Revised and Extended Strawman for SWSL: ROSE: Rules and Ontologies for web SErvices

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PREVIOUS SLIDES FOLLOW

- Ff. is included for RECAP …

Outline of Presentation

- Intro: Review the "NO Procedural Process Model" proposal and discussion from Oct. 2003 SWSI F2F (see separate text file)
- Rest is Further Thinking and clarification
  - KR Approach
  - What we'll be able to do with it
  - Strategy for combining/extending it with other approaches

Outline of Proposed KR Approach

- LP Rules as core of near-term Knowledge-based Service Descriptions
  - + Procedural Attachments: Effectors, Sensors, Events
  - + DLP Ontologies
  - + OO default inheritance, e.g., using Courteous Inheritance
    - Model C++, Java, C#, UML
  - + Hilog/F-Logic-y "meta-"logical expressiveness
    - Close relationship to Flora, via underlying LP representation
- Other Aspects / Extensions – less immediately:
  - FOL
    - Constraints
    - (DL – DLP)
    - ? What else needed ?
  - Procedural Process Models
    - ? Which model ? Concurrent Transaction Logic? (Am open-minded.)
    - Best guess: Start with capabilities of BPEL, WS Choreography design
    - ? What will be the "extension points" of the KR / Process Model?

Goals wrt Key SWS Tasks

- The point of SWS is <u>knowledge reuse</u>
  - Especially the Knowledge-based service descriptions
- … Across the Key Tasks in our Requirements:
  - Advertising/Discovery/Matchmaking; Contracts (selection, negotiation); Enactment, Composition; Monitoring, problem resolution, exception handling; Verification; Trust/Security/Privacy Policies
- Underlying: Hypothetical Reasoning

Where Rules + Ontologies alone are useful

- LP Rules + ~DL Ontologies alone are useful -- enough to be worthwhile – in almost all of the main Tasks areas, with reuse between Tasks as well as between Applications:
- ADM: partial contracts, subsumption
  - E.g., see papers from WWW-2003 EC session
- Contracts/selection/negotiation: pricing, policies, contingent provisions
  - E.g., cf. SweetDeal approach
- Monitoring, problem resolution, exception handling
  - E.g., cf. SweetDeal approach
- Enactment
  - Via procedural attachments, esp. effectors, events
- Composition: e.g., via composing service-description knowledge bases by union'ing their rules/ontologies
- Trust Policies:
  - Most major practical approaches are rule-based already:
    - RBAC, XACML, P3P, etc.
- Underlying: Hypothetical Reasoning
  - A major strength of Rule-based KR

NEW SLIDES FOLLOW

- Ff. are further thoughts…

Outline of Revised & Elaborated Approach

- Design Philosophy
  - Where we have business value to offer to WS
- Tasks to Focus Upon
  - Security, Contracts, Advertising, access, authorization, mappings/mediation for semantic interoperability, Monitoring, privacy, and Policies (SCAMP)
- Technical Approach
  - logic program expressiveness for Rules, + generic and service Ontologies + extensions, for SErvices (ROSE)
  - Combine with much of the other proposed approaches
- A (placeholder) Name: ROSE
- Game Plan

Design Philosophy

- Focus on where's the business value of Semantic WS -- that we have to offer near term to mainstream WS / Web community
  - hence the tasks focus below
- Focus on tasks
  - What it takes to support a particular set of tasks
  - NOT (primarily) on "this captures what I know about a service“ in an undirected way
- Usually, any particular service description is incomplete
  - (Quite incomplete!)

New Tasks for SWSL Requirements from SWSA Requirements Analysis

- "New" here = wrt current emphasis in SWSL Requirements doc
- Tasks focus to add to requirements:
  - Security
    - Esp. policy / decision-making aspects
  - Semantic Interoperability
    - Esp. mapping outputs of one service to inputs of another service
      - E.g., Semantic Web based "glue" processes/services
- These were of broadest need according to the SWSA scenarios requirements analysis
    - (Presented by Mark Burstein at Oct. 2003 SWSI F2F)

Focus Tasks for nearer-term

- Focus on pieces to support particular set of tasks
  - Which need little or no procedural process modeling, temporality, or planning.
  - Start with what rules + ontologies alone can handle

1. Policies for trust:
   - For task of security/privacy/authorization
2. Mapping-type mediation, e.g., of input and output info, or very light workflow:
   - for task of semantic interoperability

Focus Tasks for nearer-term, cont.'d

3. Contracts, incl. advertising, request for proposals, proposals, selection
   - Focus on policy provisions/aspects and decision making in terms of those
   - For task of contracts and negotiation
   - For tasks of advertising and discovery
4. Monitoring and exception handling
   - Focus on contract/policy aspects
   - For task of monitoring and exception handling

Business Value ⇒ Strategy

1. Policies for security and monitoring and contracts would meet immediate needs in WS today
   - Want them checked at run time
   - Ensuring compliance with trust policies has become high-priority in many areas of business today:
     - USA: Sarbanes-Oxley (financial reporting liability), HIPAA (patient records privacy)
     - EU: privacy reg's
- Yet to a great extent they can be specified and enforced using a relatively simple and mature technology: LP rules.
  - Most trust policy languages / engines today are based on, or equivalent to, rules (+ DLP-expressible ontologies).
  - Ditto for Web standards for trust policies e.g., XACML, P3P both have (prioritized) rules.

Business Value ⇒ Strategy, cont.'d

  - Pricing policies want/need nonmon, e.g., cf. scenarios in SweetDeal (B. Grosof et al.) and by M. Kifer et al.
  - Many other policies are represented well as rules, e.g., cf. SweetRules e-commerce application scenarios (B. Grosof et al.), e.g., refunds, late deliveries, product/service goods descriptions, etc. Lawyers view contracts as default rules.
- … So those are tasks where Semantic Web / knowledge-based techniques can shine in near-term.

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*

Business Value ⇒ Strategy, cont.'d

2. Semantic interoperability mappings between information models used by different services – e.g., output of one service to input of another service – would also meet an immediate need in WS today.
   - Rules + ontologies – e.g., SWRL – are good for doing such mappings.
     - More clean, and more cleanly expressive, than XSLT – the state of the art for XML stuff today.
     - Today's thriving commercial vendors in the overall (not-necessarily-XML) space, such as Vitria, often use Rules heavily for this (e.g., Event-Condition-Action rules).

- This is intrinsically "semantic" stuff where Semantic Web techniques can shine. It's another WS niche we should "own" as SW'ers.

Business Value ⇒ Strategy, cont.'d

3. By contrast: more general Composition tasks (including Discovery matchmaking aspect) are hard
   - There are many competing approaches to procedural process modeling
     - And composition is computationally intractable worst-case
   - Requires a lot of completeness in the service descriptions to fully automate these
   - Near term: programmers/developers do it (i.e., only lightly automated)
     - They expect to, and wouldn't easily trust anyone else
       - Especially until more is available in way of standardized service contracts
     - It's OK for them to be done at development time rather than run time

- … So it's an important topic for research rather than near-term standardization or development

Summary of Technical Approach

- Basic KR foundation:
  - Start with LP expressiveness
  - Add nice generic LP extensions:
    - Courteous priorities
    - Situated procedural attachments for queries (sensing) and actions (effecting)
    - HiLog "higher-order" expressiveness
    - F-Logic syntax for 2-ary properties etc.
    - Etc.
- Generic ontology capabilities – from the basic KR foundation:
  - Expresses a considerable fragment of OWL: DLP+extensions
  - Can express OO process ontologies with default inheritance, cf.:
    - Process Handbook frames, C++, Java, UML

Summary of Technical Approach, cont.'d

- Develop Service Ontologies – with associated definitional knowledge bases
  - Start with OWL-S (esp. its profiles aspect); draw also from FLOWS, (?)CTR++
  - In overall spirit of OWL-S profile, but can go further/deeper
  - Service Ontology here = talks about relevant aspects of services, e.g., activities, WSDL "interfaces", WS-Choreo messages, profile aspects, etc.
  - Provide & use hooks to WSDL, WS-Choreo, ?BPEL, ?SOAP
  - Extend info models in those
  - Draw upon the LP-expressible subsets of the above
- Later: more extensions
  - E.g., for procedural process modeling, temporality, planning, etc.
  - E.g., hopefully to get more of "LP union FOL" as fundamental expressiveness

Outline of Revised & Elaborated Approach

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  - Combine with much of the other proposed approaches
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Details on Technical Approach I

- To start: in the KR itself, have little or no procedural process modeling, temporality, or planning.

- Some caveats:
  - To start, avoid that (or don't rely on that) in the basic KR constructs.
    - So this is different than (much of the) CTR++ proposal.
  - Can have some temporal-process ontology, however.
    - Could combine with much of FLOWS ontology!
  - Should be relatively easy in principle to extend to include light workflow.
    - But maybe that's not helpful compared to other available WS pieces such as WS Choreography.

Details on Technical Approach II

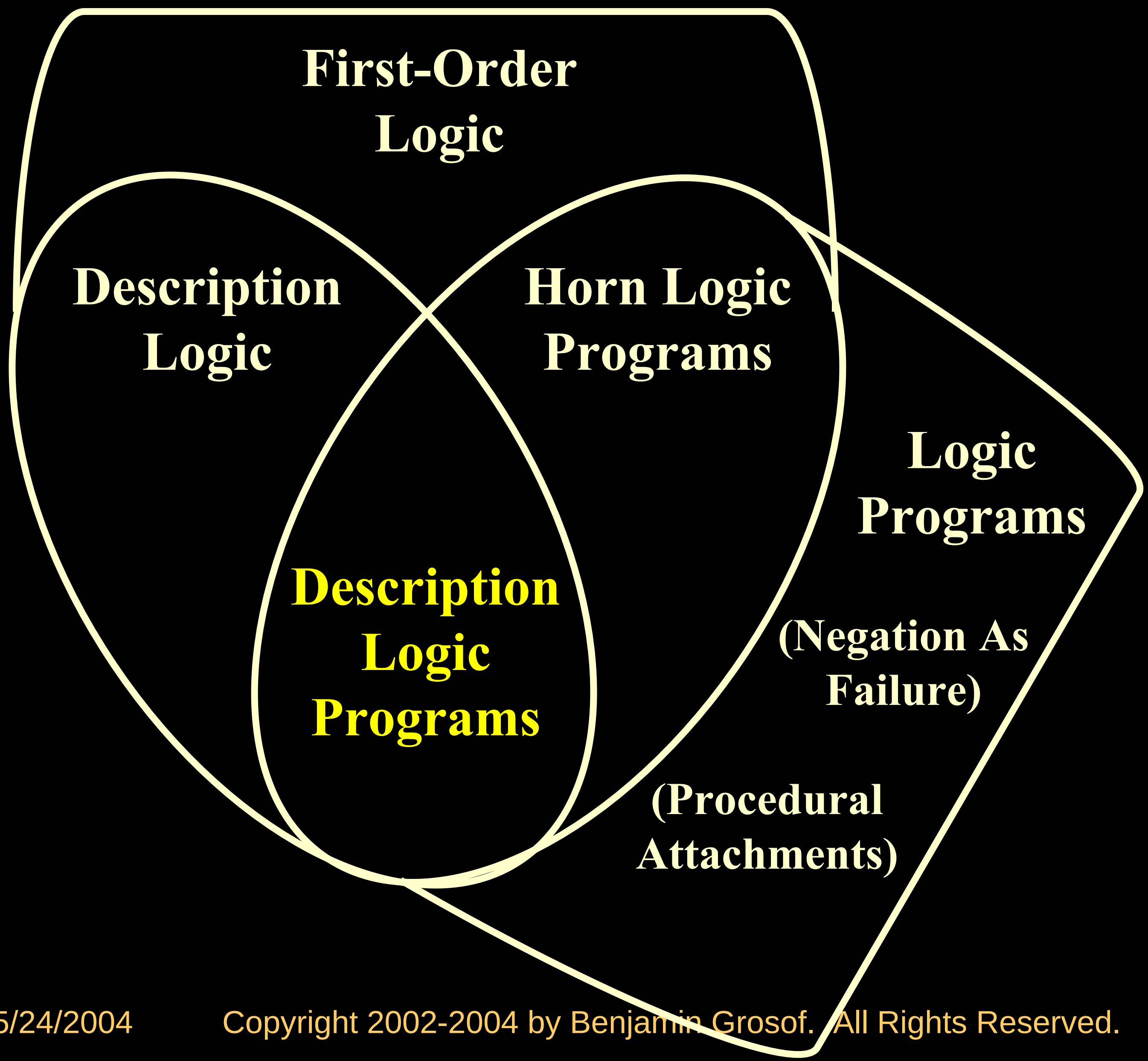
- Basic KR issue:
  - "LP ↑ FOL" Start with LP, then try to get as much FOL expressiveness (e.g., head disjunction) as possible
    - This proposal. Also (much of) CTR++.
    - Can be viewed as capturing computationally attractive subset of FLOWS – hence very compatible with FLOWS from that viewpoint.

  Versus

  - "FOL ↑ LP" Start with FOL, then try to get as much LP expressiveness (e.g., nonmon, side-effectful actions) as possible
    - FLOWS proposal, PSL

- How to view OWL-S in above terms? (Neutral?)

Venn Diagram: Expressive Overlaps among KR's



Technical Capabilities Enabled by DLP

- LP rules "on top of" DL ontologies.
  - E.g., LP imports DLP ontologies, with completeness & consistency
  - Consistency via completeness and use of Courteous LP
- Translation of LP rules to/from DL ontologies.
  - E.g., develop ontologies in LP (or rules in DL)
- Use of efficient LP rule/DBMS engines for DL fragment.
  - E.g., run larger-scale ontologies
  - $\Rightarrow$ Exploit: Scaleability of LP/DB engines >> DL engines , as |instances| $\uparrow$.

- Translation of LP conclusions to DL.
- Translation of DL conclusions to LP.

- Facilitate rule-based mapping between ontologies / “contexts”

Details on Technical Approach III

- Coexists with PSL – insofar as have overlap in the basic KR (Horn + some more)
- In LP approach, one can use FLOWS/PSL ontology and styles of formulation,
  - But with some expressive limitations wrt disjunction etc.
  - Extends with nonmon and procedural attachments

Details on Technical Approach IV

- Wrt CTR++:
  - From Courteous LP: add courteous to subset of CTR++
    - Should be pretty straightforward using Courteous Compiler transformation approach
  - From CTR++: use its HiLog approach to get (bit limited) meta
    - Should be pretty straightforward
  - From CTR++: use its F-Logic approach for OO syntax where useful
    - Should be pretty straightforward

Details on Technical Approach V

- Wrt OWL:
- can integrate OWL via DLP and also via info passing of facts etc. that are derived, e.g., via procedural attachments

- Wrt OWL-S:
  - Add rules to profiles etc.
  - Have more extension points (see next slide)

Details on Technical Approach VI

- Wrt existing (non-”Semantic”) Web Services standards/pieces:
  - Introduce mechanisms to define rule+ontology knowledge bases (small or large) for profiles, mappings, policies, contracts; then later for actions, sequencing
- Work up from existing WSDL, and to lesser extent WS Choreography
  - add OWL-S + rules + some service ontologies

More about Game Plan

- More Extensions:
  - Could create one or more languages with task-specific constructs, which compile down to, or extend from, a base LP rule+onto language
- Need to divvy up our intellectual territory, e.g.:
  - LP-oriented for SCAMP tasks
  - FOL-oriented for synthesizing compositions and other aspects (e.g., enactment) involving deeper procedural process modeling

More about Game Plan, cont.'d

- Have more in the way of formal coordination with W3C and Oasis etc.
  - Liaison members officially in relevant W3C and Oasis etc. working groups:
    - W3C: WSDL, WS Choreo, SWS Interest Group, WS Policy; P3P, Semantic Web activity incl. www-rdf-rules
    - Oasis: WS Security, XACML, Legal XML, ?ebXML,
    - RuleML; ISO Common Logic
    - ?RosettaNet; ? UN CEFACT EDI / UBL

Alternative Name: ROWS

- ROWS = Rules and Ontologies for Web Services

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OPTIONAL SLIDES FOLLOW

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	**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.

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

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 over bank rules

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.

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.)

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)]

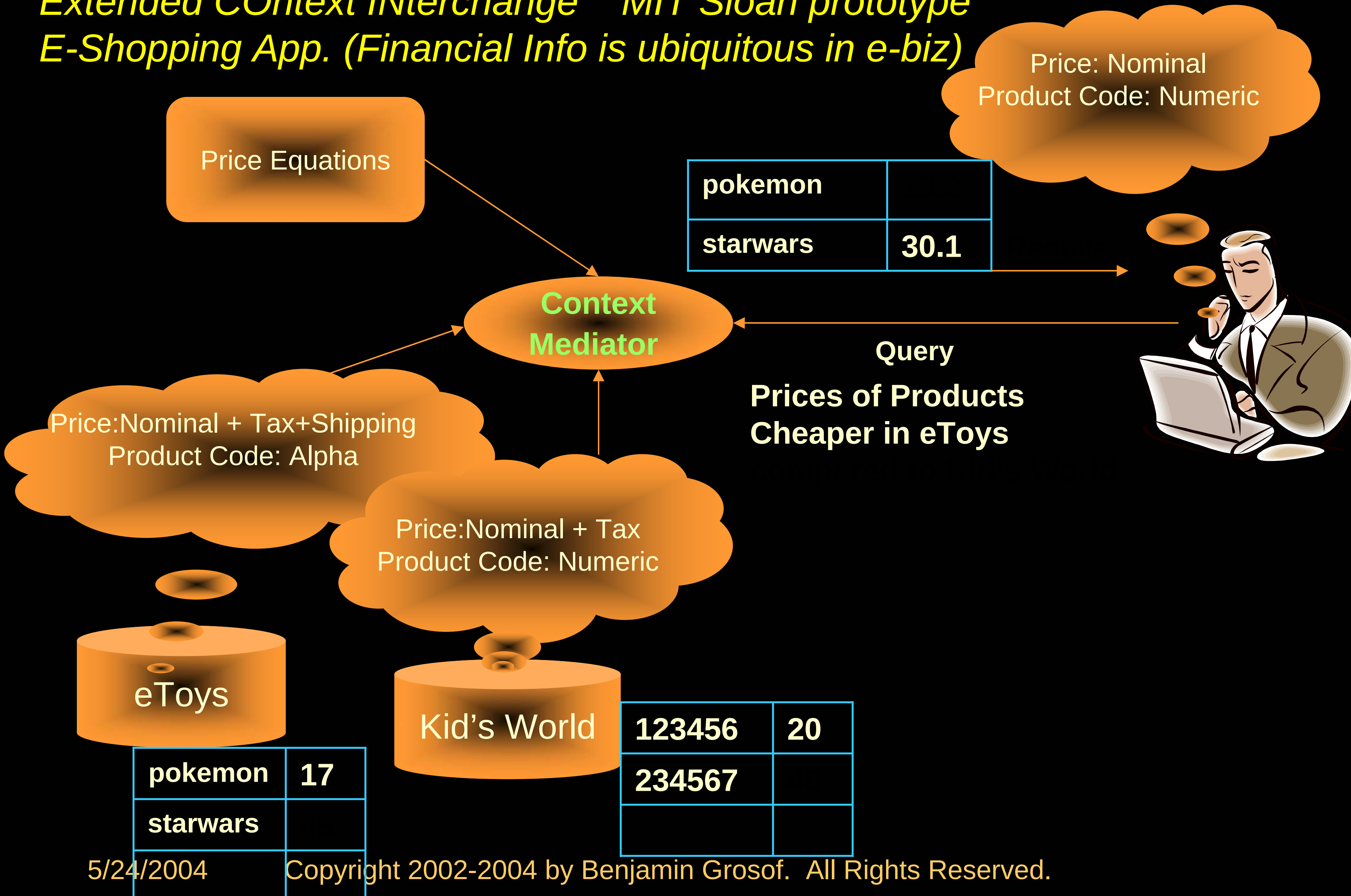
Price = Nominal Price + Shipping + Tax

“ 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)



Approach: ECOIN

- Context-based loosely-coupled integration

  Extends the Context Interchange (COIN) framework developed at MIT

- Symbolic Equation Solving using Constraint Logic Programming

  Integrates symbolic equation solving techniques with abductive logic programming

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

