Introduction to RuleML

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http://www.daml.org/committee

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Outline of Talk

- Overview of RuleML Today
- Motivation, Background
  - – heterogeneous commercial rule systems/rep'ns
  - – evolutionary strategy for standards
- Fundamental Technical Issues and Approaches
  - – logic programs and extensions
  - – Webizing; syntax mechanics
  - – relationship to other Semantic Web standards
- Plans: Organizational, Technical

Overview of RuleML Today

- RuleML Initiative (2000--)
  - Dozens of institutions (~35), researchers; esp. in US, EU
  - Mission: Enable semantic exchange of rules/facts between most commercially important rule systems
  - Standards specification: 1st version 2001; basic now fairly stable
  - A number of tools (~12 engines, translators, editors), demo applications
  - Successful Workshop on Rules at ISWC was mostly about RuleML / LP
  - Can itself use a "home" institutionally.
    - Candidates: DAML, Joint Committee, W3C, Oasis
- Initial Core: Horn Logic Programs KR

…Webized (in markup)… and with expressive extensions

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

Overview of RuleML Today, Continued

- Fully Declarative KR (not simply Prolog!)
  - Well-established logic with model theory
  - Available algorithms, implementations
  - Close connection to relational DB’s; core SQL is Horn LP
  - *See [Baral & Gelfond ’94] for good survey on declarative LP.*
- Abstract graph syntax
  - 1st encoded in XML…
  - … then RDF (draft), … then DAML+OIL (draft)
- Expressive Extensions incrementally, esp. already:
  - Non-monotonicity: Negation as failure; Courteous priorities
  - Procedural Attachments: Situated actions/effecting, tests/sensing
  - *In-progress:* Events cf. OPS5/Event-Condition-Action

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Flavors of Rules Commercially Most Important today in E-Business

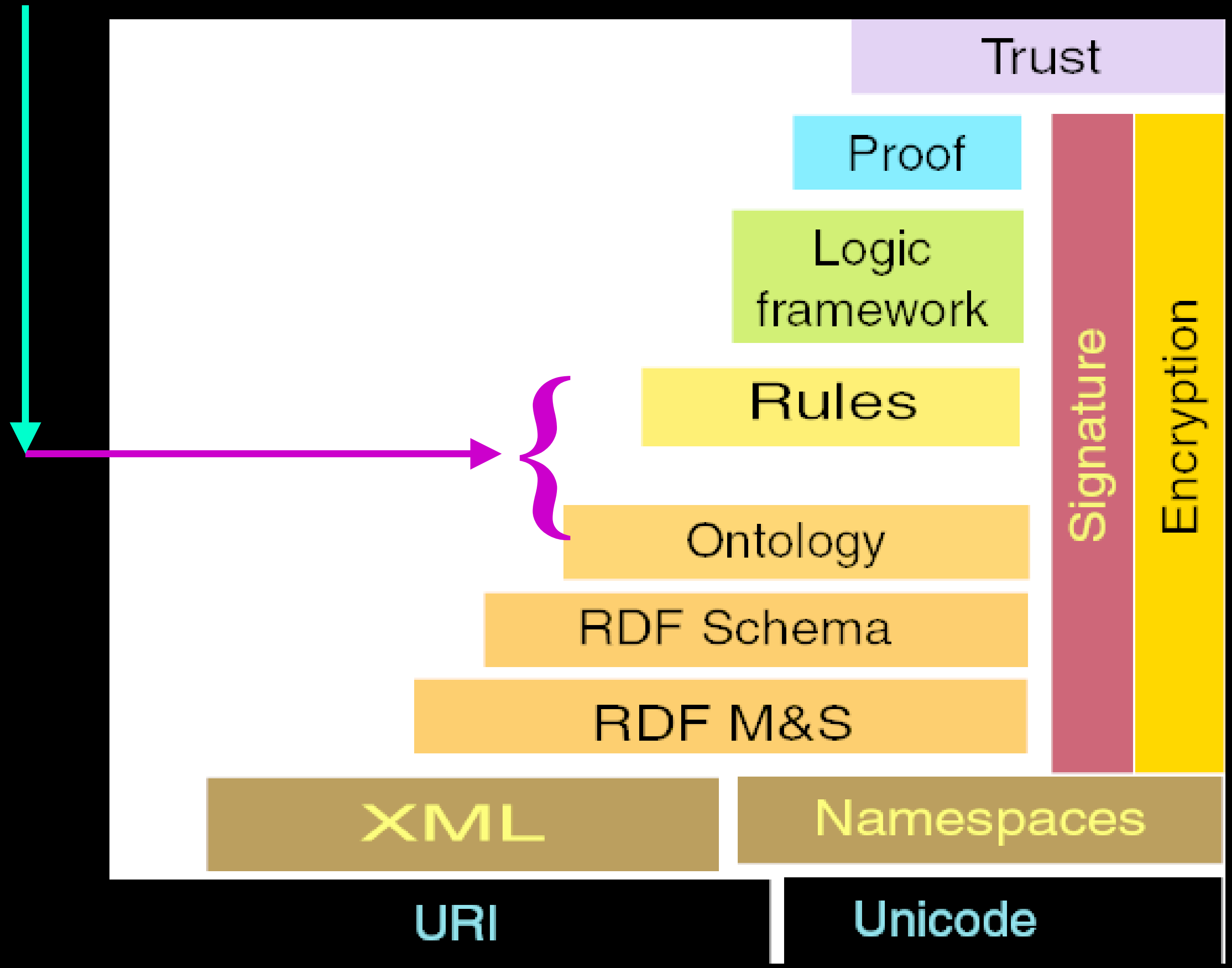
- E.g., in OO app’s, DB’s, workflows.

- Relational databases, SQL: Views, queries, facts are all rules.
  - SQL99 even has recursive 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.)*

Vision: Uses of Rules in E-Business

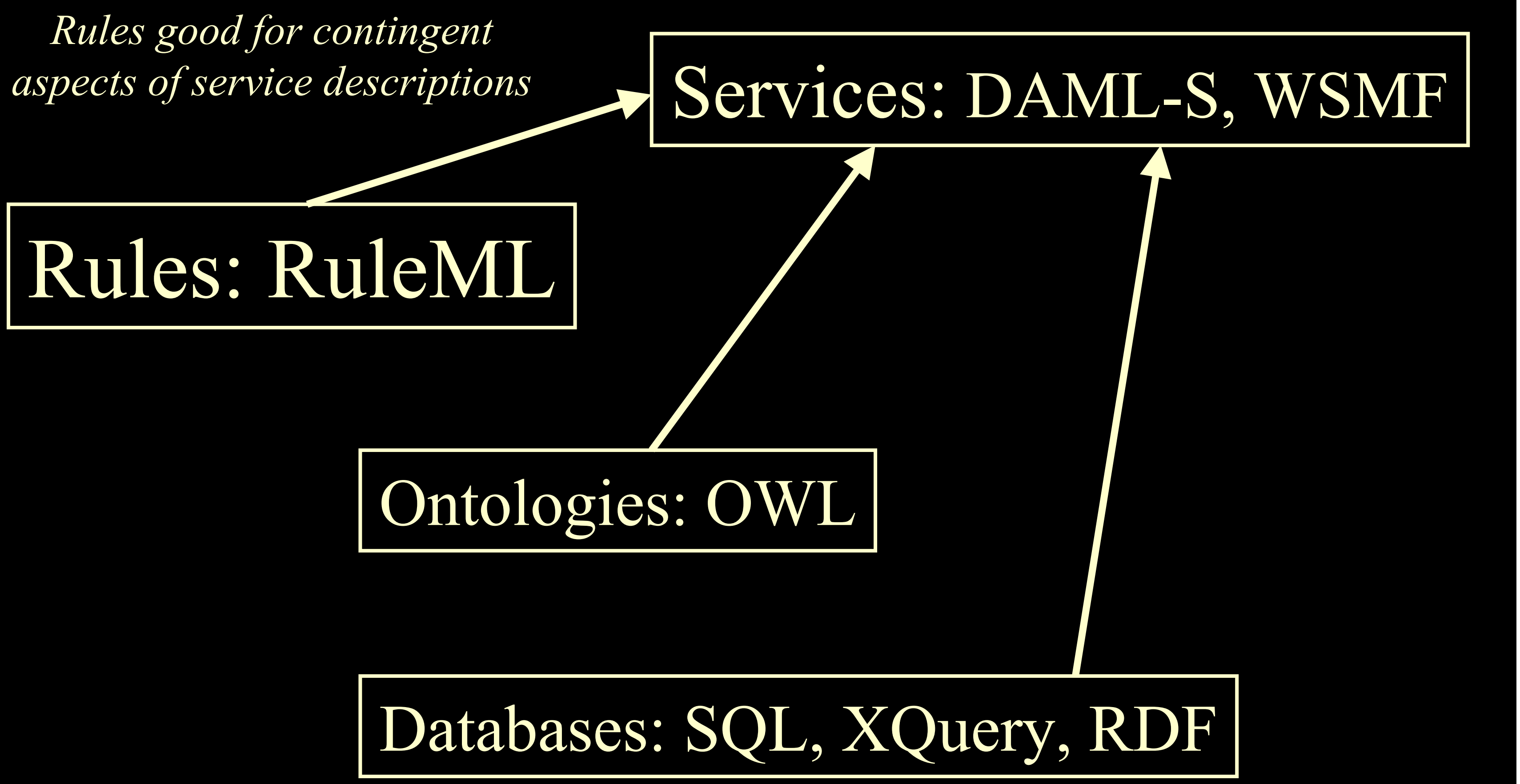
- Rules as an important aspect of coming world of Internet e-business: rule-based business policies & business processes, for B2B & B2C.
  - represent seller's offerings of products & services, capabilities, bids; map offerings from multiple suppliers to common catalog.
  - represent buyer's requests,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

Motivation from Semantic Web "Stack"



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

Vision: Semantic Web and Web Services Use DB's, Ontologies, and Rule Systems



Rules good for contingent aspects of service descriptions

Services: DAML-S, WSMF

Rules: RuleML

Ontologies: OWL

Databases: SQL, XQuery, RDF

Why Standardize Rules Now?

- Rules as a form of KR (knowledge representation) are especially useful:
  - relatively mature from basic research viewpoint
  - good for prescriptive specifications (vs. descriptive)
    - a restricted programming mechanism
  - integrate well into commercially mainstream software engineering, e.g., OO and DB
    - easily embeddable; familiar
    - vendors interested already: Webizing, app. dev. tools
- *⇒⇒ Identified as part of mission of the W3C Semantic Web Activity*

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Technical Approach of RuleML: I

- 1. Expressively: Start with: Datalog Logic Programs *as kernel*
  - Rule := H ← B1 /\ … /\ Bk ; k ≥ 0, H and Bi's are atoms.

    head if body ;
- Declarative LP with model-theoretic semantics
  - forward ("derivation"/ "transformation") and backward ("query") inferencing
- Rationale: captures well a simple shared core among CCI rule sys.
  - Tractable! (if bounded # of logical variables per rule)
- Horn LP -- differences from Horn FOL:
  - Conclusions are a set of ground atoms.
  - Consider Herbrand models only, *in typical usage.*
    - Can extend to permit equalities in rules/conclusions.
  - Rule has non-empty head, *in typical usage.*

Technical Approach of RuleML: II

- 2. Syntax: Permit rules to be labeled -- need names on the Web!
- 3. Syntax: Permit URI’s as predicates, functions, etc. (names)
  - namespaces too
- 4. Expressively: Add: extensions cf. established research
  - negation-as-failure (well-founded semantics) -- in body *(stays tractable!)*
    - “Ordinary” LP (cf. declarative pure Prolog)
  - classical negation: limited to head or body atom – syntactic sugar
  - prioritized conflict handling cf. Courteous LP *(stays tractable!)*
    - modular rulesets; modular compiler to Ordinary LP
  - procedural attachments: actions, queries ; cf. Situated LP
  - 1st-order logic type expressiveness cf. Lloyd LP’s – syntactic sugar
    - ∨,∀,∃ in body; ∧,∀ in head *(stays tractable!)*
  - logical functions (arity > 0)

Technical Approach of RuleML: III

- 5. Expressively: Add: restrictions cf. established R&D
  - E.g., for particular rule systems, e.g., Prolog, Jess, …
    - Also “pass-thru” some info without declarative semantics (pragmatic meta-data)
- 6. Syntax for XML:
  - Family of DTD’s/Schemas:
    - a generalization-specialization hierarchy (lattice)
    - define DTD’s modularly, using XML entities (~macros)
    - optional header to describe expressive-class using “meta-”ontology
- 7. Syntax: abstract unordered graph syntax (data model)
  - Support RDF as well as XML (avoid reliance on sequence in XML)
  - “Roles” name each child, e.g., in collection of arguments of an atom
  - Orderedness as optional special case, e.g., for tuple of arguments of an atom
- 8. Syntax: module inclusion: merge rulesets ; import/export
  - URI’s name/label knowledge subsets

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Technical Plans: I

- *Refine existing* expressiveness
  - Procedural attachments, built-in functions, and events are foci now
- *Refine existing* syntax
  - RDF and modules are foci now
- *More expressive extensions:*
  - Ontologies imported from OWL; exporting to OWL too
    - E.g., cf. Description Logic Programs [Grosof & Horrocks ’02]
  - Typing
  - Events, e.g., cf. Event-Condition-Action / production rules; “reactive”
  - Equalities in heads/conclusions
  - Equivalence/rewriting/transformation rules
  - Integrity checking (still regarded as special queries)
  - *Later:* temporal, …

Technical Plans: II

- “Header” meta-data
  - specify KR incl. expressive/syntactic restrictions
  - Seems good opportunity to use OWL

- More tools: translators, editors, inference engines
  - IBM has announced it will support in CommonRules V3

- More application scenarios
  - Services, e-contracting, financial info integration, …
    - E.g., SweetDeal [Grosof & Poon ’02]

Relationships to other Semantic Web areas

- Services
  - *See talks on Services and Rules from 10/02 DAML PI Mtg*
    - *http://ebusiness.mit.edu/bgrosof/#DAMLRulesInvitedTalkOct02*
- OWL/Ontologies
  - Overlap: Description Logic Programs (DL)
    - *See paper and talk at http://ebusiness.mit.edu/bgrosof/#DLP*
  - Interesting to compare expressive power, usage scenarios
    - E.g., can DL represent discount pricing policies?
- RDF -- current: 1. exploit new collection classes ; 2. RDF Query
- DQL, Explanations ; Xquery and RDF Query too!
- CommonLogic
  - Aim: maximize congruity on overlap – e.g., Horn case
  - Pat Hayes liaison from DAML / Joint Committee

Organizational Plans/Efforts: I

- Establish closer relationship with DAML
- Establish closer relationship with Joint Committee
- W3C Working Note (in progress)
- Aim: W3C Working Group - 2003?
  - Relationship to RDF Query area
- Use www-rdf-rules list (already blessed by W3C)

Organizational Plans/Efforts: II

- Possible OASIS Technical Committee on Policy RuleML – interchange policies via RuleML
- Industry outreach: developers, executives
- Events (being planned) for 2003:
  - WWW Conf., ISWC, W3C Plenary (Boston 3/03), …
- Website:
  - editing/revamping
  - setting up ruleml.org site

RuleML Subgroups -- started recently

- Reaction Rules
  - Leads: Gerd Wagner & Steve Ross-Talbot
- Ontology Combo
  - Leads: Benjamin Grosof & Andreas Eberhart
- Defeasible Rules
  - Grigoris Antoniou & Michael Schroeder

- Thanks!

- Questions?

- For More Info:
  - http://ebusiness.mit.edu/bgrosof/#RuleML
  - http://www.dfki.de/ruleml

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