

*Research Directions for  
Policies and Compliance in Financial Services:  
Leveraging Semantic Web and Web Services*

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# Outline

- Introduction
  - Challenge of Semantics
  - Opportunities of the New Generation Web
- Policies and Compliance
  - Landscape Today
  - Advantages of Standardized Semantic Web Rules (Situating Courteous Logic Programs in RuleML)
- Financial Information Integration
  - Conflicting Definitions in Business Reporting
  - Mapping Approach (Extended Context Interchange)
- Research Challenges & Directions

# *Challenge: Capturing Semantics*

- 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 entities, e.g., in reporting
  - Integrate information powerfully

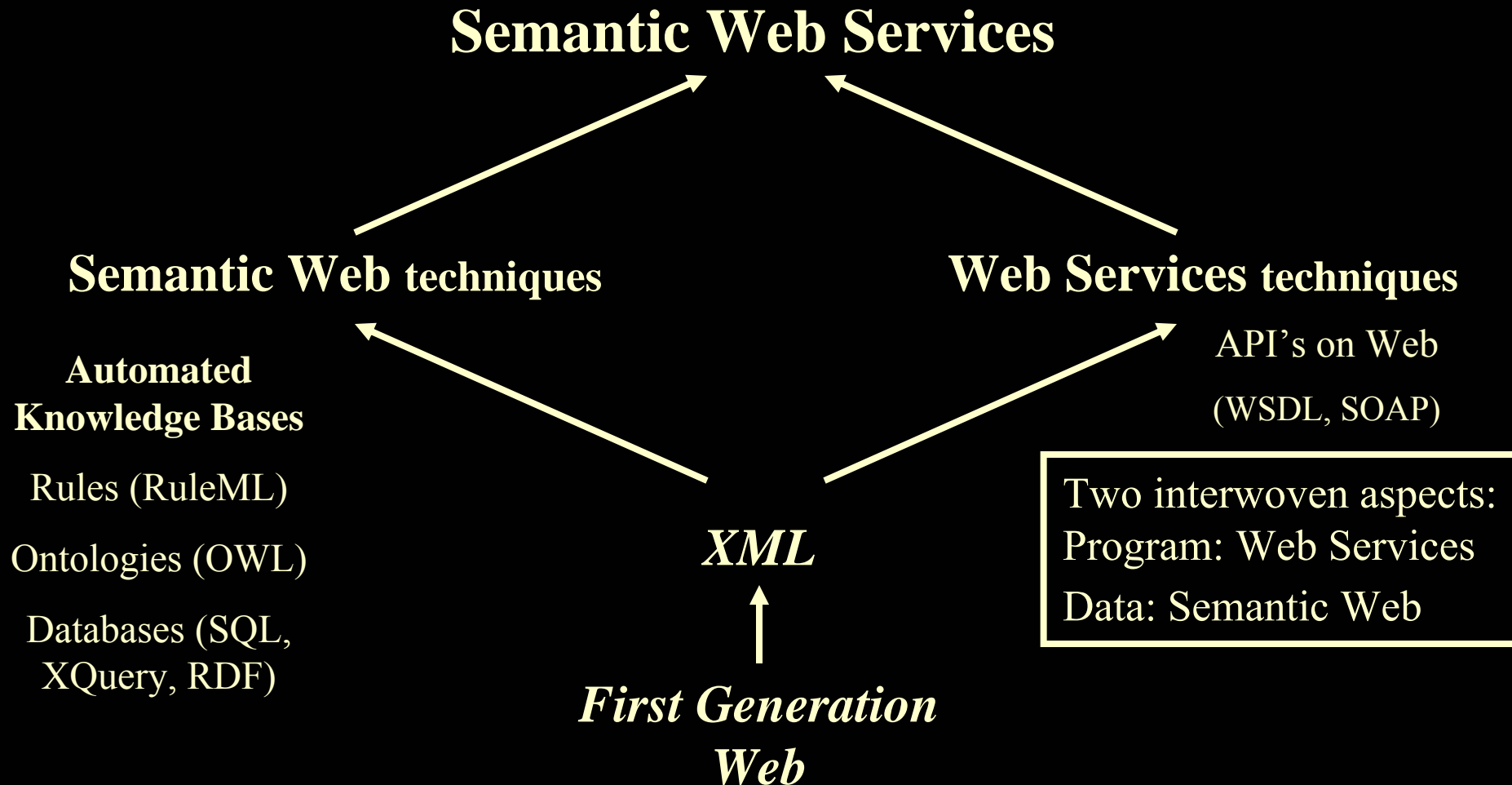
# *Opportunity from Semantic Web Services*

## *-- the New Generation Web Platform*

- New technologies for Rules (RuleML standard, based on Situated Courteous Description Logic Programs knowledge representation)
  - + New technologies for Ontologies\* (OWL standard)
  - + Databases (SQL, XQuery, RDF)
  - + Web Services (WSDL, SOAP, J2EE, .Net)
- Status today:
  - Technologies: emerging, strong research theory underneath
  - Standards activities: intense (W3C, Oasis, ...)
  - Commercialization: early-phase (majors in alpha, startups)

(\* *Ontology = structured vocabulary, e.g., with subclass-superclass, domain, range, datatypes. E.g., database schemas.*)

# *Next Generation Web*



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# *Policies and Compliance in US Financial Industry Today*

- Ubiquitous high-stakes Regulatory Compliance requirements
  - Sarbanes Oxley, SEC, 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

# *Example Financial Authorization Rules*

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



# *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

# *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

*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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# *Equational Ontological Conflicts in Financial Reporting*

# of customers = # of  
end\_customers + # of distributors

Gross Profit = Net Sales – Cost of  
Goods

P/E Ratio = Price / Earnings(**last 4**  
Qtr)

Price = Nominal Price + Shipping

# of customers = # of end\_customers  
+ # of prospective customers

Gross Profit = Net Sales – Cost of  
Goods – **Depreciation**

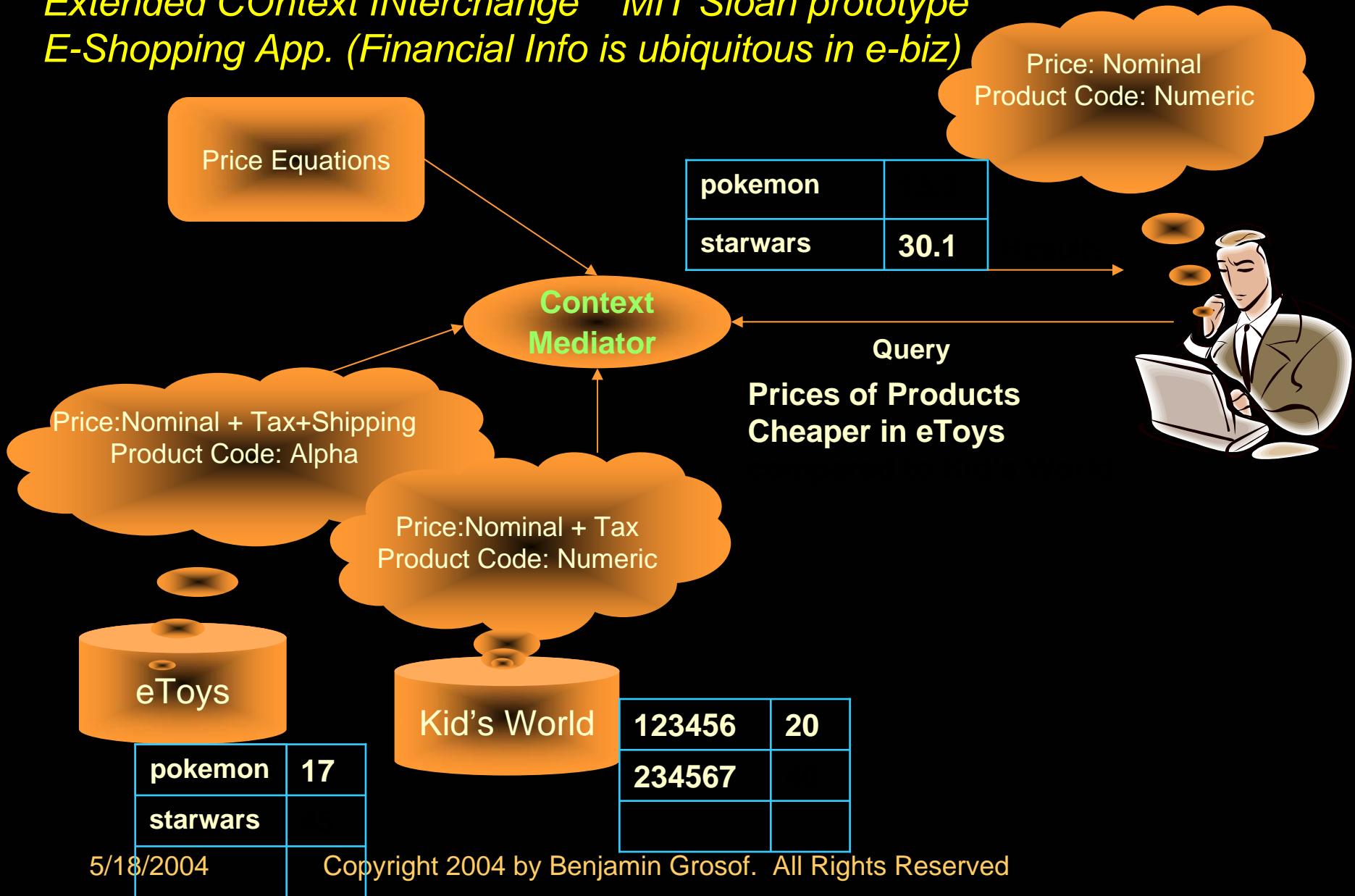
P/E Ratio = Price/ [Earnings(**last 3**  
Qtr) +Earnings(**next** quarter)]

Price = Nominal Price + Shipping +  
**Tax**

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

# Solution Approach: ECOIN

Extended COntext INterchange MIT Sloan prototype  
E-Shopping App. (Financial Info is ubiquitous in e-biz)



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# *Research Challenges: Core*

- Integrating rules with ontologies
  - Rules refer to ontologies (e.g., in RuleML)
  - Rules to specify ontologies (e.g., Description Logic Programs)
  - Rules to map between ontologies (e.g., ECOIN)
  - Combined rules + ontologies knowledge bases (e.g., RuleML + OWL)
- Describing business processes & web services via rules + ontologies
  - Rules query web services (e.g., in RuleML Situated feature)
  - Rules trigger actions that are web services (e.g., ditto)
  - Capture object-oriented process ontologies
    - Default inheritance via rules (e.g., Courteous Inheritance)
    - Wrapper/transform to legacy C++, Java, UML
    - Develop open source knowledge bases (e.g., MIT Open Process Handbook Initiative)
  - Event triggering of rules (e.g., capture ECA rules in RuleML)



# *Research Challenges: Business Policies*

- Apply advanced rule and ontology representation to business policies in compliance, trust, contracts, etc.
  - Application scenarios for compliance checking/support services intra- and inter- enterprise
  - Policy language & engines on top of rule language & engines
  - In/with existing/emerging standards: XBRL, XACML, P3P, ebXML, EDI, Legal XML, ...
  - Strategy and roles in the market ecology: regulators, communal repositories, service providers, etc.
  - Embedding into the bigger pictures of financial services, e-commerce, semantic web services, business process automation

# *Context: Our Overall Research Agenda*

- Invent Core Technologies and concepts of the New Generation Web
  - Semantic Web; Rules and RuleML emerging standard
    - supporting knowledge representation theory of Situated Courteous Description Logic Programs
  - Semantic Web Services; Business Process Automation for B2B and EAI
    - Requirements analysis
    - Use of Rules, together with ontologies – or to represent ontologies
- Pilot Business Application Scenarios
  - End-to-end e-contracting, e.g., in manufacturing supply chain
    - SweetDeal approach using rules (plus ontologies)
  - Financial information and reporting:
    - ECOIN approach mapping ontologies
  - Other: security authorization, travel, ...
- Analyze Prospective Early Adopter Areas
  - Strategy: Adoption Roadmap; Market Evolution
  - Entrepreneurial Opportunities

# *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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# *OPTIONAL SLIDES FOLLOW*

# *Quickie Bio of Presenter*

- 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>)
- 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)

# *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 proposed 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 proposed 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

## *Some Semantic Web Advantages for Biz*

- Builds upon XML's much greater capabilities (vs. HTML\*) for structured detailed descriptions that can be processed automatically.
  - Eases application development effort for **assimilation of data in inter-enterprise interchange**
- **Knowledge-Based E-Markets -- where Agents Communicate**  
(Agent = knowledge-based application)
  - ∴ potential to revolutionize interactivity in Web marketplaces: B2B, ...
- Reuse same **knowledge for multiple purposes/tasks/app's**
  - Exploit declarative KR; Schemas
- \* new version of HTML itself is now just a special case of XML



# *Web Service -- definition*

- *(For purposes of this talk:)*
- A procedure/method that is invoked through a Web protocol interface, typically with XML inputs and outputs
  - Add the flexibility of XML to the concepts of RPC
  - XML Tools support extra functionality required
- Purpose: Program integration across application and organizational boundaries
  - Needs commercial semantics

# *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

# *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

# *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

*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

# *Role of Standards*

- Obs.: Standards are crucial, and central, to integration in an open era.
- → high percentage of effort invested in standards development in new generation web (XML, WS, SW, SWS)
- In SWS, this begins with basic research!
- Lots of strategy surrounding standards.
- Emerging standards efforts include much research.