

Description Logic Programs: Overview for DAML and WebOnt

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Joint work with Ian Horrocks

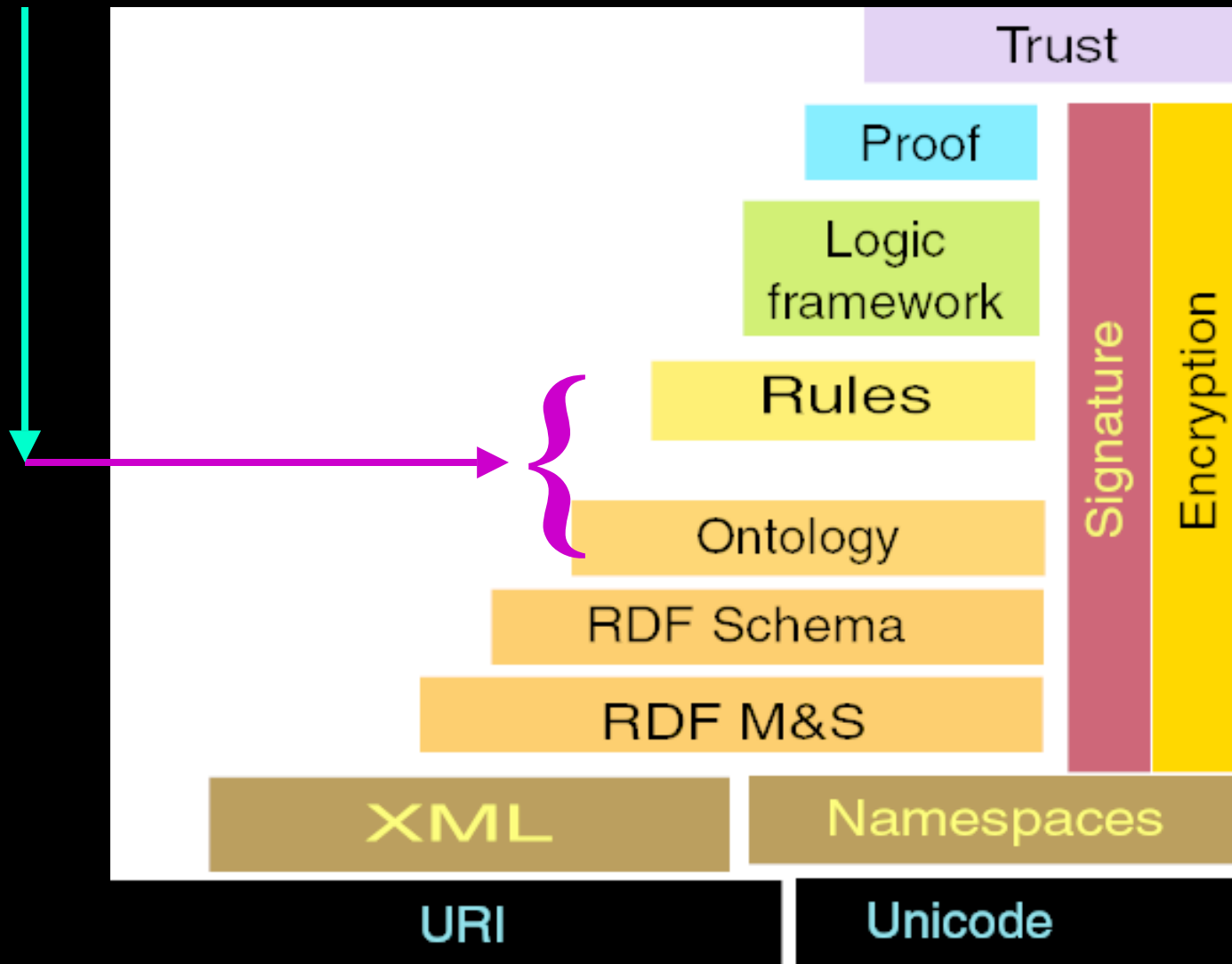
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Motivation from “DAML Rules” effort

- 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]

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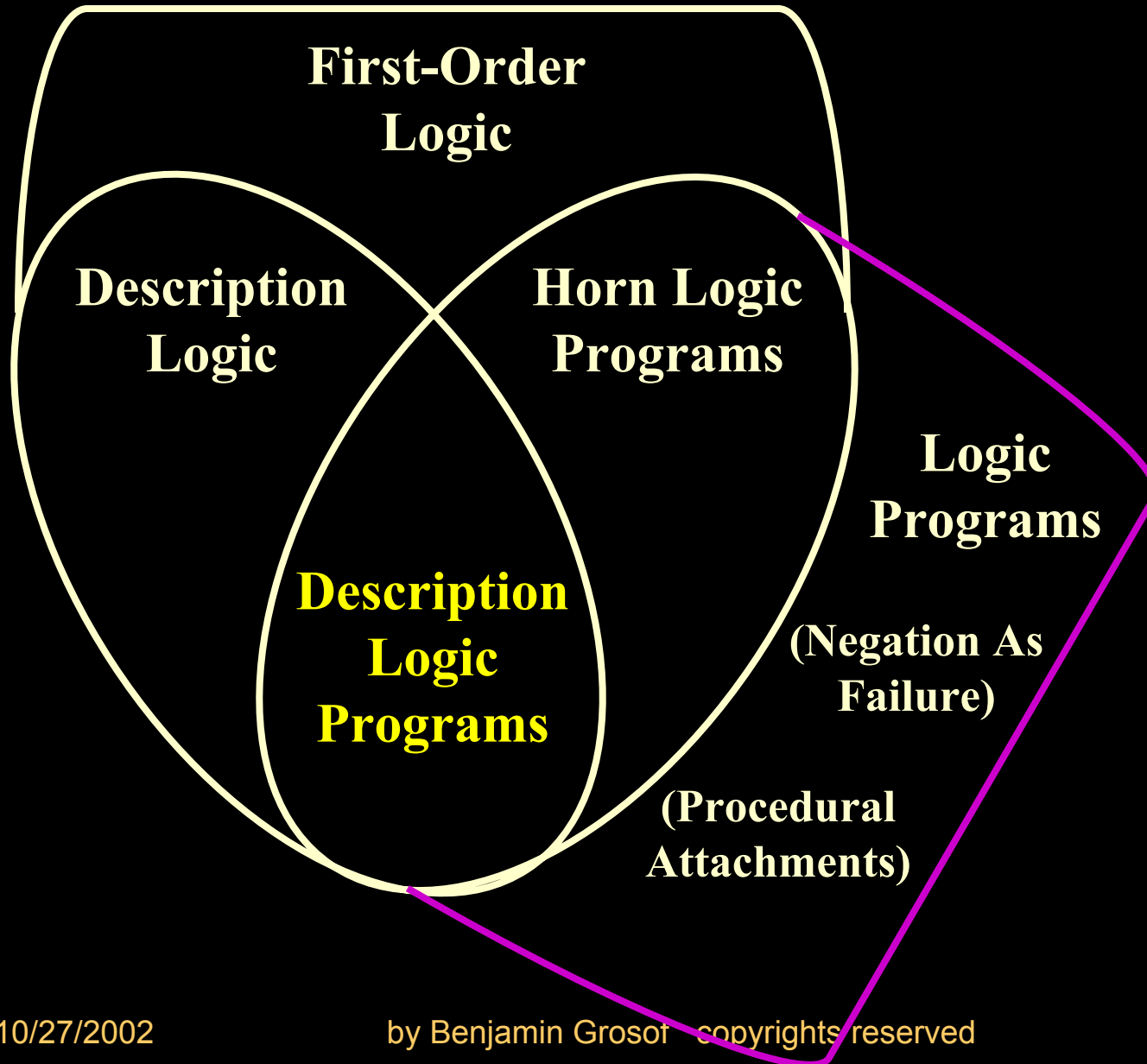
Motivation from DAML-Services

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

Description Logic Programs (DLP)

- Status: [Grosf & 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.,
 - $(\text{Human} \cap \text{Adult}) \subseteq (\text{Man} \cup \text{Woman})$
 - State a subclass of a complex class expression which is an existential. E.g.,
 - $\text{Radio} \subseteq \exists \text{ hasPart.Tuner}$
- 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.,
 - $\text{PotentialLoveInterestBetween}(?X, ?Y)$
 $\leftarrow \text{Man}(?X) \wedge \text{Woman}(?Y).$
 - Chaining (besides simple transitivity) to derive values of Properties. E.g.,
 - $\text{InvolvedIn}(?Company, ?Industry)$
 $\leftarrow \text{Subsidiary}(?Company, ?Unit)$
 $\wedge \text{AreaOf}(?Unit, ?Industry).$
- 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.