RuleML Overview and Position Statement

The RuleML Initiative
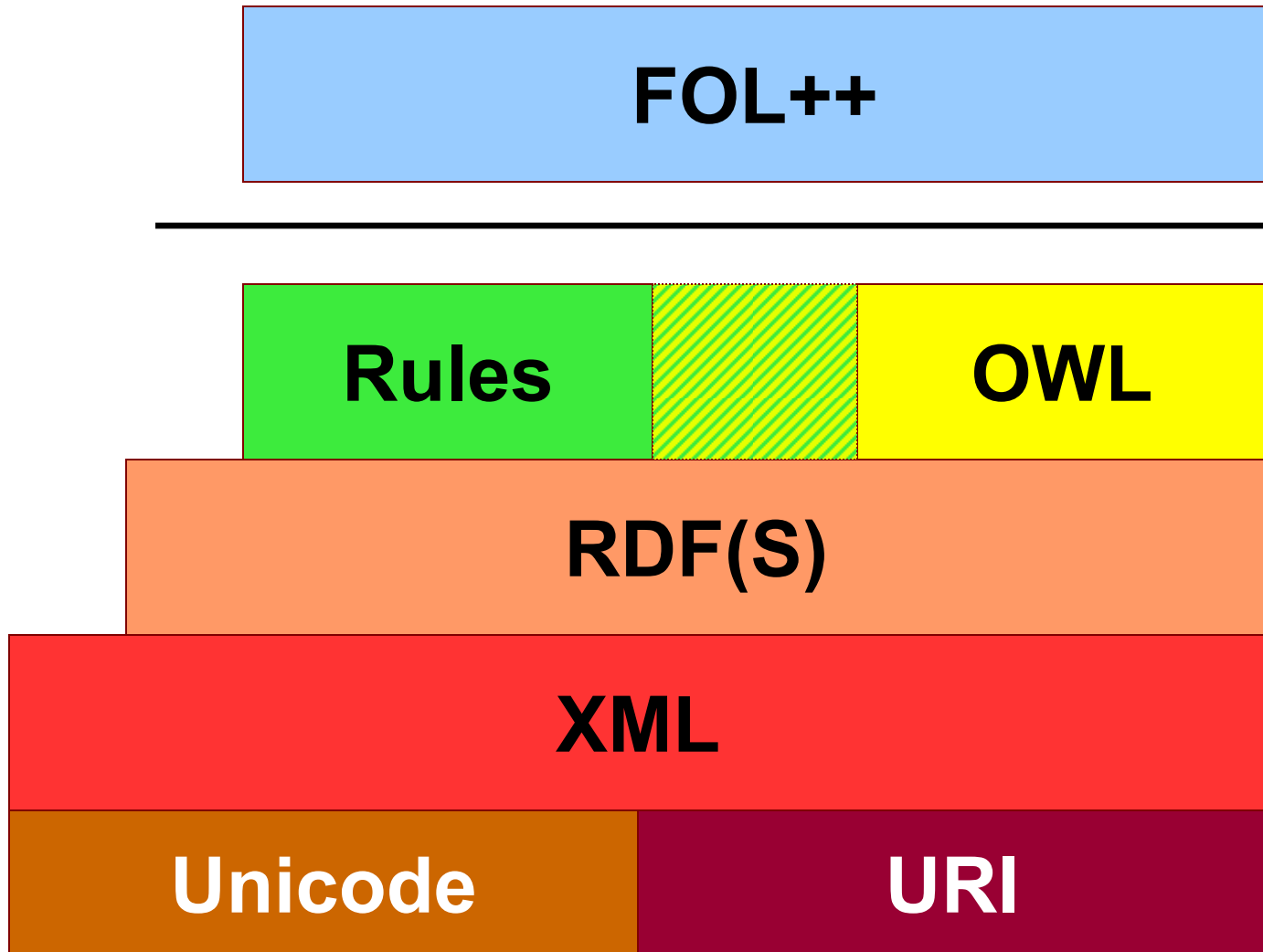
Prepared by (in alphabetical order):
Harold Boley, Mike Dean, Benjamin Grosof,
Michael Kifer, Said Tabet, Gerd Wagner

http://www.ruleml.org

The Web Rule Language in its Context
RuleML, WSML, SWSL View

Introduction

- The RuleML Initiative was formed in 2000 to provide a neutral platform for semantic **interoperation** of rules, across the Web, between commercially important rule systems:
  - Production rules
  - Relational databases
  - Prolog
  - Event-Condition-Action rules
- ... $\rightarrow$ Enable rule-based Semantic Web Services

- Pioneered webized representation of a modular family of rule sublanguages, catering to a variety of needs on the Web

RuleML is ...

An open *semantic* standard for

- *Semantics* founded on logical knowledge representation

1. Rule Modeling:
- Data model integrates
  - Ordered XML trees
  - Labeled RDF graphs
- Abstract syntax uses MOF
  - Mappings for OMG PRR [53] and SBVR [85]

2. Rule Classification: Modular Family of
- XML Schemas   and associated
- (Model-Theoretic, Well-Founded) Semantics

RuleML is …

An open semantic standard for **Rule**

3. **Serialization**: XML, RDF, Presentation
4. **Distributedness**: Fully webized, cf. N3 [94]
5. **Interoperation**:
   - Mature experience with RDF/RuleML [93] and OWL: SWRL [81]; also with F-logic: SWSL [124]
   - Adapt Sublanguages, write XSLT, … Translators, or establish APIs such as JSR94 [107]
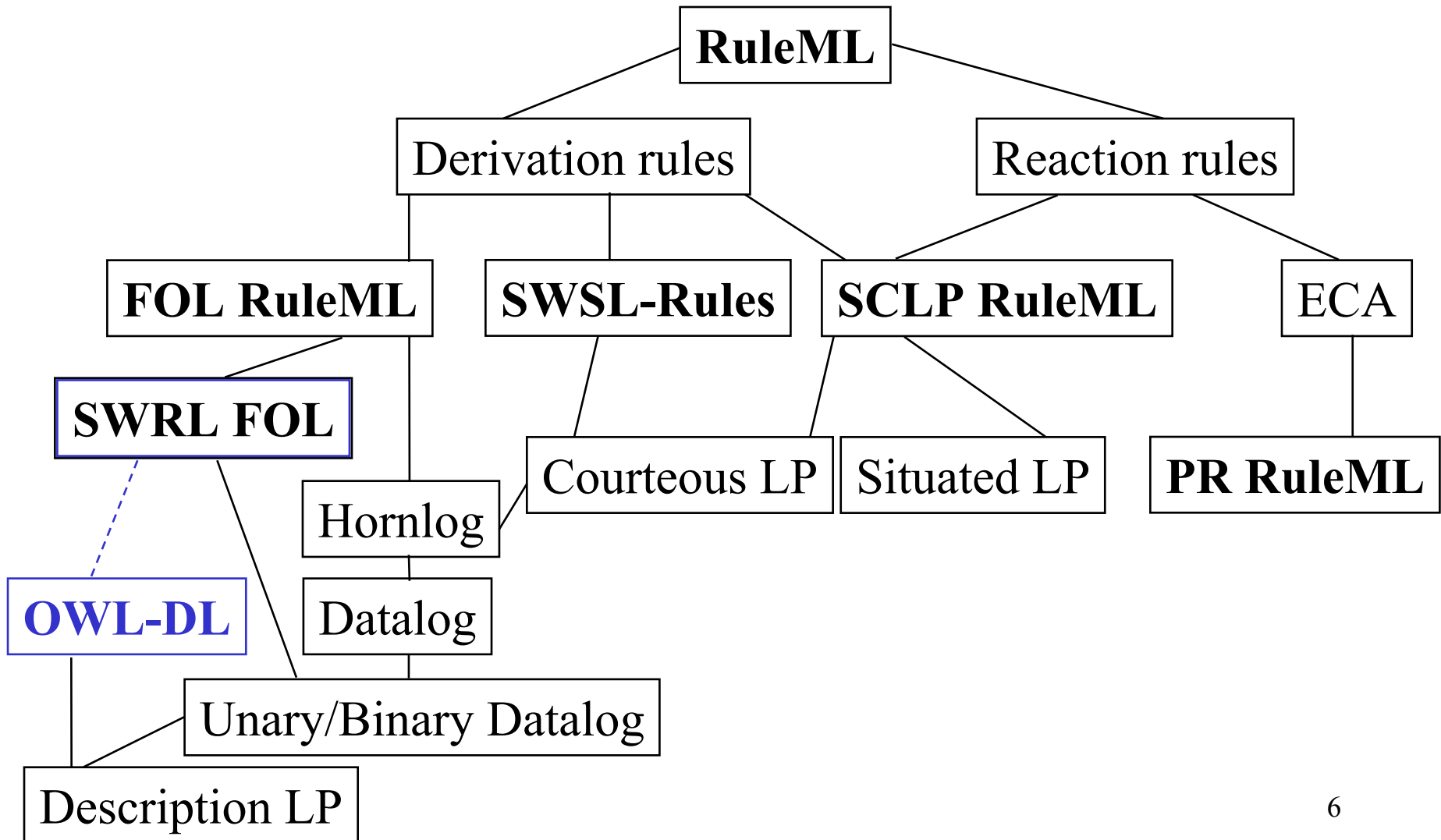6. **Execution**: Mandarax, jDREW [49], Jess, XSB …
7. **Tools**: SweetRules V2.1, IW Editor, …

RuleML Identifies ...

- Expressive **sublanguages**
  - for Web rules
  - explored mostly with
    - *Derivation* rules: to derive beliefs
    - *Reaction* rules: to perform actions
  - empowering their **subcommunities**

SWRL FOL, SWSL-Rules in RuleML Family

RuleML Specification & Interoperation

- Rule Family specified via XML Schemas
  - All sublanguages, pre-release: RuleML 0.89
    - First Order Logic, cf. SCL [103]: FOL RuleML 0.9
  - With Ontology language, cf. [81]: SWRL 0.7
    - A Semantic Web Rule Language combining OWL and RuleML
  - With Services language, cf. [124]: SWSL 0.91

- Rule Translators in & out (e.g. Jess, XSB)
  - Interoperation between many commercially important rule systems

(FOL) RuleML Has N-ary Relations & Functions, Extending SWRL (FOL)

- N-ary relations (predicate symbols)
  - Extends SWRL, which is unary/binary

- N-ary constructors (function symbols)
  - Extends SWRL, which uses individuals as 0-ary constructors (function-free)

FOL RuleML: Syntax and Semantics

- **Spec**: http://www.w3.org/Submission/2005/SUBM-FOL-RuleML-20050411

- **Modular** combination of syntactically characterized new sublanguages with:
  - Explicit quantifiers
  - Head disjunctions
  - Equivalence and Negation

- Semantics is FOL model theory
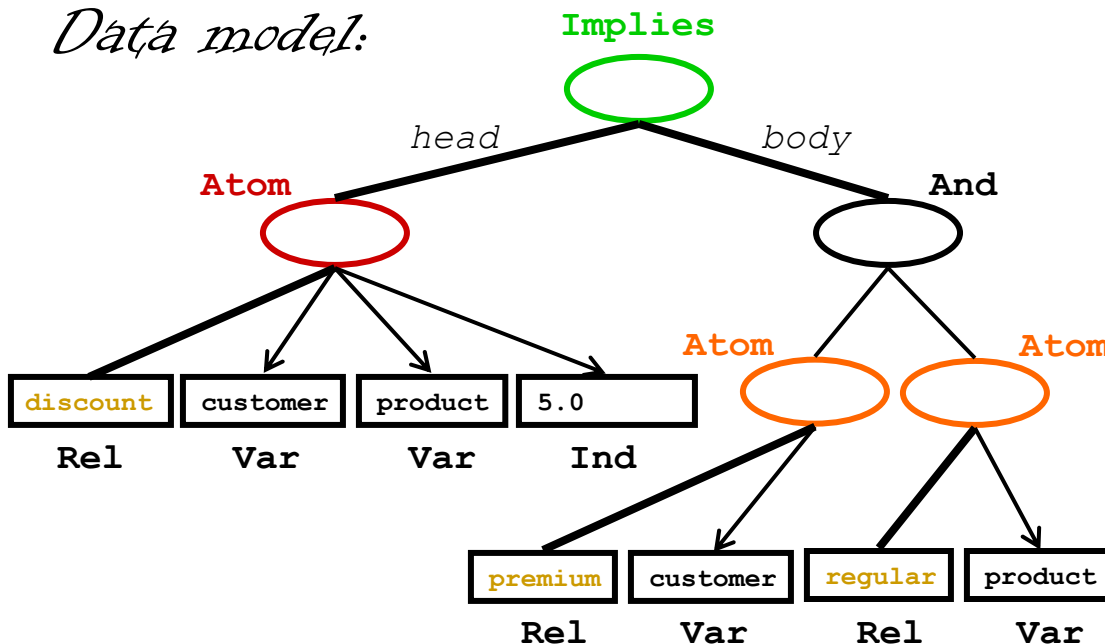
- (Pragmatics via performatives)

Business Rule: Positional

1.   2.   3.

"The **discount** for a *customer* buying a *product* is 5 percent if the *customer* is **premium** and the *product* is **regular**."

Data model:

Serialization:

```
<Implies>
  <head>
    <Atom>
      <Rel>discount</Rel>
      <Var>customer</Var>
      <Var>product</Var>
      <Ind>5.0</Ind>
    </Atom>
  </head>
  <body>
    <And>
      <Atom>
        <Rel>premium</Rel>
        <Var>customer</Var>
      </Atom>
      <Atom>
        <Rel>regular</Rel>
        <Var>product</Var>
      </Atom>
    </And>
  </body>
</Implies>
```

10

DTD for Recursive FO Formulas

```
<!ENTITY % foformula
        "(Atom | And | Or | Neg | Implies | Equivalent | Forall | Exists)">
<!ELEMENT Atom (Rel, (Ind | Var | Cterm)*)>
<!ELEMENT Cterm (Ctor, (Ind | Var | Cterm)*)>

<!ELEMENT And ((%foformula;)*)>
<!ELEMENT Or ((%foformula;)*)>
<!ELEMENT Neg (%foformula;)>
<!ELEMENT Implies (%foformula;, %foformula;)>
<!ELEMENT Equivalent (%foformula;, %foformula;)>

<!ELEMENT Forall (Var+, %foformula;)>
<!ELEMENT Exists (Var+, %foformula;)>

<!ELEMENT Ind (#PCDATA)>
<!ELEMENT Var (#PCDATA)>
<!ELEMENT Rel (#PCDATA)>
<!ELEMENT Ctor (#PCDATA)>
```

→ *Translated to XML Schema since RuleML 0.88*

11

Slotted (FOL) RuleML Extension

- N-ary relations and constructors can contain set of slots ('user-labeled arcs')
  - Enables Object Oriented modeling:
    - `rdf:Description`s (rather than triples)
    - RDFS and OWL class descriptions
  - Positional logic ☞ Frame logic (F-logic)
- Serialization of SWSL-Rules

Business Rule: Slotted (for OO)

buyer   item   rebate

"The **discount** for a *customer* buying a *product* is 5 percent if the *customer* is **premium** and the *product* is **regular**."

Data model:

Serialization:

```
<Implies>
  <head>
    <Atom>
      <Rel>discount</Rel>
      <slot><Ind>buyer</Ind><Var>customer</Var></slot>
      <slot><Ind>item</Ind><Var>product</Var></slot>
      <slot><Ind>rebate</Ind><Ind>5.0</Ind></slot>
    </Atom>
  </head>
  <body>
    <And>
      <Atom>
        <Rel>premium</Rel>
        <Var>customer</Var>
      </Atom>
      <Atom>
        <Rel>regular</Rel>
        <Var>product</Var>
      </Atom>
    </And>
  </body>
</Implies>
```

Slots

13

Some RuleML Use Cases

- RACSA, RALOCA, RACOFI: Rule Applying Agents for Comparison Shopping, Learning Object Comparison, and COllaborative FIltering (led to inDiscover.net)

- NBBizKB: New Brunswick Business Knowledge Base uses OO RuleML for data validation and integration

- AgentMatcher: e-Learning metadata interchanged in Weighted OO RuleML

- Teclantic: Startup project descriptions for Atlantic technology transfer in Weighted OO RuleML

- Regulatory guidelines for financial services in the US, Can, and UK by Inference Web Inc.

- MITRE Convoy Mission [28]

SweetRules & MIT RuleML Use Cases

- Contracts/negotiation, advertising/discovery
  - E-procurement, E-selling
  - Pricing, terms & conditions, supplier qualification, …

- Monitoring:
  - Exception handling, e.g., of contract violations
    - Late delivery, refunds, cancellation, notifications
  - Notifications, personal messaging, and other workflow

- Trust Policies: authorization, confidentiality & 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

- Object-oriented process ontologies: MIT Process Handbook
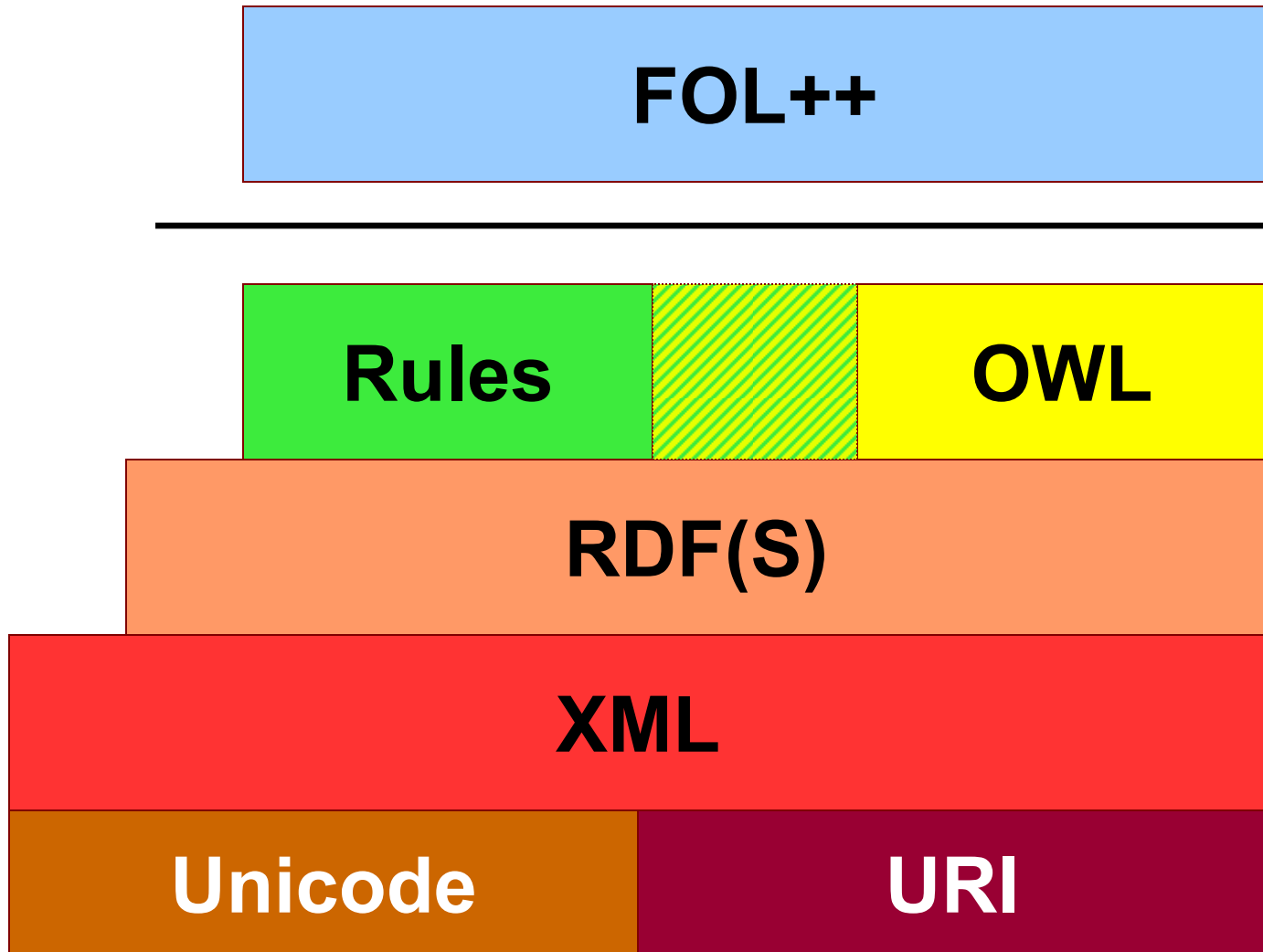 - With default inheritance

Lessons from RuleML Experience

- Rule standardization process requires
  - Long-term vision
  - Engaging with all stake-holders
  - Full understanding of needs of various communities

- Each sublanguage also requires very strict and explicit scope to guarantee delivery of mature results in a phased fashion

- Focussing on certain sublanguages will be necessary for planned W3C Working Group

The Web Rule Language in its Context
RuleML, WSML, SWSL View

FOL++

| Rules | | OWL |

RDF(S)

XML

Unicode · URI

Position Based on Experience

- Since 2000 the RuleML Initiative has engaged/collaborated with:
  - Large variety of use cases: finance, insurance, e-commerce, supply-chain, security & trust, biomed, ...
  - RDF, N3, TRIPLE
  - OWL, DL, Joint Committee
  - Semantic Web Services, SWSI, WSMO
  - Development of dozens of tools
- Pioneered webized representation of modular family of rule sublanguages, catering to a variety of needs on the Web

Position: Proposed Scope of WG (1)

First Phase (ca. 9 months)**:**

- Start with LP expressiveness including Datalog Horn + NAF, then add logical functions

- Enable use of RDF and of OWL-DL [81]

- Draw especially on:
  - Use cases
  - RuleML, SWSL [124], WSML [44, 128], N3 [94], TRIPLE [98], SCL/KIF [103]

Position: Proposed Scope of WG (2)

First Phase (cont'd)**:**

- Add some subset of following ten features:
  - Slotted/Frame syntax; webized OIDs/labels
  - Datatyping; lists
  - Signature declarations
  - Lloyd-Topor: syntactic sugar for enriched connectives
  - Integrity constraints, mutual exclusions, functional dependency
  - Prioritized conflict handling, cf. Courteous
  - Procedural attachments, cf. Situated:
    - built-ins/tests/sensors
    - actions/effectors
    - events/time
  - Hilog: syntactic sugar for restricted higher-order
  - User-defined head equality and functions
  - Reification

Position: Proposed Scope of WG (3)

Second Phase (additional ca. 6-9 months)**:**

- Extend for more expressiveness as required by more use cases and doable in that period
  - Vote now for your top k out of 10 ☺

Upcoming Events

- **Workshop on Protégé with Rules**

- **Will be held in conjunction with [8th Intl. Protégé Conference](#), on 18 July 2005**

- **Deadline for paper or abstract submissions: 1 June 2005**

- [http://www.med.univ-rennes1.fr/~cgolb/Protege2005/ProtegeWithRulesCFP.htm](#)

- **RuleML-2005: International Conference on Rules and Rule Markup Languages for the Semantic Web**

- **Will be held in conjunction with [ISWC-2005](#), on 10-11 November 2005**

- **Deadline for paper submissions: 1 July 2005**

- [http://2005.ruleml.org](#)