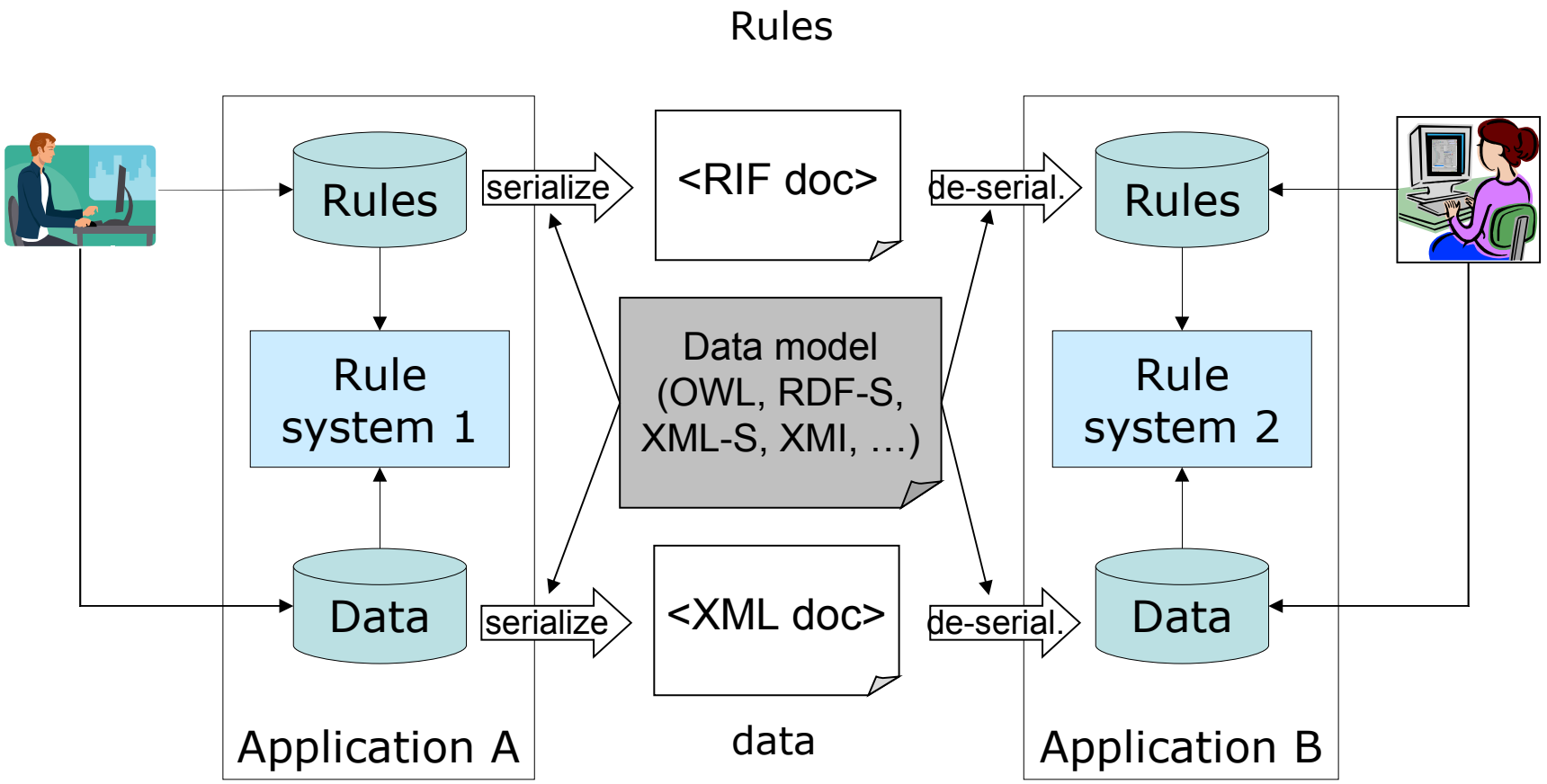
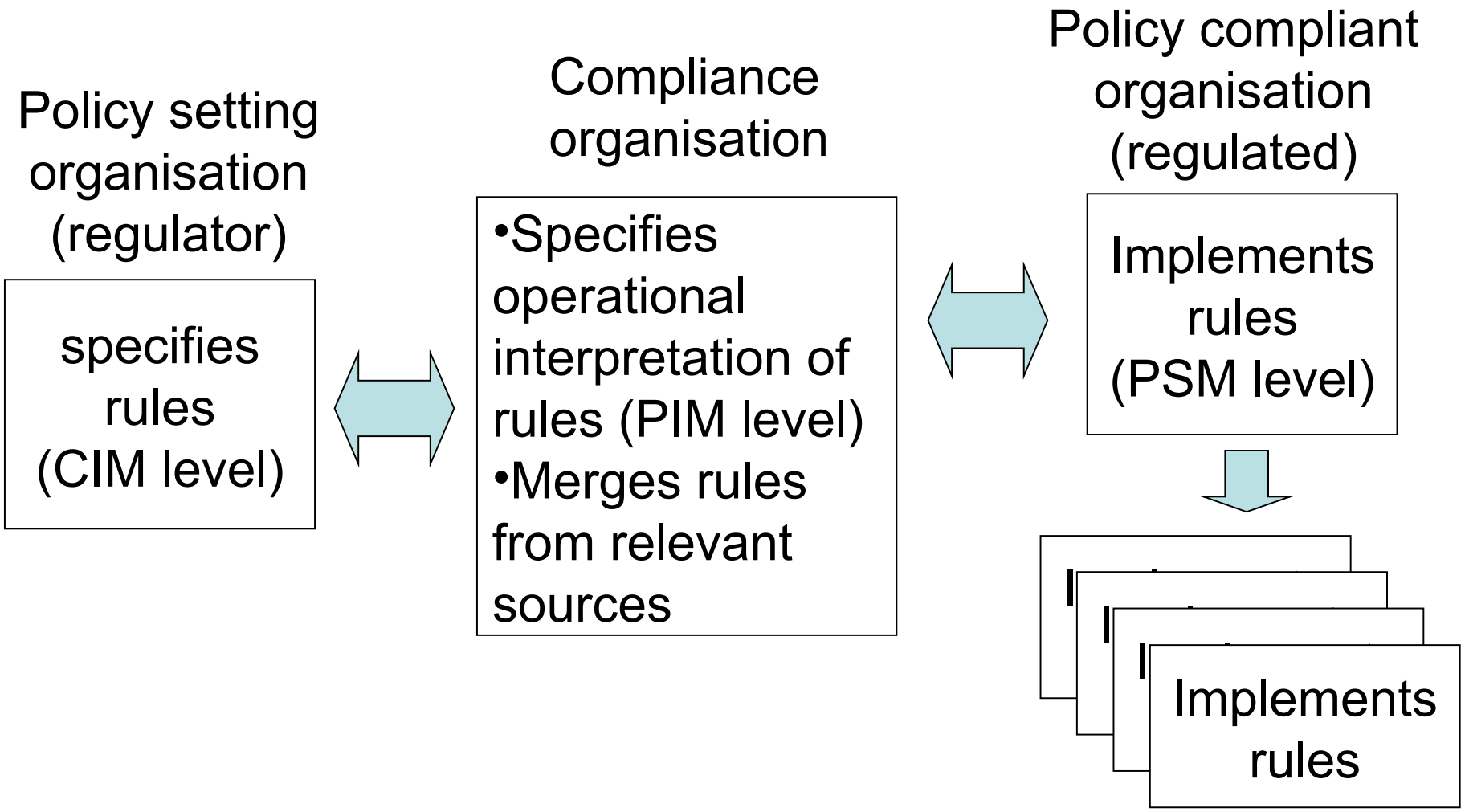
W3C rule interchange format

Rule interchange



Rules interchange



Negotiating eCommerce Transactions Throug

- In order to grant access a buyer must provide valid credit card information together with delivery information (address, postal code, city, and country)

```
Forall ?buyer
   Forall ?card ?address
          such that (?buyer[ex:creditCard->?card
                            ex:deliveryAddress->?address])
   if ex:validAddress(?address) and ex:validCreditCard(?card)
   then Execute(ex:grantAccess(?buyer))
ex:validAddress(?address) :-
Exists ?x ?y ?z …
       And(?address[ex:zip->?x ex:city->?y ex:country->?z …]
           ex:isValidZip(?x ?y ?z)
           …)
```

- Disclose Alice's credit card information only to online shops belonging to the Better Business Bureau
- For anonymity reasons, never provide both her birth date and postal code.

Interchanging Rule Extensions to OWL

- “A rule is used to express the dependency between the ontology properties isMAEConnectedTo and isMAEBoundedBy, in particular (a simplified form of) the knowledge that two Material Anatomical Entities having a shared boundary are connected”

```
Forall ?x ?y ?z
(?x[isMAEConnectedTo->?y :-
And(?x[isMAEBoundedBy->?z]
      ?y[isMAEBoundedBy->?z]))
```

Publishing Rules for Interlinked Metadata

- Every science fiction movie is a movie
  ?Movie#ex:Movie :- ?Movie#ex:ScienceFictionMovie
- Every movie produced before 1930 is black and white
  ?Movie#ex:BlackWhiteMovie :-
  ?Movie#ex:Movie[ex:date -> ?Date], ?Date < "1930"^^xs:dateTime
- All movies listed at http://altmd.example.org but not listed at http://imd.example.org are independent movies
  ?Movie#ex:IndependentMovie :-
  listed(?Movie#ex:Movie,http://altmd.example.org)
  ***not**(listed(?Movie#ex:Movie,<http://imd.example.org>))*
- All movies with budgets below 5 million USD are low-budget movies.
  ?Movie#ex:LowBudgetMovie :-
  ?Movie#ex:Movie [date -> ?Date, budget -> ?Budget]
  ?Budget < 5000000^^xs:long

- All of these can be expressed with OWL, but not all of them belongs in an ontology

Publishing Rules for Interlinked Metadata

- FOAF user Charlie might choose to complement his normal FOAF profile with his preferences about which of his phone numbers should be used depending on his iCalendar schedule:
  - *If Charlie is currently in a meeting according to http://charlie.example.org/calender.ical and the importance is high then call his cell number*
  - *If Charlie is currently attending a public talk according to http://charlie.example.org/calender.ical then leave him a voicemail message*
  - *If Charlie currently has no appointments according to http://charlie.example.org/calender.ical then call his office number*

Access control policies

- PRIME

  <subject> with [<subject_expression>] can <actions> on <object> with [<object_expression>] for <purposes> if [<conditions>]

- RIF-BLD

  Forall ?subject ?object

  prime:allowed(prime:action ?object prime:purpose) :-

  And(subject_expression object_expression conditions)

- RIF-PRD

  Forall ?subject such that (subject_expression)

  Forall ?object such that (object_expression)

  If conditions then Execute(prime:action(?object prime:purpose))

What is the Rule Interchange Format?

- Format for interchanging rules, so they can be used across diverse systems
  - allowing rules written for one application to be published, shared, and re-used in other applications and other rule engines.
  - In a semantic preserving way (between languages with compatible semantics)
  - Encouraging interoperability
  - XML syntax
  - Compatible with relevant standards (PRR, RDF, OWL, …)
- A rule is (just another) data item
  - RIF provides a standard means to feed rules into an application (at run time)
  - Semantics to prescribe (intended) application's behaviour

RIF Background: standards

- The early days of rule interchange
  - 1998: KIF – Knowledge Interchange Format
  - 2000: RuleML
  - 2001: SRML – Simple Rule Markup Language (Colleen and Changhai)
  - …
- 2001-2004: JSR 94 – Java rule engine API
  - Prescribes a set of fundamental rule engine operations (i.e. loading rulesets, parsing rules, adding objects to an engine, firing rules, and getting resultant objects from the engine)
  - Engine semantics are not defined, so the API and specification are very high level (JDBC API ... without SQL)
  - No underlying rule language, hence no API to introspect rules, create rulesets, provide pluggable parsers etc.
- 2003-2008: OMG PRR – Production Rule Representation
  - "A metamodel for a language that can be used with UML models for explicitly representing production rules as visible, separate and primary model elements in UML models"
    - A MOF/UML meta-model and an UML profile
    - Addresses the PIM level of MDA
  - Engine semantics are defined (forward chaining + sequential)
  - No underlying rule language: PRR Core + non-normative PRR OCL
- April 2005: W3C workshop on rule languages for interoperability
- November 2005: W3C Rule Interchange Format working group chartered
- OMG SBVR, ISO Common Logic, …

RIF Background: semantic Web

- Semantic web approach
  - interoperability requires a formal semantics
- The OWL WG approach
  - Start with something (DAML+OIL)
- Literally *hundreds* of rule system implementations
  - ISO-Prolog, CLIPS, OPS…
  - http://www.w3.org/2005/rules/wg/wiki/List_of_Rule_Systems
  - Already several “SW” rule languages
    - SWRL, RuleML, WRL, SWSL, KAON2, TRIPLE, JenaRules…
  - Everyone wants “their” system/technique/theory to be the SW rule standard

Wherefore the RIFt(s)?

- OWL DL < OWL < FOL
  - Original idea to add full first-order at the logic level
  - Semantic web *very* “open world”
- Most back-end DBs support closed queries
- Many rule systems have non-FO features
  - CWA/NAF
  - Procedural Attachment
  - Rule ordering
  - Non-monotonicity

  … can’t be layered on OWL
- Not a strict SW layering already
  - OWL restricted dialects (DL) not layered on (all of) RDF/S semantics
  - RDF & RDFS not layered at all

RIF Background: Business rules

- "Business Rule systems" Vendors
  - $1B/year existing market
  - 1,000's end users
  - 1,000,000's rules in use
  - ILOG, Fair Isaac, Haley, …
- Database vendors
  - Oracle, IBM
- OMG PRR effort
  - Simple production rules
  - Event-condition-action
  - Vendors understand the value of standardization (see also JSR 94)
  - Interchange already a priority
  - …a common *semantics?*

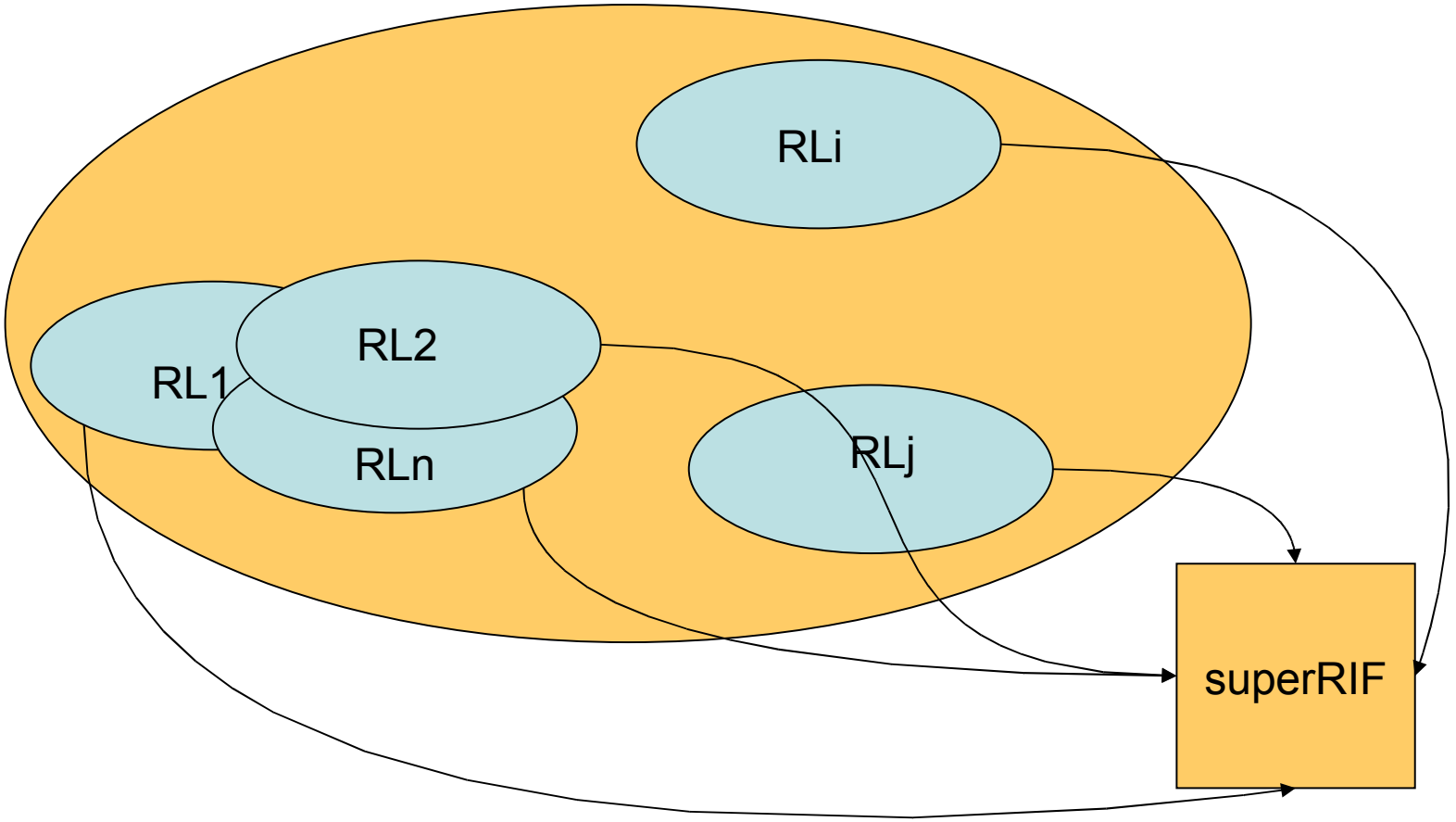
W3C RIF working group

- W3C working group
  - Chartered Nov. 05 (for 2 years)
    - Phase 1: extensible XML rule interchange format, Horn expressiveness, semantic Web compatibility
  - Kick-off Dec. 05
    - March 06: FPWD UCR
    - March 07: FPWD Core
    - Oct. 07: FPWD BLD
  - Extended Nov. 07 (for 6 months)
    - BLD to Last Call
  - Extended May 08 (for 1 year)
    - BLD, SWC to REC
    - FLD, DTB, PRD, extensibility
- 74 participants from 35 organisations
  - IBM, HP, Oracle, ILOG, JBoss, Fair Isaac, Corticon, Tibco, MITRE…
  - NIST, OMG (esp. SBVR and PRR), RuleML…
  - Research organisations, universities…
  - And 4 invited experts
  - Chairs: Chris Welty (IBM), Christian de Sainte Marie (ILOG)
- Working in the public eye
  - http://www.w3.org/2005/rules/wiki/RIF_Working_Group
  - Under the W3C patent policy

W3C RIF: Design issues

- Very large number of rule users/use cases and types to satisfy!!!
  - Descriptive {OMG MDA level = CIM} VS executable rules {OMG MDA level = PIM & PSM}
  - Logical (side-effect free) VS active (side-effect full) rules
  - Data-oriented (SQL triggers, PR, …) VS proof-oriented (FOL…)
    - All kinds of different data sources (DB, WM, OO, OWL…)
  - Semantic Web VS non-SW usage
- Simplicity VS coverage
- Extensibility VS compliance VS interoperability
- Executable (AST) VS human-readable syntax
- …

Superset approach

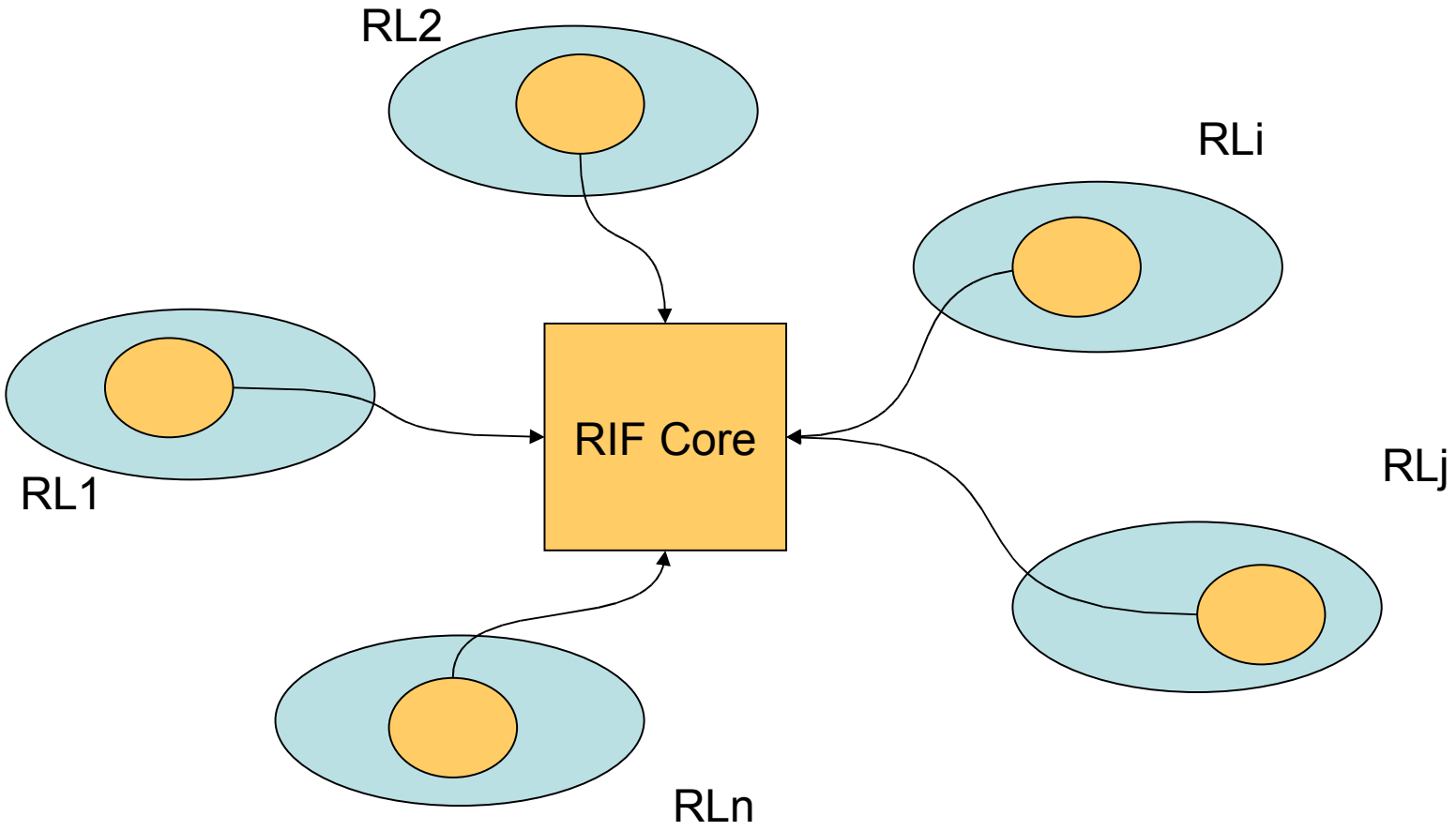


Super-set approach

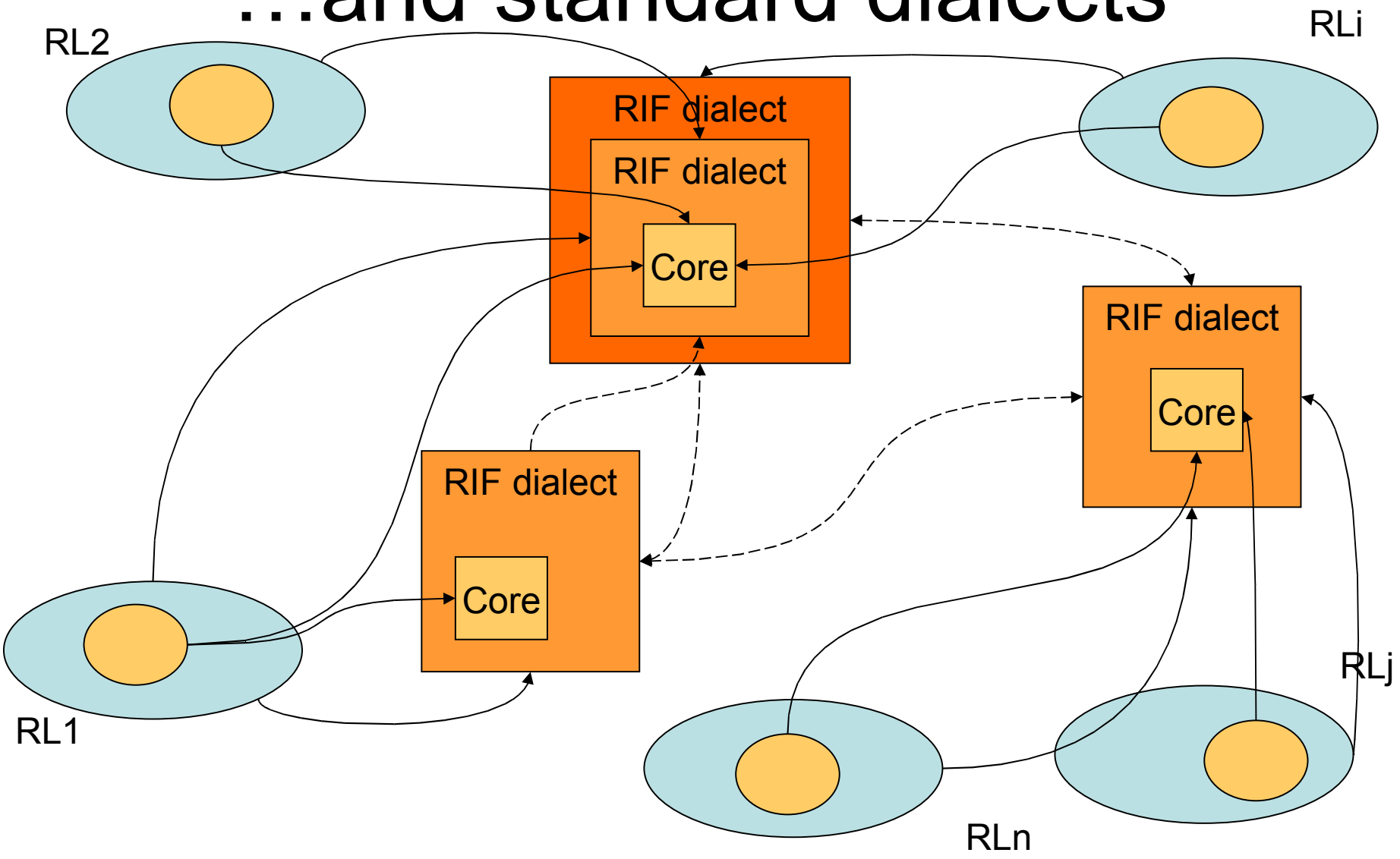
- Define a super-language so expressive that any language can be translated to/from it
  - The CL and IKL approach

  @deprecated: infeasible for this group, as major differences appeared irreconcilable (e.g. non-mon vs. mon)

A common core…



…and standard dialects

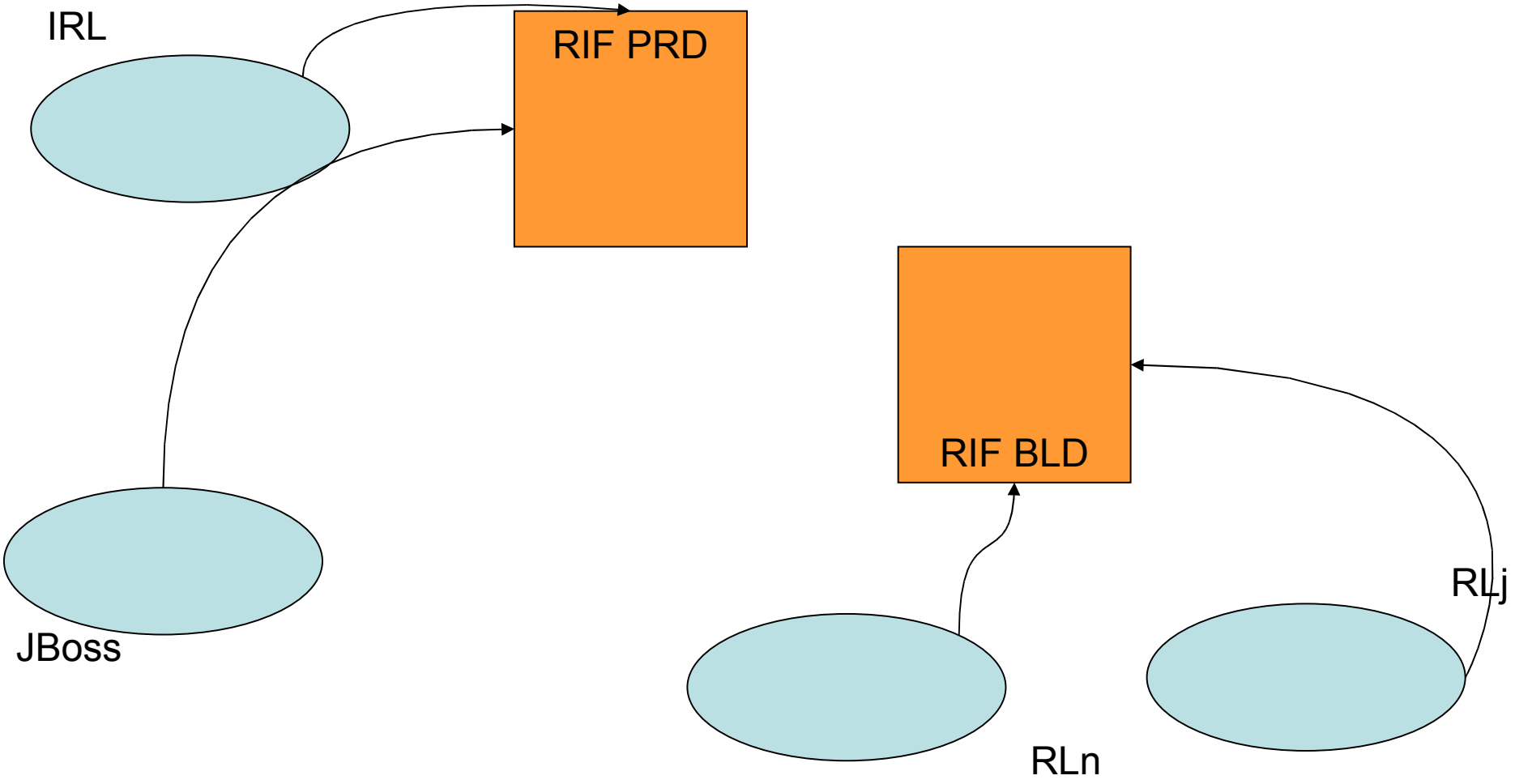


Core + standard dialects

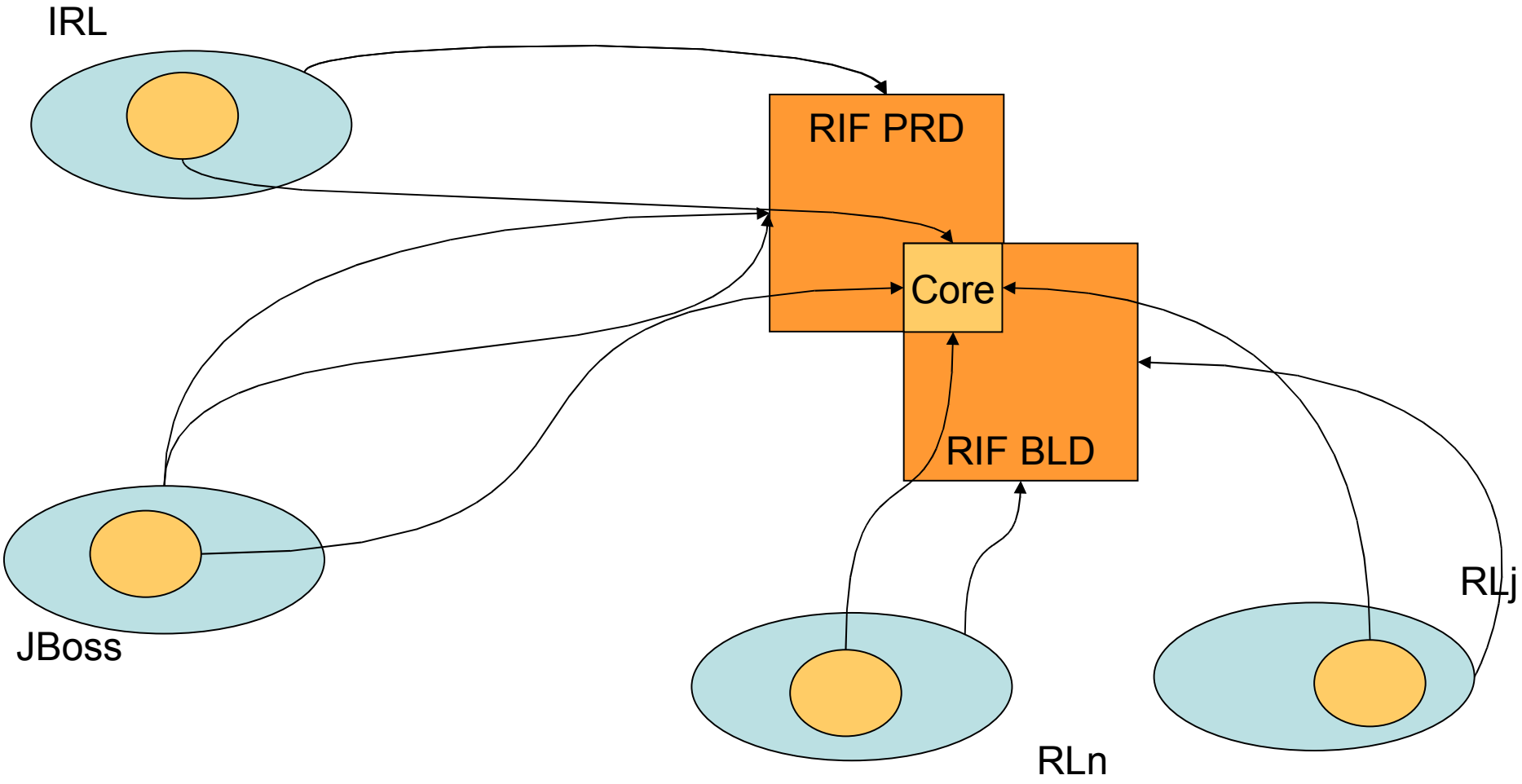
- Define a *core* language that accounts for the intersection of all rule language capabilities
  - E.g. Horn, datalog, …

  @postponed: The production rule, logic programming, and FO core is not clear

Separate families + Core



Separate families + Core



Separate families + Core

- Define a logic-based core and a separate production-rule core
- If there is an intersection, define the common core (which may possibly be just a syntax)

  @version 0.1: BLD LC (July 08)

  @version 0.0.1: PRD FPWD (July 08)

Approach 3a

- Define a *framework* in the form of a menu of syntactic and semantic features that can be combined into dialects
  - @version 0.0.9: FLD

Design principles

- Translation paradigm
  - No intrusion in covered rule languages and rule sets
- Same semantics ⇔ same syntax
  - Share constructs accross dialects wherever they agree on the semantics
  - Different constructs where semantics do not agree
- Fully striped XML (type-tagged, object-oriented, …)
  - alternating Class and role tags
  - Metadata can be attached to any class element
- Only XML schema is normative
  - Presentation syntax added for specification's readability (examples, semantics etc)

- Principles are there so you can rest on them…until they break

BLD Overview

- Definite Horn rules
  - Disjunction of atoms with exactly one positive literal
- Equality, functions, and a standard *first-order* semantics
- Syntactic features
  - objects and frames
  - internationalized resource identifiers (IRIs) as identifiers
  - XML Schema data types and builtins
- XML (1.0) syntax with normative XMLS definition
- Non-normative presentation syntax
- Metadata and (RDF+OWL) imports

Symbols

- Used to identify constants, variables, functions, predicates
- "*literal*"^^<symspace-*identifier*>
  - Notable symbol spaces: xsd:string, rif:local, rif:iri
  - “Chris”^^<xsd:string>
  - “http://www.w3.org/1999/02/22-rdf-syntax-ns#ty rif:iri>
  - “Person1”^^rif:local

Rules

- IF <condition> THEN <conclusion>
  - <condition> aka rule body, antecedent
  - <conclusion> aka rule head, consequent
- BLD rule:
  - (**Forall** var* <conclusion> **:-** <condition>)
  - Conclusions may contain conjunction
  - Conditions may contain conjunction, disjunction, and existential
- Restrictions on conclusion
  - No existential, disjunction, external functions

Horn Extensions

- Functions and external calls (DTB)
- Equality (in conclusion and condition)
- Frames
  - Objects with slots and (multiple) values
    - Used to map to RDF and OWL (SWC)
  - Special syntactic treatment of class membership and subclass
- Named argument functions and predicates
  - However all arguments must be provided

Structure

- Rules occur in Groups

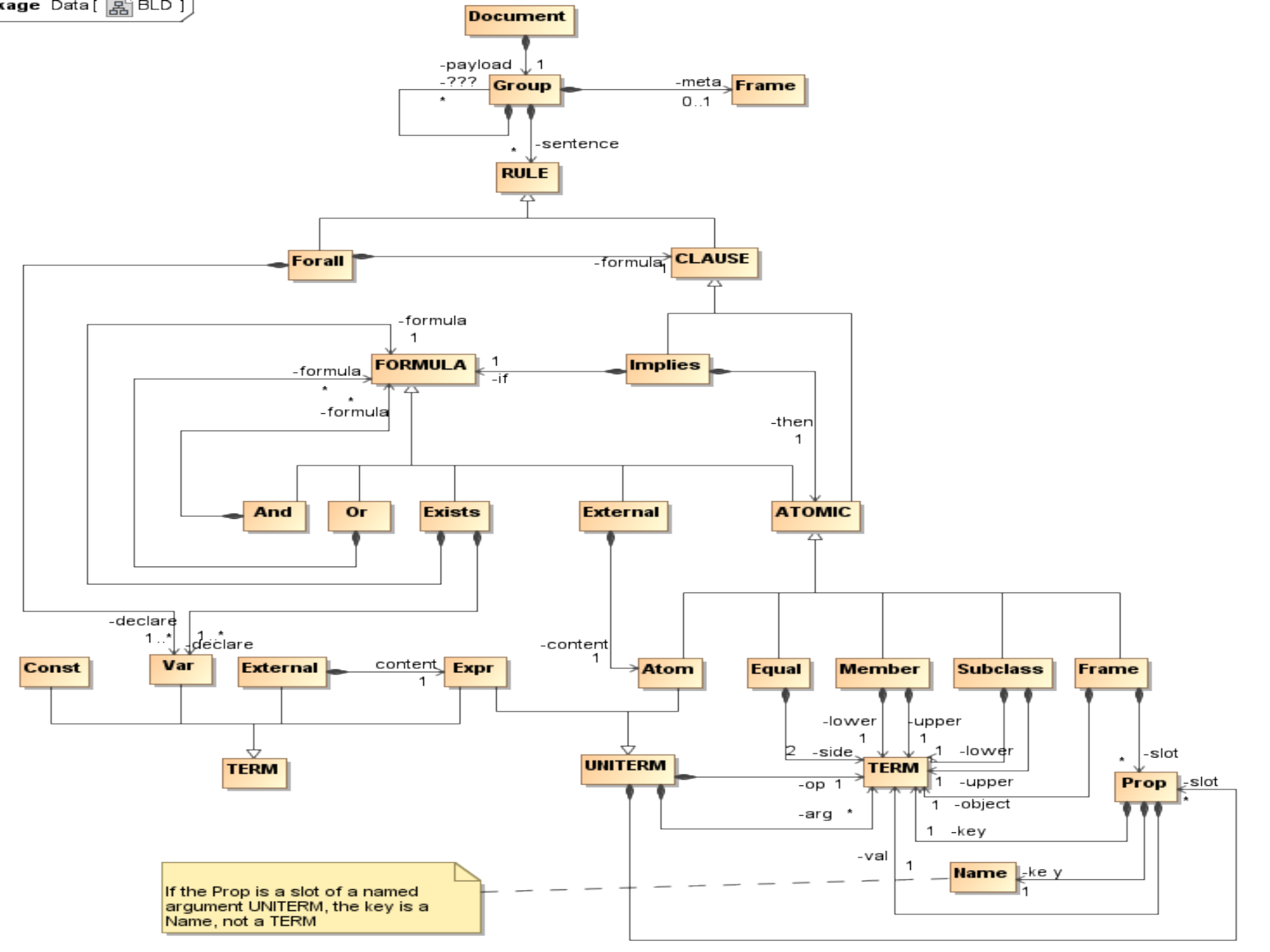
```
Group(  (Forall ?x _Q(?x) :- _P(?x))
        (Forall ?x _Q(?x) :- _R(?x)) )
```

- Groups occur in Documents

```
Document(
  Group((Forall ?x _Q(?x) :- _P(?x))
        (Forall ?x _Q(?x) :- _R(?x))))
```

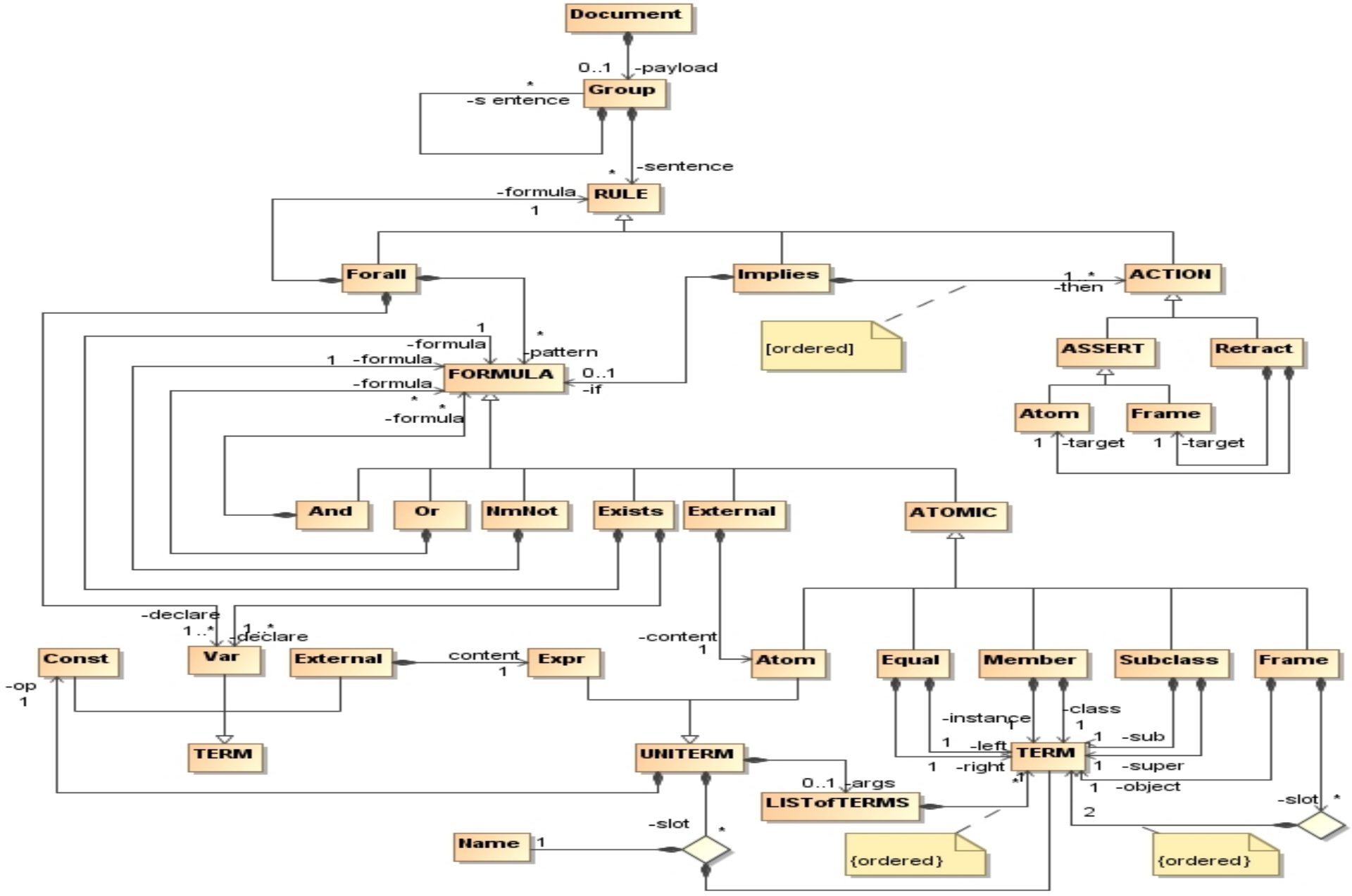
Warning

- While representative of the RIF syntax, the following diagrams and examples are not completely up-to-date at the time of the presentation

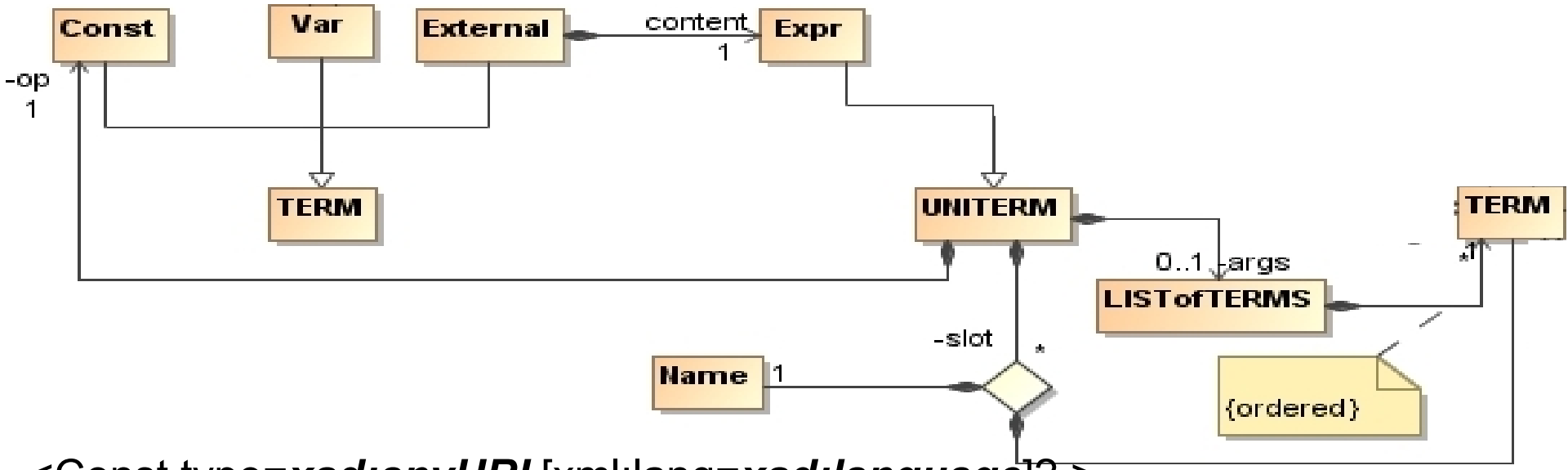

xage Data [BLD]
Document
-payload
-???
1
*
Group
-meta
0..1
Frame
-sentence
*
RULE
Forall
-formula
1
CLAUSE
-formula
1
FORMULA
1
-if
Implies
-formula
*
*
-formula
-then
1
And
Or
Exists
External
ATOMIC
-declare
1..*
1..*
-declare
-content
1
Const
Var
External
content
1
Expr
Atom
Equal
Member
Subclass
Frame
TERM
UNITERM
-lower
1
-upper
1
2
-side
1
-lower
1
-upper
1
-object
1
-key
-op
1
-arg
*
TERM
*
-slot
Prop
-slot
*
-val
1
Name
-ke y
1
If the Prop is a slot of a named argument UNITERM, the key is a Name, not a TERM

PRD Overview

- Production rules
  - FOR <variables> WITH <binding patterns>,
    IF <condition> THEN <actions>
  - FORALL Var* (IF patterns AND condition THEN action
  - With an operational semantics a a labelled transition system
- Patterns and condition
  - BLD condition language minus logic functions plus negation
  - With a model-theoretic semantics (compatible with BLD)
- Assert, Retract, New
  - Assign, Remove, Execute
  - Defining a transition relation
- Syntactic features
  - **objects** and frames
  - internationalized resource identifiers (IRIs) as identifiers
  - XML Schema data types and builtins
- Metadata


Document
0..1
-payload
Group
*
-s entence
-sentence
*
-formula
1
RULE
Forall
Implies
1..*
-then
ACTION
[ordered]
ASSERT
Retract
Atom
Frame
1
-target
1
-target
1
-formula
*
-pattern
1
-formula
FORMULA
0..1
-if
-formula
*
*
-formula
And
Or
NmNot
Exists
External
ATOMIC
-declare
1..*
1..*
-declare
-content
1
Const
Var
External
content
1
Expr
Atom
Equal
Member
Subclass
Frame
-op
1
TERM
UNITERM
-instance
1
1
-left
1
-right
-class
1
1
-sub
TERM
1
-super
1
-object
2
-slot
*
0..1
-args
LISTofTERMS
-slot
*
Name
1
{ordered}
{ordered}

TERM

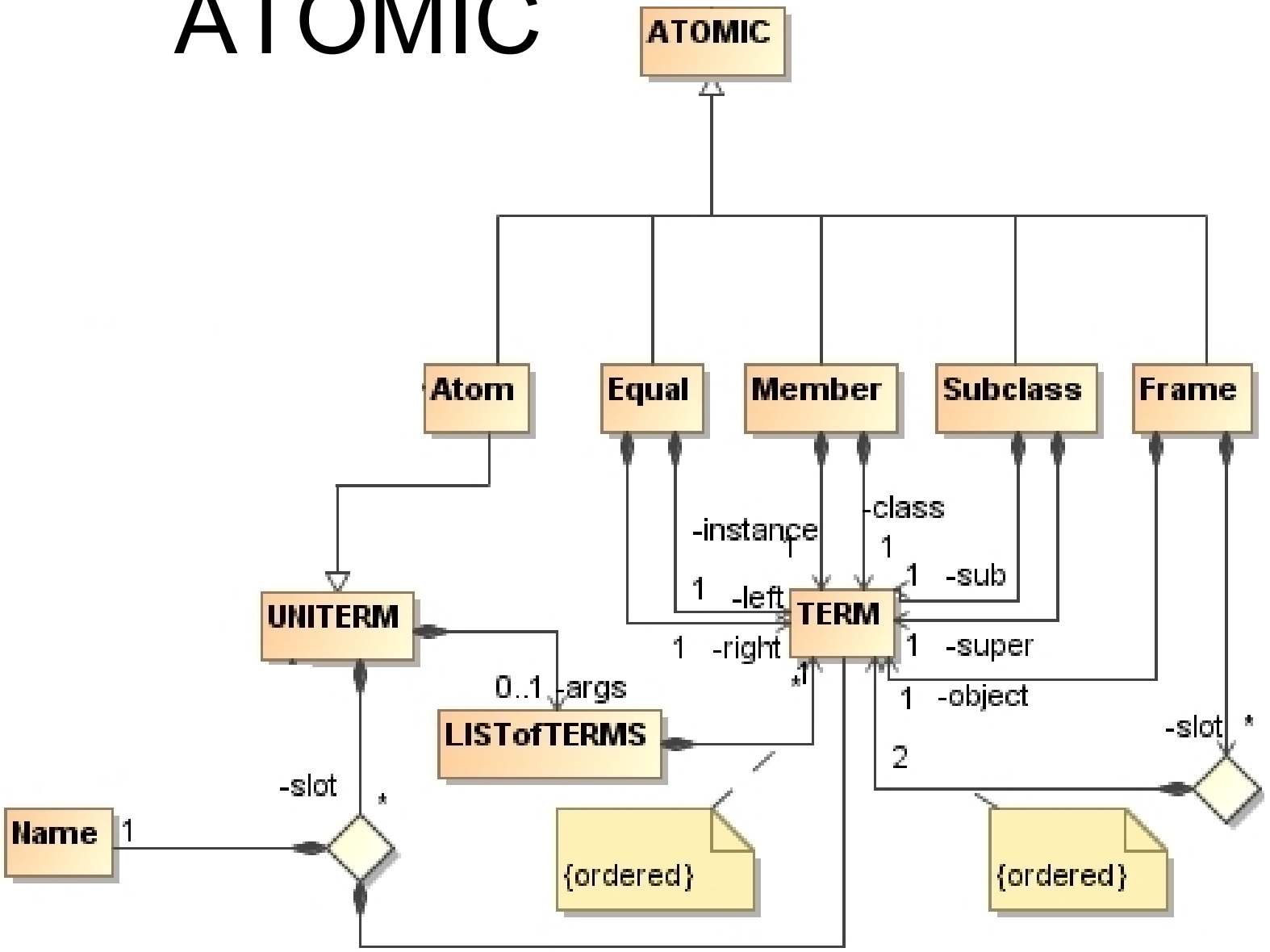


<Const type=***xsd:anyURI*** [xml:lang=***xsd:language***]? >
Any Unicode string
</Const>

<Var> ***any Unicode string*** </Var>

<External><content><Expr><op> ***Const*** </op>
<args rif:ordered="yes"> ***TERM**** </args>?
</Expr> </content> </External>

ATOMIC


ATOMIC
Atom
Equal
Member
Subclass
Frame
-instance
1
-class
1
1
-left
1
-sub
UNITERM
TERM
1
-right
1
-super
0..1
-args
*
1
-object
LISTofTERMS
-slot
*
2
-slot
*
Name
1
{ordered}
{ordered}

ATOMIC

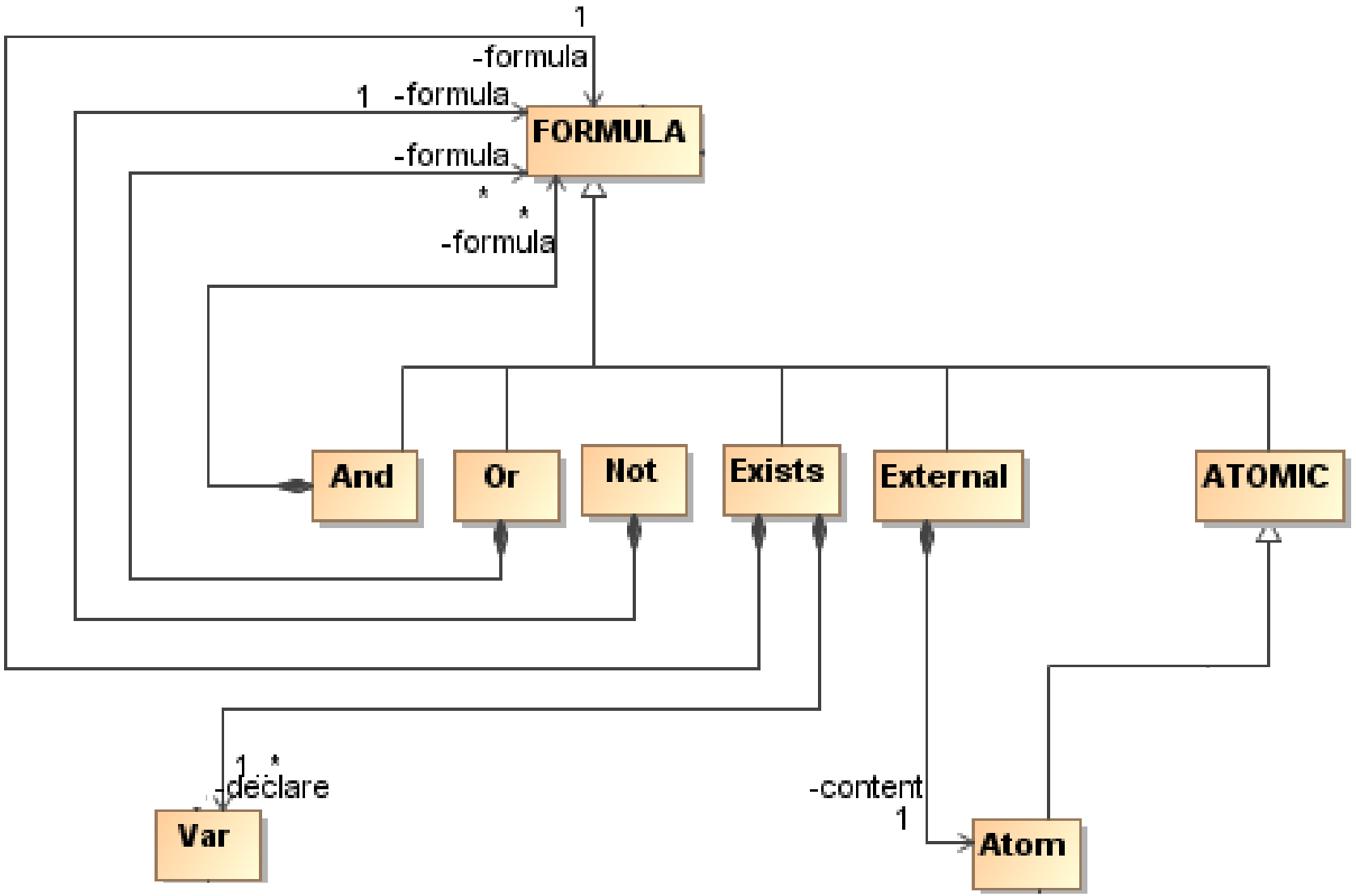
- jim:owns(?c ?p)

```
<Atom>
    <op>
      <Const type="rif:iri">http://rif.examples.com/2008/jim#owns</Const>
    </op>
    <args rif:ordered="yes">
      <Var> ?c </Var>
      <Var> ?p </Var>
    </args>
</Atom>
```

- ?c.age = ?a

```
<Frame>
    <object> <Var> ?c </Var> </object>
    <slot rif:ordered="yes">
      <Const type="rif:iri"> ttp://rif.examples.com/2008/jim#Chicken/age
    </Const>
      <Var> ?a </Var>
    </slot>
</Frame>
```

FORMULA

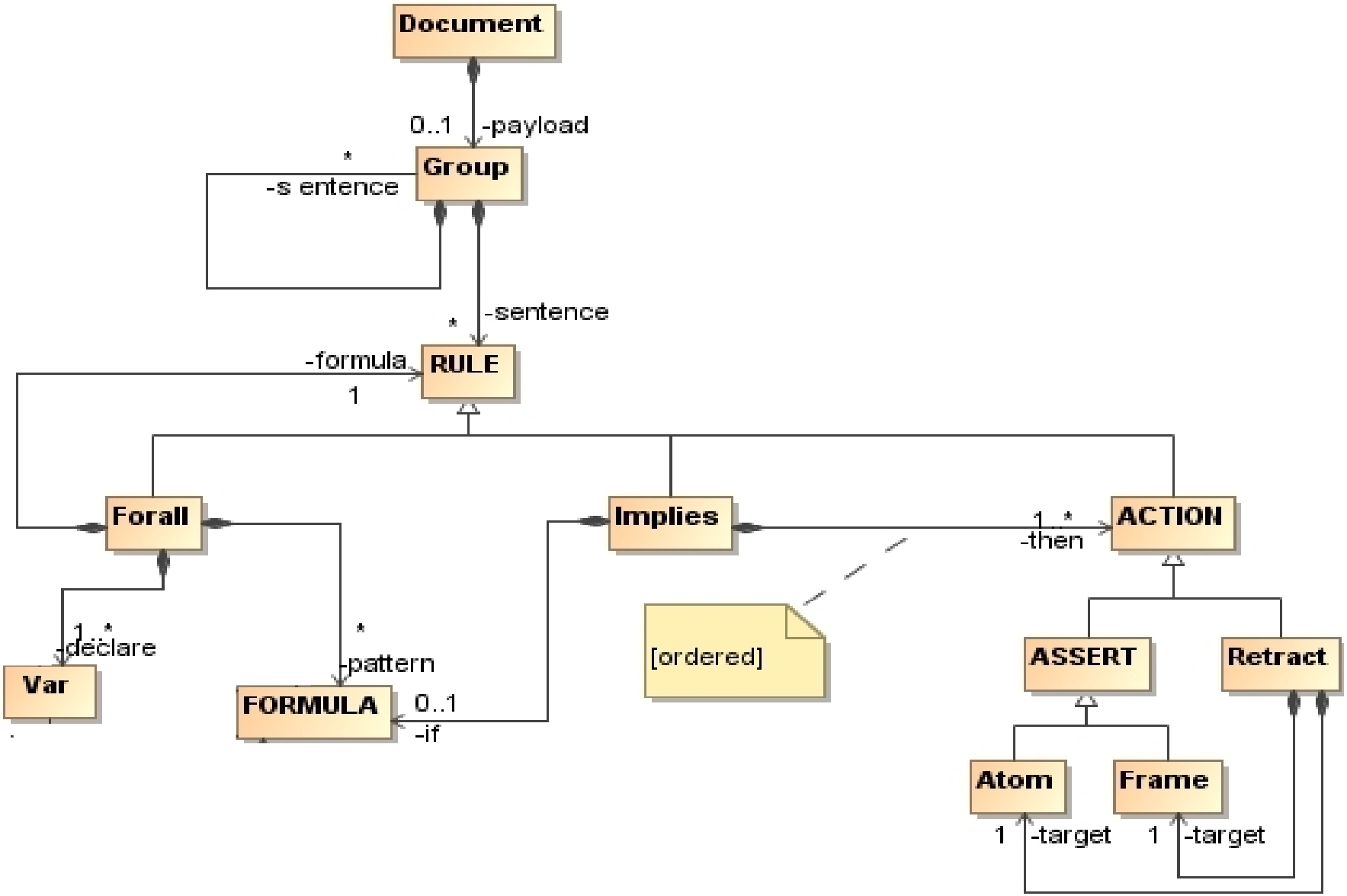

1
-formula
1
-formula
FORMULA
-formula
*
*
-formula
And
Or
Not
Exists
External
ATOMIC
1
*
-declare
Var
-content
1
Atom

FORMULA

- Exists Chicken(age>8)

```
<Exists>
    <declare> <Var> ?c </Var> </declare>
    <declare> <Var> ?a </Var> </declare>
    <formula>
      <And>
                <Member> ?c jim:Chicken </Member>
                <Frame> ?c.age=?a </Frame>
                <External>
                  <content>
                    <Atom>
                      <op> <Const type="rif:iri"> op:numeric-greater-than</Const>
    </op>
                      <args rif:ordered="yes">
                          <Var> ?a </Var>
                          <Const type="xsd:decimal"> 8 </Const>
                      </args>
                    </Atom>
                  </content>
                </External>
      </And>
    </formula>
</Exists>
```

RULE etc


Document
0..1
-payload
*
-s entence
Group
*
-sentence
-formula
1
RULE
Forall
Implies
1..*
-then
ACTION
1..*
-declare
Var
*
-pattern
FORMULA
0..1
-if
[ordered]
ASSERT
Retract
Atom
Frame
1
-target
1
-target

RULE

- When

  ?c Chicken(age==8)

  evaluate(today()=’’Monday’’)

  Then …

```
<Forall>
   <declare> <Var> ?c </Var> </declare>
   <pattern>
     <And>
                <Member> ?c jim:Chicken </Member>
                <Frame> ?c.age=8 </Frame>
                </And>
   </pattern>
   <formula>
     <Implies>
       <if> <External> today()=’’Monday’’ </External>
      <then> … </then>
     </Implies>
   </formula>
</Forall>
```

Metadata

<CLASSELT>
  <id> ***Const*** </id>?
  <meta>
    [***Frame***
    |
    <And>
      <formula> ***Frame***
      </formula>*
    </And>]
  </meta>?
  other CLASSELT content
</CLASSELT>

<Forall>
  <id><Const
    type="rif:iri">*jim:CMP*</Const></id>
  <meta><Frame>
    <object ><Const type="rif:iri">
      jim:CMP
      </Const>
    </object>
    <slot
    rif:ordered="yes">dc:creator csma</slot>
    <slot rif:ordered="yes">…</slot>
    …
  </Frame>
  </meta>
  <declare> <Var> ?c </Var> </declare>
  <pattern>…</pattern>
  <formula>…</formula>
</Forall>

RIF Documents

- BLD: RIF basic logic dialect
  - LC July 2008
  - REC by May 2009?
- FLD: RIF framework for logic dialects
  - 2nd public WD July 2008
  - LC November 2008?
- PRD: RIF production rule dialect
  - FPWD July 2008
  - LC May 2009?
- DTB: RIF data types and builtins
  - FPWD July 2008
  - LC November 2008?
- SWC: RIF RDF and OWL compatibility
  - LC July 2008
  - REC by May 2008?
- UCR: RIF use cases and requirements
  - 4th public WD July 2008
- Test Cases: FPWD November 2008

Web site: http://www.w3.org/2005/rules/wiki/RIF_Working_Group

Credits

- BLD and FLD Editors
  - Michael Kifer (U. Stonybrook), Harold Boley (NRCC)
- PRD Editors
  - Christian de Sainte Marie (ILOG), Adrian Paschke (FUBerlin), Gary Hallmark (ORACLE)
- SWC Editor
  - Jos de Bruijn (FUB)
- DTB Editors
  - Axel Polleres (DERI Galway)? Michael Kifer (U. Stonybrook), Harold Boley (NRCC)
- UCR Editors
  - Adrian Paschke (TU Dresden)? David Hirtle (NRCC), Allen Ginsberg (Mitre), Paula-Lavinia Patranjan (REWERSE), Frank McCabe (Fujitsu)
- Test Cases Editors
  - Stella Mitchell (IBM), Leora Morgenstern (IBM), Adrian Paschke (FUBerlin)
- Active WG members
  - Adrian Paschke (FUBerlin), Axel Polleres (DERI), Dave Reynolds (HP), Gary Hallmark (ORACLE), Hassan Aït-Kaci (ILOG), Igor Mozetic (JFI), John Hall (OMG), Jos de Bruijn (FUB), Leora Morgenstern (IBM), Mike Dean (SRI), Stella Mitchell (IBM), Changhai Ke (ILOG), Stuart Taylor (U Aberdeen)
- WG Team
  - Chris Welty (IBM), Christian de Sainte Marie (ILOG), and Sandro Hawke (W3C/MIT)

Thank you!

Questions?