What's My Deal? Contract Communications in XML Agent Marketplaces

Invited Presentation for
Center for eBusiness @ MIT Annual Conference
April 19, 2002, Cambridge, MA USA

Prof. Benjamin Grosof

MIT Sloan School of Management
bgrosof@mit.edu http://www.mit.edu/~bgrosof/

Outline

- *Aiming to be provocative*
- 1. Intro: XML, Semantic Web
  - example: e-signatures: deeper issues & opportunities
- 2. What's Doable Now in rule-based agent contracting
  - functionality: communicate, execute, modify
  - what kind of stuff represented by rules

- 3. Example of Agent Contract Communication:
  - Approach: Inter-operable, modular XML Rules represent parts of Contract Content
- 4. Applications:
  - Current
  - Vision
- *5. Discussion: Directions for the Glorious Future*

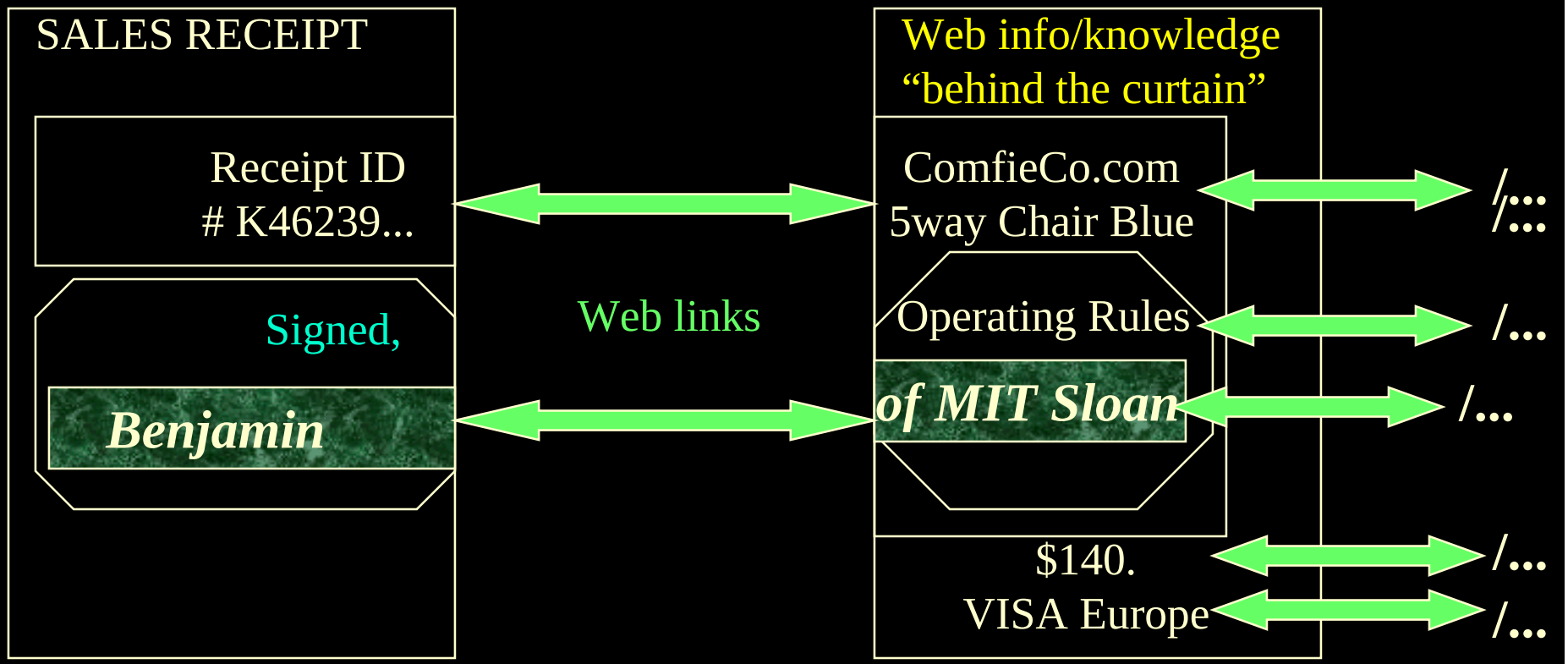
Deeper Issues of E-Signatures

- WHAT'S THE DEAL ? ... !!
- SIGN AS WHAT ?? ... !!

- *Vision/Approach:* A net of documents combined by links, on the Web

Looks Simple To Start...
then Gets Interestingly Precise

A Vision/Approach of what Web & Agents enable



The Web is becoming XML → the Semantic Web

- XML (vs. HTML) offers much greater capabilities for structured detailed descriptions that can be processed automatically.
  - Eases application development effort for assimilation of data in inter-enterprise interchange
  - A suite of open standards both current and emerging
  - … including for knowledge-level SEMANTICS
- *Soon, Agents will Talk according to these standards…*
  - ∴ potential to revolutionize *interactivity* in Web marketplaces
    - B2B, ...

What's Doable Today *in rule-based agent contracting, based on our approach to rule representation ("SweetDeal")*

- Communicate: with deep shared semantics
  - XML, inter-operable with same sanctioned inferences
  - ⇔ heterogeneous rule systems / rule-based 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)*

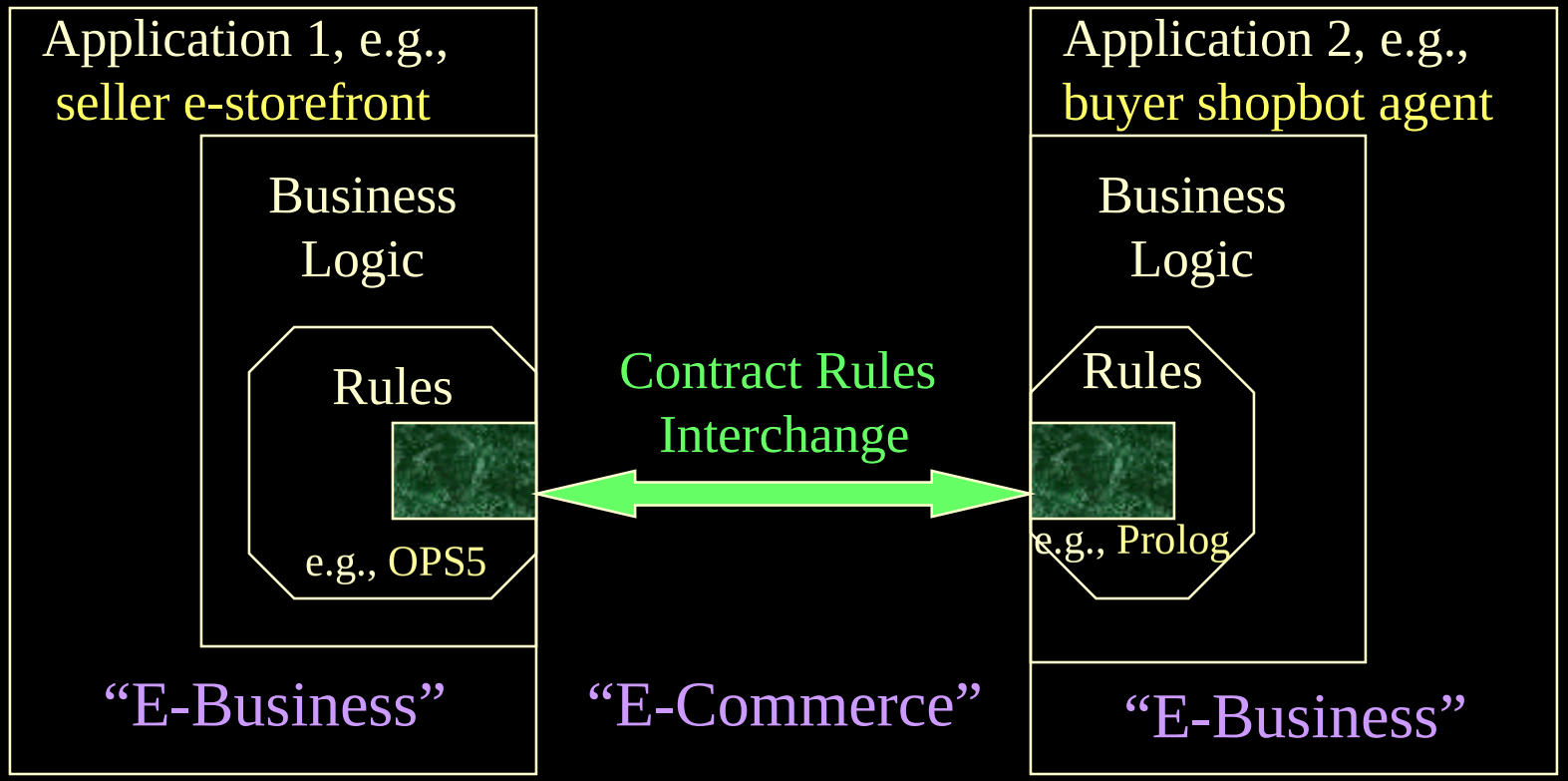
Approach: Rule-based Contracts for E-commerce

- 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.

our SweetDeal System

- 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 (co-founder)
  - WebOnt ontologies (W3C)
- Uses *repositories* of business processes and contracts
  - MIT Process Handbook (Sloan IT)
  - legal/regulatory sources: law firms, ABA, CommonAccord, … *Suggestions welcome!!*

Contract Rules across Applications / Enterprises

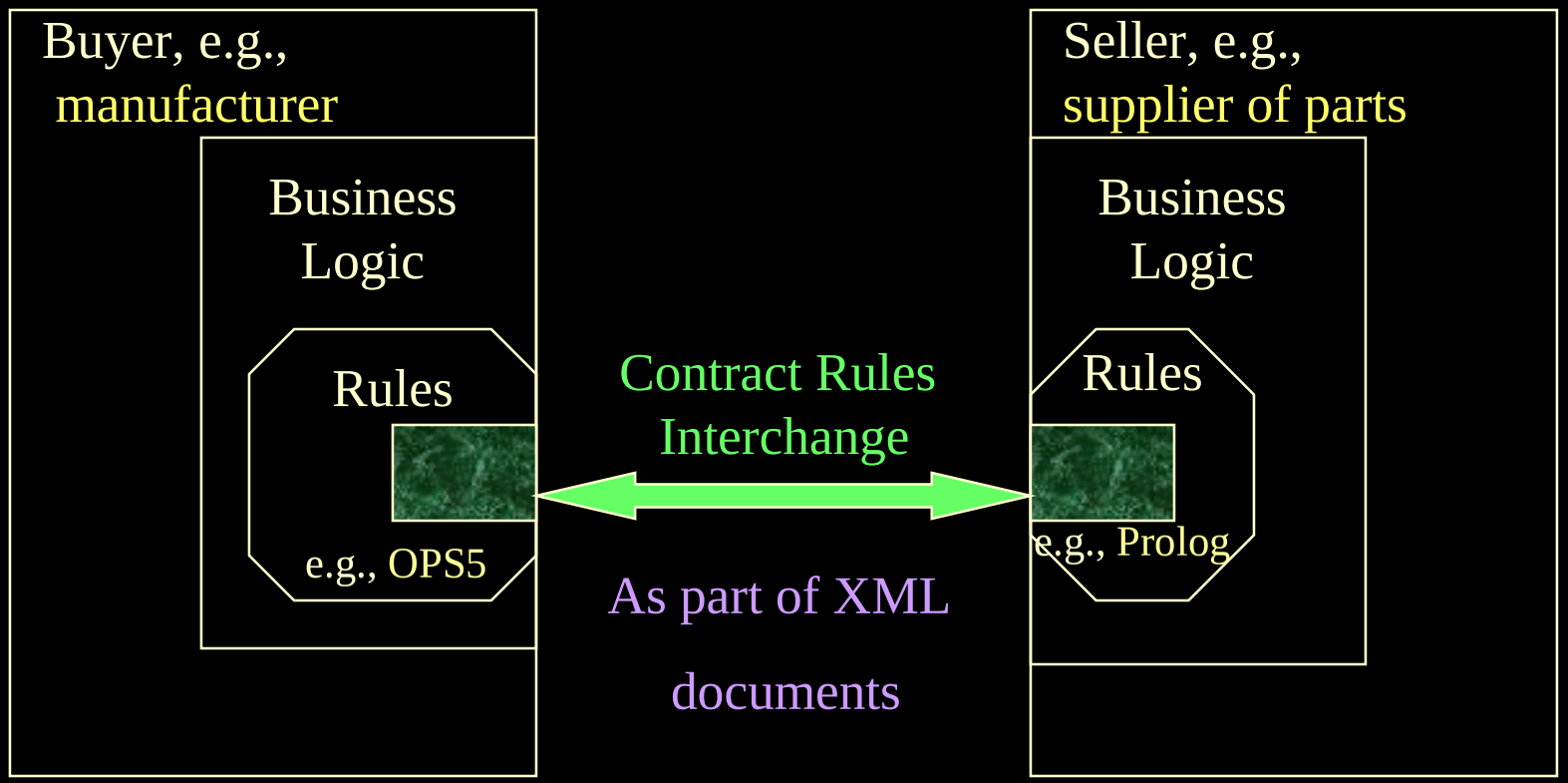


Contracting parties integrate e-businesses via shared rules.

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

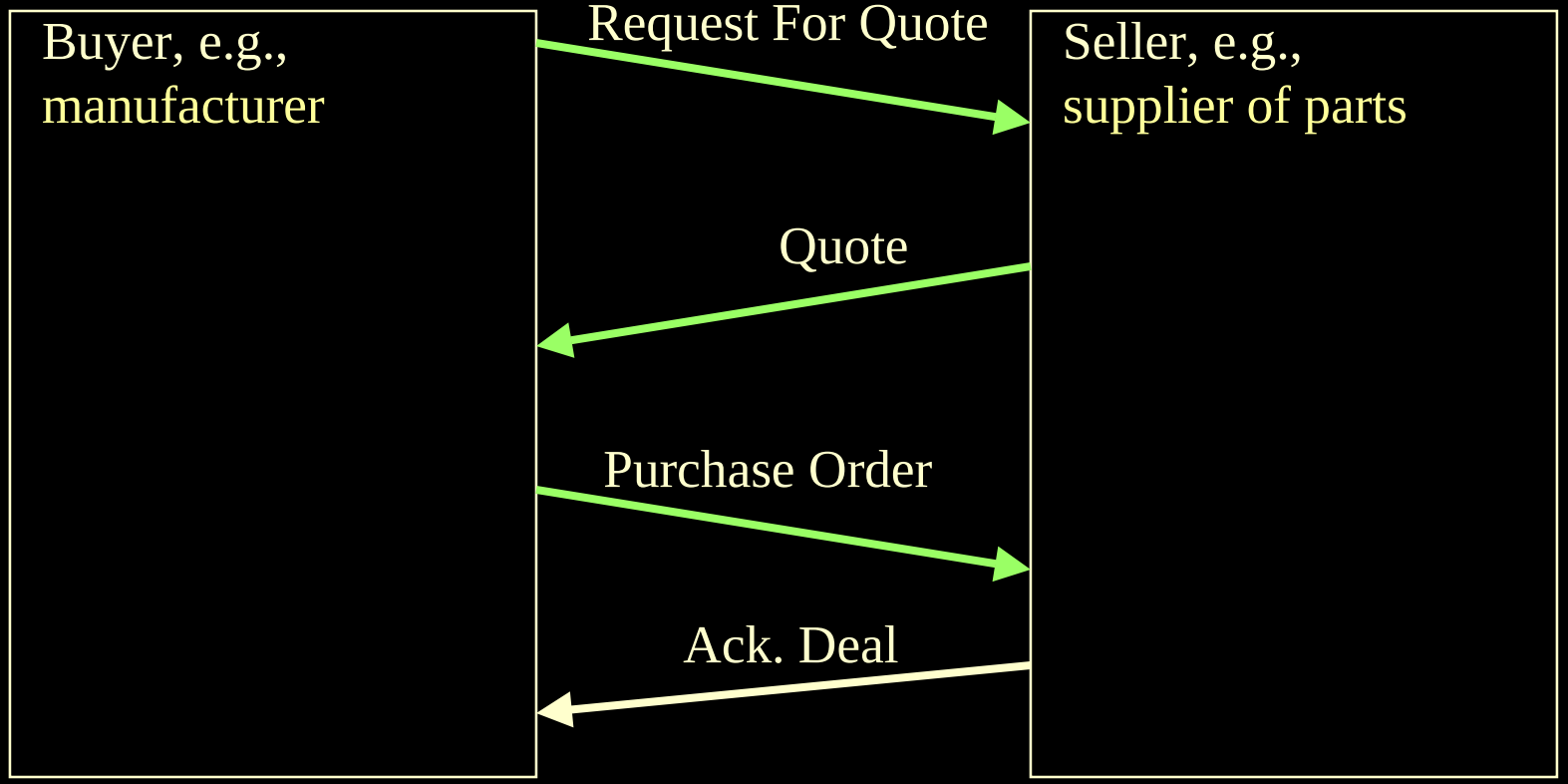
- Product descriptions
  - Product catalogs: properties, conditional on other properties.
- Pricing dependent upon: delivery-date, quantity, group memberships, umbrella contract provisions
- Terms & conditions: refund/cancellation timelines/deposits, lateness/quality penalties, ordering lead time, shipping, 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*

Contract Rules during Negotiation

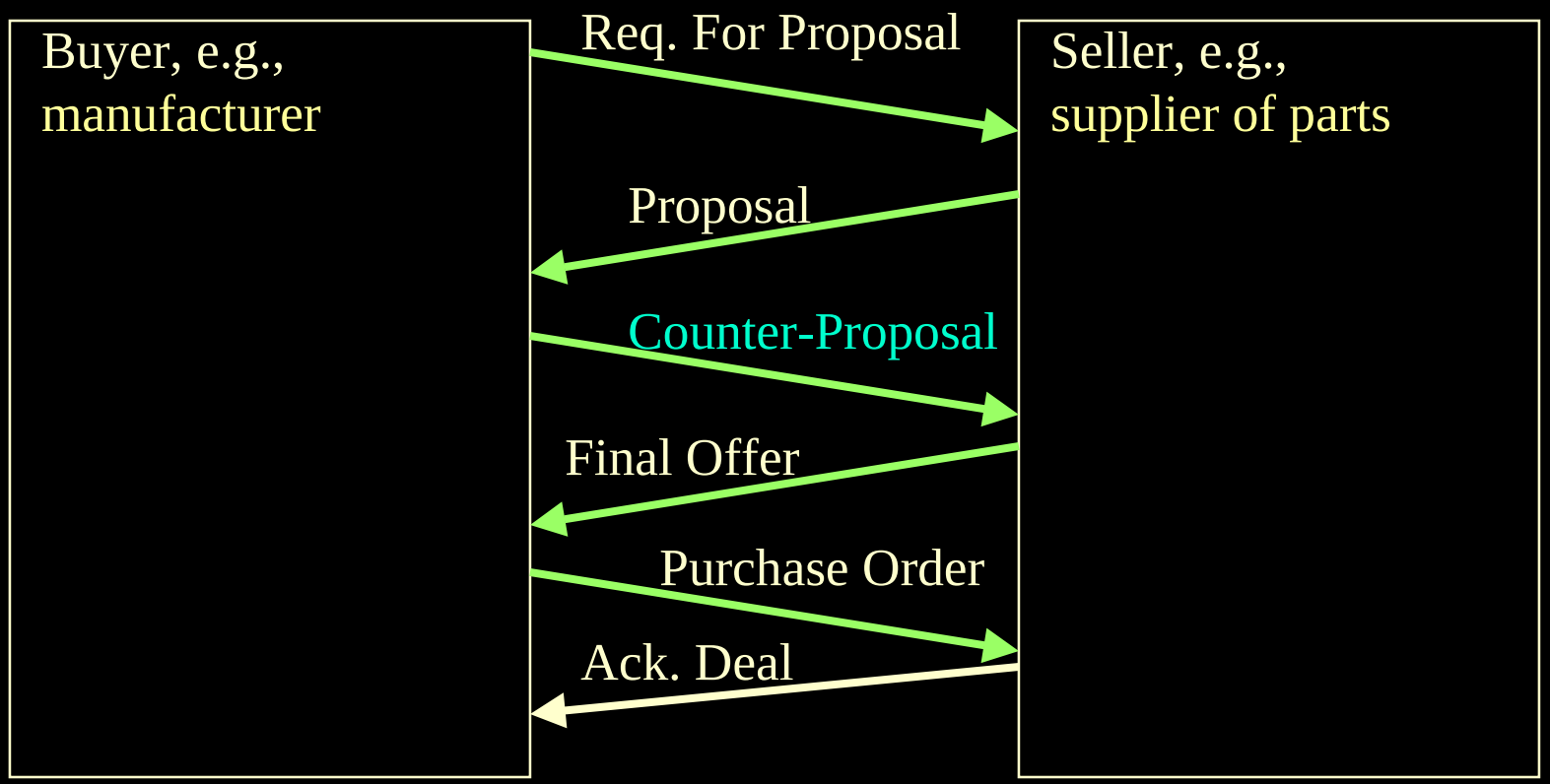


Contracting parties NEGOTIATE via shared rules.

Exchange of Rules Content during Negotiation: example



Exchange of Rules Content during Negotiation: example



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).

Negotiation Ex. Doc. Rules: 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).
- ...

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!

Negotiation Example --

XML Encoding of Rules in RuleML

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

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>
```

Commercial Implementation & Piloting

- IBM CommonRules: AlphaWorks Java library
  - implements rule-based capabilities:
    - XML inter-operability; prioritized conflict handling

- Rule Markup Language: nascent industry standards effort
  - XML Knowledge Representation (KR) $\rightarrow$ make the Web be "Semantic"
  - KR: **Situated Courteous Logic Programs in XML**

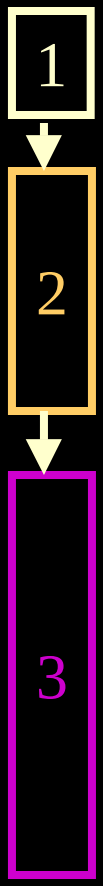
- EECOMS industry consortium including Boeing, Baan, TRW, Vitria, IBM, universities, small companies
  - $29Million 1998-2000; 50% funded by NIST ATP
  - application piloted
    - contracting & negotiation; authorization & trust

Flavors of Rules Commercially Most Important today in E-Business

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

- Relational databases, SQL: Views, queries, facts are all rules.
- Production rules (OPS5 heritage): e.g.,
  - Blaze, ILOG, Haley: rule-based Java/C++ objects.
- Event-Condition-Action rules (loose family), cf.:
  - business process automation / workflow tools.
  - active databases; publish-subscribe.
- Prolog. *"logic programs" as a full programming language.*
- *(Lesser: other knowledge-based systems.)*

Criteria for Contract Rule Representation



- *High-level:* Agents reach common understanding; contract is easily modifiable, communicatable, executable.
- Inter-operate: heterogeneous commercially important rule systems.
- Expressive power, convenience, natural-ness.
- ... but: computational tractability.
- Modularity and locality in revision.
- Declarative semantics.
- Logical non-monotonicity: default rules, negation-as-failure.
  - essential feature in commercially important rule systems.
- Prioritized conflict handling.
- Ease of parsing.
- Integration into Web-world software engineering.
- Procedural attachments.

OLP

Courteous

XML

Situated

Also Currently Being Developed in the world today

- Delegations between agents
- XML Ontologies (Vocabularies)
  - knowledge representation: infer with definitional knowledge
  - specific domain/industry vocabularies
- DARPA Agent Markup Language: ontologies, rules
- Industry Standards:
  - Web, incl. Web services
  - Agents, Business Processes, Workflow
  - E-Commerce: ebXML, ...
  - Industry-Specific
  - *Legal XML*
- *Law: Electronic Signatures, …*
- *Reusable Contract doc's on Web: CommonAccord, our work, ...*

Our Current Research Directions

- SweetRules: prototyping of SCLP RuleML inferencing, translation, knowledge integration
  - ontologies; justifications; queries; using Web protocols to invoke procedural actions; Jess.

- In SweetDeal, using SweetRules: deals about Web services, using MIT Process Handbook; integrating shallowly automated legal text; reputations; exception handling and management of risk contingencies; financial services; P3P privacy policies; and distributed trust management incl. for security authorization.

- *I.e.*, Business Intelligence on the Semantic Web

- Thanks!
- Questions?
- Comments? Pointers?
- For More Info:
  - http://www.mit.edu/~bgrosof/
    - links to http://www.research.ibm.com/rules/

Speaker Bio

- Benjamin Grosof is Douglas Drane Assistant Professor in Information Technology at MIT Sloan School of Management. His research is to create and study knowledge-based information technology for e-commerc eapplications, including high-level business/agent communication,information integration, contracts/negotiation, trust, product descriptions, business rules/policies, Web services, and e-marketplaces. The pioneer of inter-operable XML business rules and of their application to contracting, he co-leads the RuleML emerging industry standards effort on inter-operable XML/RDF rules. He is PI currently for a project in the DARPA Agent Markup Language (DAML) initiative, to create Semantic Web technology and explore its business applications.

- Previously, he was a senior research scientist at IBM T.J. Watson Research Center (12 years there), where most recently he conceived and led IBM CommonRules (V3.0 currently on IBM alphaWorks) and co-led its application piloting for rule-based XML agent contracting in EECOMS, a $29Million NIST industry consortium project on manufacturing supply chain management. His notable technical contributions also include fundamental advances in rule-based security authorization, conflict handling for rules, rule-based intelligent agents, and integration of rules with machine learning. He is author of over 30 refereed publications, two major software releases, and a patent. His recent service includes co-chairing the AAAI (National Conference on Artificial Intelligence) Workshops on AI in E-Commerce (1999) and Knowledge-Based E-Markets (2000). His background includes 2 years in software startups, PhD in Computer Science (specialty AI) from Stanford University, and BA in Applied Mathematics from Harvard University.

OPTIONAL SLIDES FOLLOW

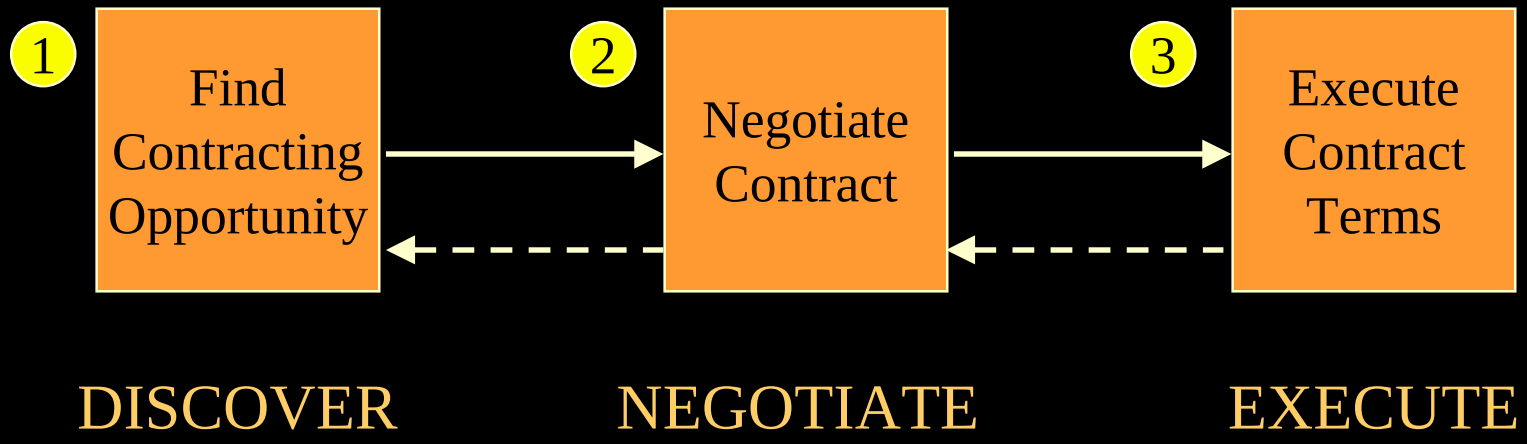
Intelligent Agents in Web E-Commerce

- *Today:* especially in the discovery phase of shopping
  - sales agents: recommend products, target ads
  - buyer agents: find vendors; compare offers on price, delivery, and availability
- *Coming soon to a world near you:…*
  - billions/trillions of agents
  - ...with smarts: knowledge gathering, reasoning, economic optimization
  - ...doing our bidding
    - but with some autonomy

Automating Contracting

- "Contract" in broad sense: = offering or agreement.
- "Automate" in deep sense: =
  - 1. Communicatable automatically.
  - 2. Executable within appropriate context of contracting parties' business processes.
  - 3. Evaluable automatically by contracting parties.
    - "reason about it".
  - 4. Modifiable automatically by contracting parties.
    - negotiation, auctions.

Contracting 1-2-3



- Applies to any contracting, electronic or not.
- May iterate or interleave these steps.
- Boundaries not necessarily sharp.