Adoption Roadmap: Strategy Considerations

- Expect see beginning in a lot of B2B interoperability or heterogeneous-info-integration intensive (e.g., finance, travel)
  - Actually, probably 1st intra-enterprise, e.g., EAI
- Reduce costs of communication in procurement, operations, customer service, supply chain ordering and logistics
  - increase speed, creates value, increases dynamism
  - macro effects create
    - stability sometimes (e.g., supply chain reactions due to lag; other negative feedbacks)
    - volatility sometimes (e.g., perhaps financial market swings)
  - increase flexibility, decrease lock-in
- Agility in business processes, supply chains

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Prospective SW Early Adopters:
Areas by Industry or Task

- *We discussed earlier a number of industry or task areas:*
  - Manufacturing supply chain, procurement, pricing, selling, e-tailing, financial/business reporting, authorization/security/access/privacy policies, health records, credit checking, banking, brokerage, contracts, advertising, …
- Others:
  - travel "agency", i.e.: tickets, packages
    - See Trading Agent Competition, [M.Y. Kabbaj thesis]
  - military intelligence (e.g., funded DAML)

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Discussion: Early Adoption Application Prospects for SWS

- What business applications do you think are likely or interesting?
  - By vertical industry domain, e.g., health care or security
  - By task, e.g., authorization
  - By kind of shared information, e.g., patient records
  - By aspect of business relationships, e.g., provider network
- What do you think are entrepreneurial opportunity areas?

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