Description Logic Programs: Overview for DAML and WebOnt

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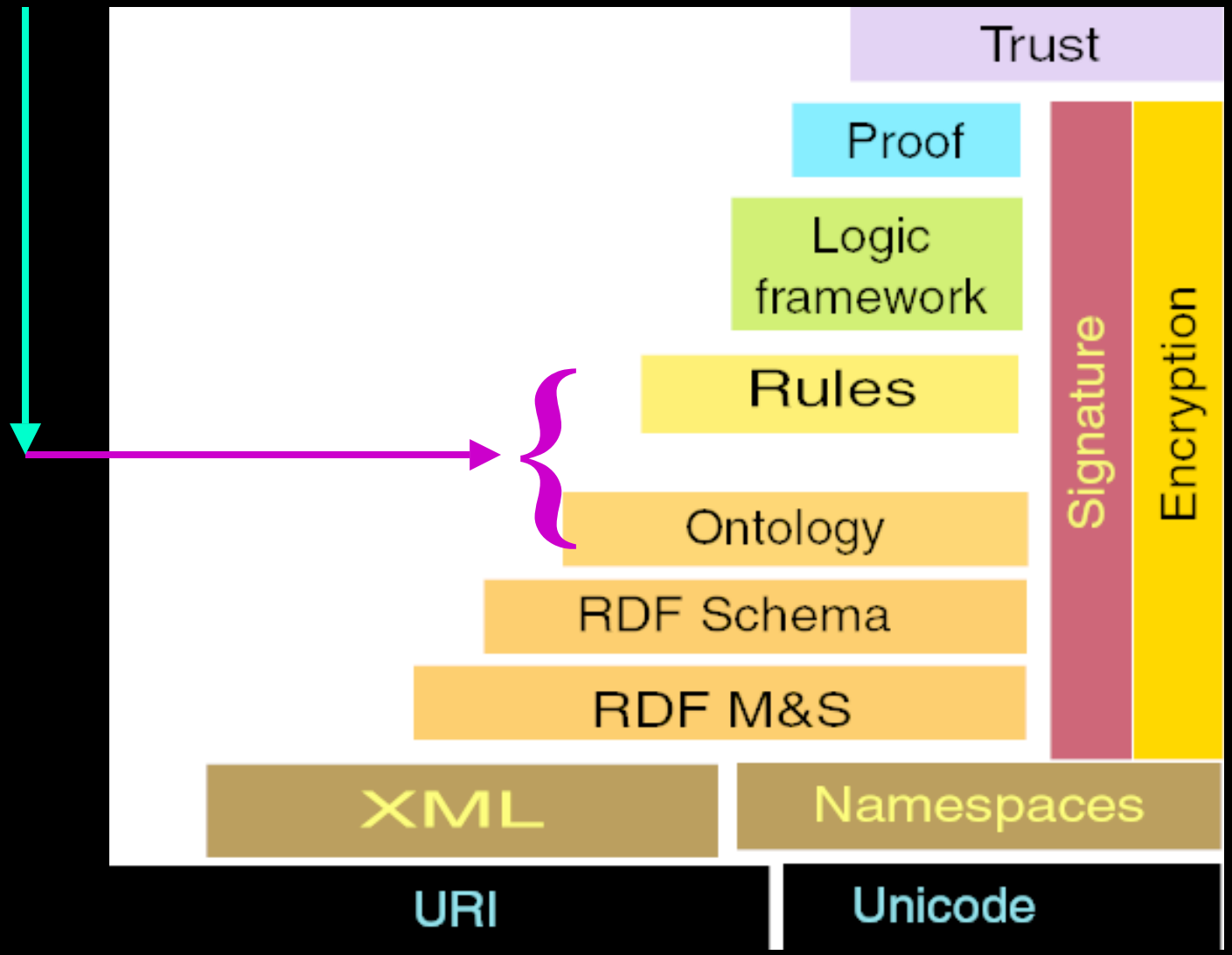
Motivation from "DAML Rules" effort

- Goal: the hybridization of DAML+OIL/OWL with Logic Program rules
  - original aim: extend expressiveness of DAML KR beyond DAML+OIL/OWL.
    - for defining ontologies, and for rules plus ontologies
  - current thrust focuses on *Description Logic Programs* as KR

Motivation from Semantic Web "Stack"



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

Motivation from DAML-Services

- Rule-based Semantic Web Services (RSWS)
- Application Scenarios
- For details, see the full Rules Report presentation by Benjamin Grosof from the DAML PI Meeting.

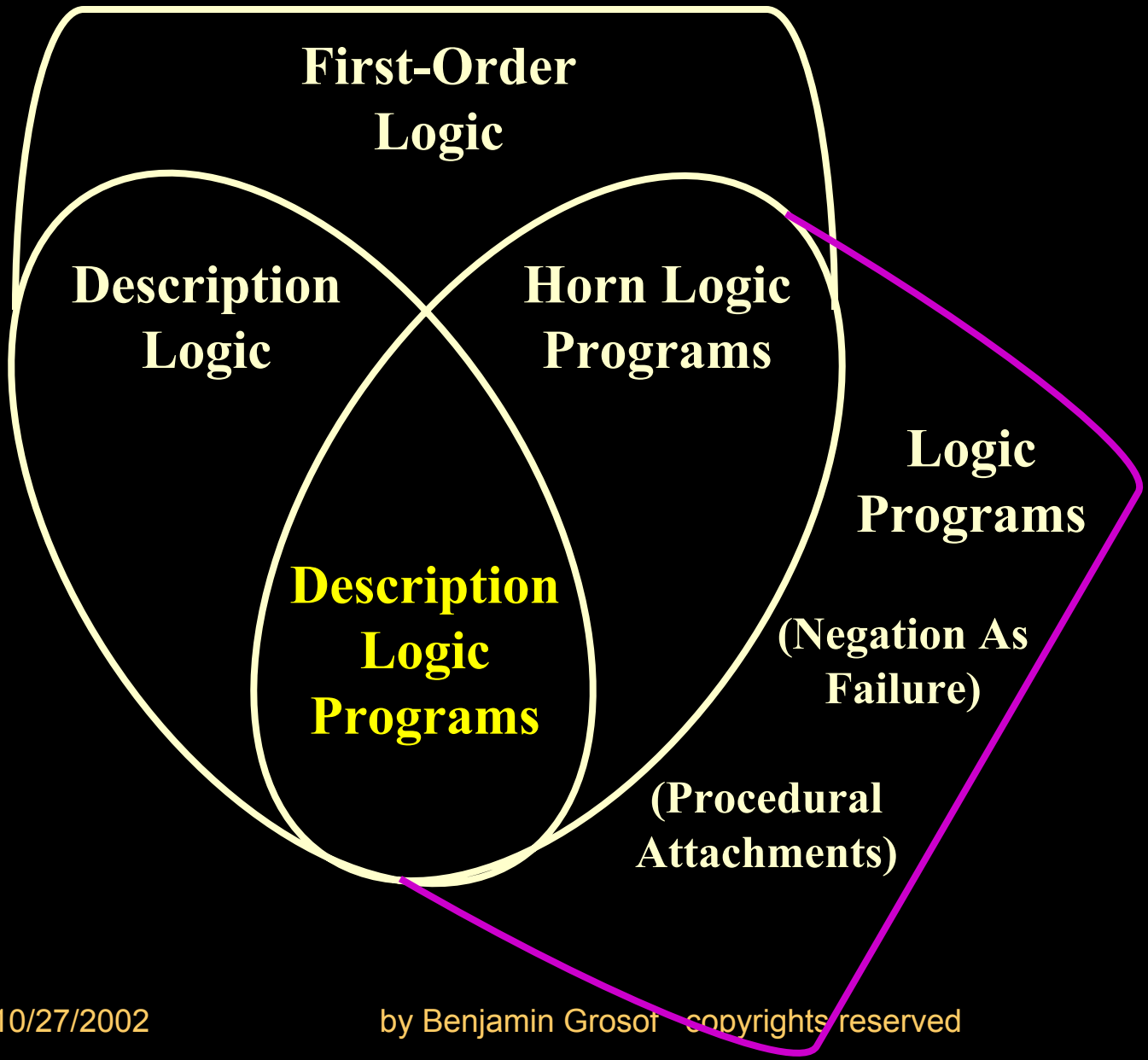
Description Logic Programs (DLP)

- Status: [Grosof & Horrocks 10/02] working paper, Joint Committee discussions, including early use cases.

- Goal: understand relationship between DL and LP/HornFOL as KR's
  - Insight: expressive intersection is also a key to expressive combination/union

- 1st step: expressive intersection of DL and Logic Programs = "Description Logic Programs" (or "Description Rules")

Venn Diagram: Expressive Overlaps among KR's



LP as a superset of DLP

- "Full" LP, including with non-monotonicity and procedural attachments, can thus be viewed as including an "ontology sub-language", namely the DLP subset of DL.

Candidate: First Order Logic

- FOL has practical and expressive drawbacks for union of DL and Rules:
  - Undecidable/Intractable
  - Lacks non-monotonicity and procedural attachments
  - Unfamiliar to mainstream software engineers
- Variant of DLP: "Horn Description Logic (HDL)"
  - Intersection of Horn Logic and Description Logic
  - Subset of FOL
- (general concept of "Description Rules": covers DLP or HDL)

Overview of DLP Features

- Essentially, DLP captures RDFS subset of DL -- plus a bit more.
- RDFS subset of DL permits the following statements:
  - Class C is Subclass of class D.
  - Domain of property P is class C.
  - Range restriction on property P is class D.
  - Property P is Subproperty of property Q.
  - a is an instance of class C.
  - (a,b) is an instance of property P.
- DLP also captures:
  - Using the Intersection connective (conjunction) in class descriptions
  - Stating that a property P is Transitive.
  - Stating that a property P is Symmetric.
- DLP can *partially* capture: most other DL features.
- Relevant technical issues in LP:
  - treatment of equality, e.g., uniqueness of names.

Examples of DL beyond DLP

- DLP is a *strict* subset of DL.
- Examples of DL that is not (completely) representable in DLP:
  - State a subclass of a complex class expression which is a disjunction. E.g.,
    - (Human $\cap$ Adult) $\subseteq$ (Man $\cup$ Woman)
  - State a subclass of a complex class expression which is an existential. E.g.,
    - Radio $\subseteq \exists$ hasPart.Tuner
- Why not? Because: LP/Horn, and thus DLP, cannot represent a disjunction or existential in the head.

Examples of LP beyond DLP

- DLP is a *strict* subset of Horn LP.
- Examples of Horn LP that are not (completely) representable in DLP:
  - A rule involving multiple variables. E.g.,
    - PotentialLoveInterestBetween(?X,?Y)
      ← Man(?X) /\ Woman(?Y).
  - Chaining (besides simple transitivity) to derive values of Properties. E.g.,
    - InvolvedIn(?Company, ?Industry)
      ← Subsidiary(?Company, ?Unit)
      /\ AreaOf(?Unit, ?Industry).
- Why not? Essentially because: Decidability of DLs crucially dependent on tree model property.
  - Intuition: DL's not used to represent "more than one free variable at a time".

Benefits: What DLP Enables, in Principle

- LP rules "on top of" DL ontologies.
- Translation of LP rules to/from DL ontologies.
- Use of efficient LP rule/DBMS engines for DL fragment.
- Development of ontologies in LP.
- Development of rules in DL.
- Translation of LP conclusions to DL.
- Translation of DL conclusions to LP.

Related Work to DLP

- CARIN [Halevy & Rousset 1998] on extending DL with some aspects of LP. Focus is on querying DL style KBs.
- [Antoniou 2002] on Defeasible Logic rules + Description Logic (variant) ontologies.