OPTIONAL SLIDES for:
DAML Rules Update and Issues

Slides on: SweetDeal e-contracting, Semantic Web Services (SWS),
and Description Logic Programs (DLP

Presentation for Rules Breakout sessions of DAML PI Meeting,
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Thanks to Mike Dean* and Stefan Decker for agenda suggestions.

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SweetDeal OPTIONAL SLIDES FOLLOW

Example Contract Proposal with Exception Handling
Represented using RuleML & DAML+OIL, Process Descriptions

```
buyer(co123,acme);
seller(co123,plastics_etc);
product(co123,plastic425);
price(co123,50);
quantity(co123,100);
```

Using concise text syntax

(SCLP textfile format)

for concise human reading

```
http://xmlcontracting.org/sd.daml#Contract(co123);
http://xmlcontracting.org/sd.daml#specFor(co123,co123_process);
http://xmlcontracting.org/sd.daml#BuyWithBilateralNegotiation(co123_process);
http://xmlcontracting.org/sd.daml#result(co123,co123_res);
shippingDate(co123,3); // i.e. 3 days after order placed
// base payment = price * quantity
payment(?R,base,?Payment) <-
   http://xmlcontracting.org/sd.daml#result(co123,?R) AND
   price(co123,?P) AND quantity(co123,?Q) AND
   multiply(?P,?Q,?Payment) ;
```

by Benjamin Grosof

SCLP TextFile Format for (Daml)RuleML

```
payment(?R,base,?Payment) <-
http://xmlcontracting.org/sd.daml#result(co123,?R) AND
price(co123,?P) AND quantity(co123,?Q) AND
multiply(?P,?Q,?Payment) ;
```

```
<drm:imp>
  <drm:_head> <drm:atom>
    <drm:_opr><drm:rel>payment</drm:_opr></drm:rel>     <drm:tup>
    <drm:var>R</drm:var> <drm:ind>base</drm:ind> <drm:var>Payment</drm:var>
  </drm:tup></drm:atom> </drm:_head>
  <drm:_body>
   <drm:andb>
    <drm:atom> <drm:_opr>

      <drm:rel href= "http://xmlcontracting.org/sd.daml#result"/>
       </drm:_opr> <drm:tup>
        <drm:ind>co123</drm:ind> <drm:var>Cust</drm:var>
       </drm:tup> </drm:atom>

... </drm:andb> </drm:_body>  </drm:imp>
```

drm = namespace for damlRuleML

Example Contract Proposal, Continued: lateDeliveryPenalty exception handler module

```
lateDeliveryPenalty_module {
// lateDeliveryPenalty is an instance of PenalizeForContingency
//    (and thus of AvoidException, ExceptionHandler, and Process)
http://xmlcontracting.org/pr.daml#PenalizeForContingency(lateDeliveryPenalty) ;
// lateDeliveryPenalty is intended to avoid exceptions of class
// LateDelivery.
http://xmlcontracting.org/sd.daml#avoidsException(lateDeliveryPenalty,
  http://xmlcontracting.org/pr.daml#LateDelivery);

// penalty = - overdueDays * 200 ; (negative payment by buyer)

<lateDeliveryPenalty_def> payment(?R, contingentPenalty, ?Penalty) <-
  http://xmlcontracting.org/sd.daml#specFor(?CO,?PI) AND
  http://xmlcontracting.org/pr.daml#hasException(?PI,?EI) AND

  http://xmlcontracting.org/pr.daml#isHandledBy(?EI,lateDeliveryPenalty) AND
  http://xmlcontracting.org/sd.daml#result(?CO,?R) AND

  http://xmlcontracting.org/sd.daml#exceptionOccurred(?R,?EI) AND
  shippingDate(?CO,?CODate) AND shippingDate(?R,?RDate) AND

  subtract(?RDate,?CODate,?OverdueDays) AND

  multiply(?OverdueDays, 200, ?Res1) AND multiply(?Res1, -1, ?Penalty) ;
}
<lateDeliveryPenaltyHandlesIt(e1)> // specify lateDeliveryPenalty as a handler for e1
 http://xmlcontracting.org/pr.daml#isHandledBy(e1,lateDeliveryPenalty);
```
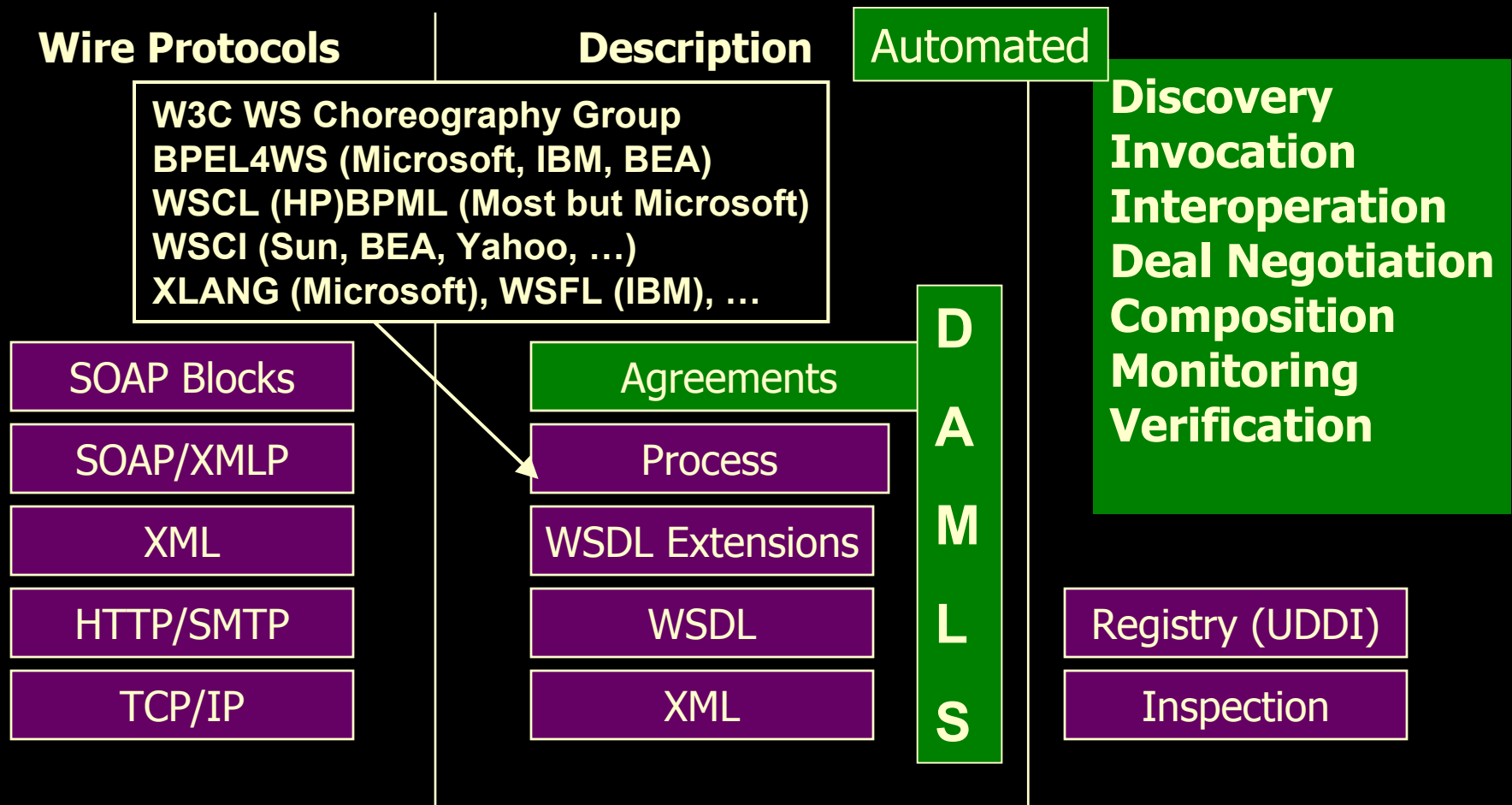
END of SweetDeal OPTIONAL SLIDES

SWS OPTIONAL SLIDES FOLLOW

Semantic Web Services

- Convergence of Semantic Web and Web Services
- Consensus definition and conceptualization still forming
- Semantic (Web Services):
  - Knowledge-based service descriptions, deals
    - Discovery/search, invocation, negotiation, selection, composition, execution, monitoring, verification
  - Integrated knowledge
- (Semantic Web) Services: e.g., infrastructural
  - Knowledge/info/DB integration
  - Inferencing and translation

Current Web Services Standards Stack; Context for Semantic Web Services

Wire Protocols   **Description**   Automated

W3C WS Choreography Group
BPEL4WS (Microsoft, IBM, BEA)
WSCL (HP)BPML (Most but Microsoft)
WSCI (Sun, BEA, Yahoo, …)
XLANG (Microsoft), WSFL (IBM), …

Discovery
Invocation
Interoperation
Deal Negotiation
Composition
Monitoring
Verification

Wire Protocols	Description	DAMLS
SOAP Blocks	Agreements	D
SOAP/XMLP	Process	A
XML	WSDL Extensions	M
HTTP/SMTP	WSDL	L
TCP/IP	XML	S

Registry (UDDI)

Inspection

[Slide co-authors: Sheila McIlraith (Stanford) , David Martin (SRI International), James Snell (IBM)]

SWS Tasks at higher layers of WS stack

Automation of:

- Web service <u>discovery</u>
  Find me a shipping service that will transport frozen vegetables from San Francisco to Tuktoyuktuk.

- Web service <u>invocation</u>
  Buy me "Harry Potter and the Philosopher's Stone" at <u>www.amazon.com</u>

- Web service <u>deals</u>, i.e., contracts, and their <u>negotiation</u>
  Propose a price with shipping details for used Dell laptops to Sue Smith.

- Web service <u>selection</u>, <u>composition</u> and <u>interoperation</u>
  Make the travel arrangements for my WWW11 conference.

[Modification of slide also by Sheila McIlraith (Stanford) and David Martin (SRI International)]

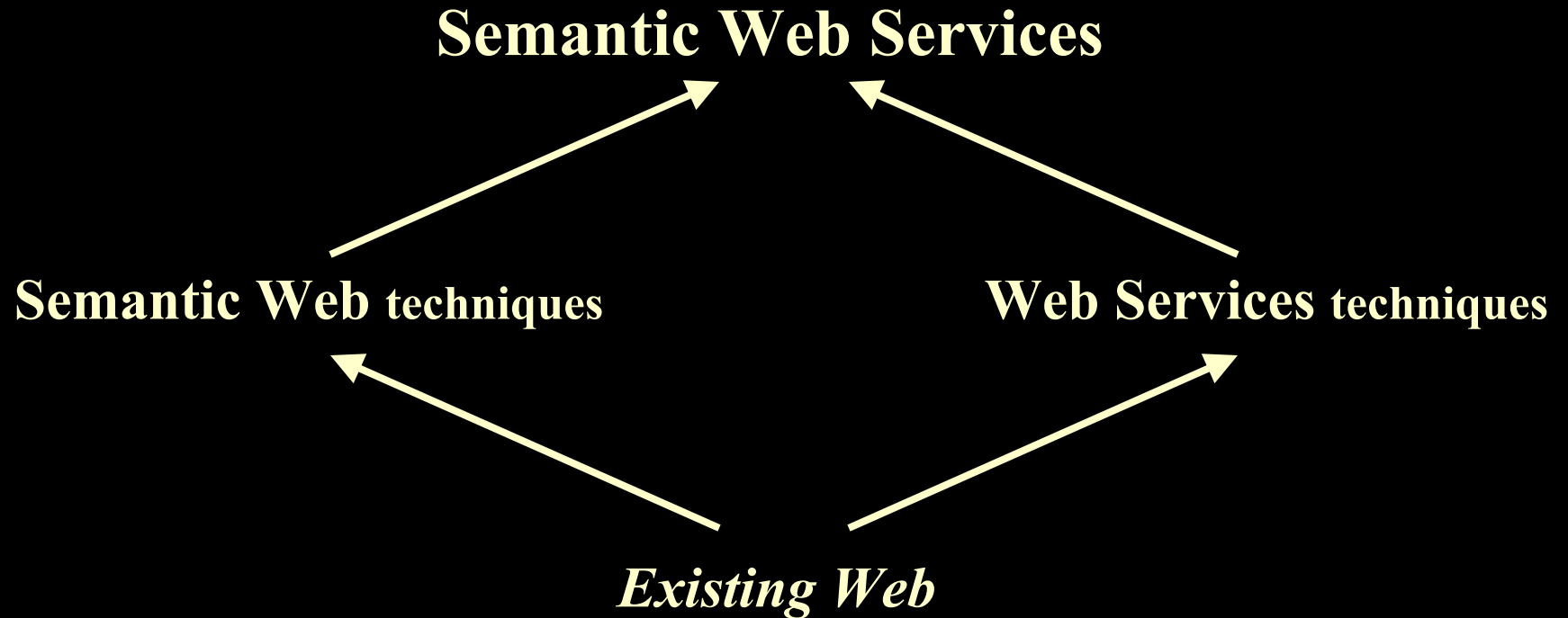# *SWS Tasks at higher layers of WS stack, continued*

- Web service <u>execution monitoring</u> and <u>problem resolution</u>
  Has my book been shipped yet? … [NO!] Obtain recourse.

- Web service <u>simulation</u> and <u>verification</u>
  Suppose we had to cancel the order after 2 days?

- Web service <u>executably specified at "knowledge level"</u>
  The service is performed by running the contract ruleset through a rule engine.

[Modification of slide also by Sheila McIlraith (Stanford) and David Martin (SRI International)]
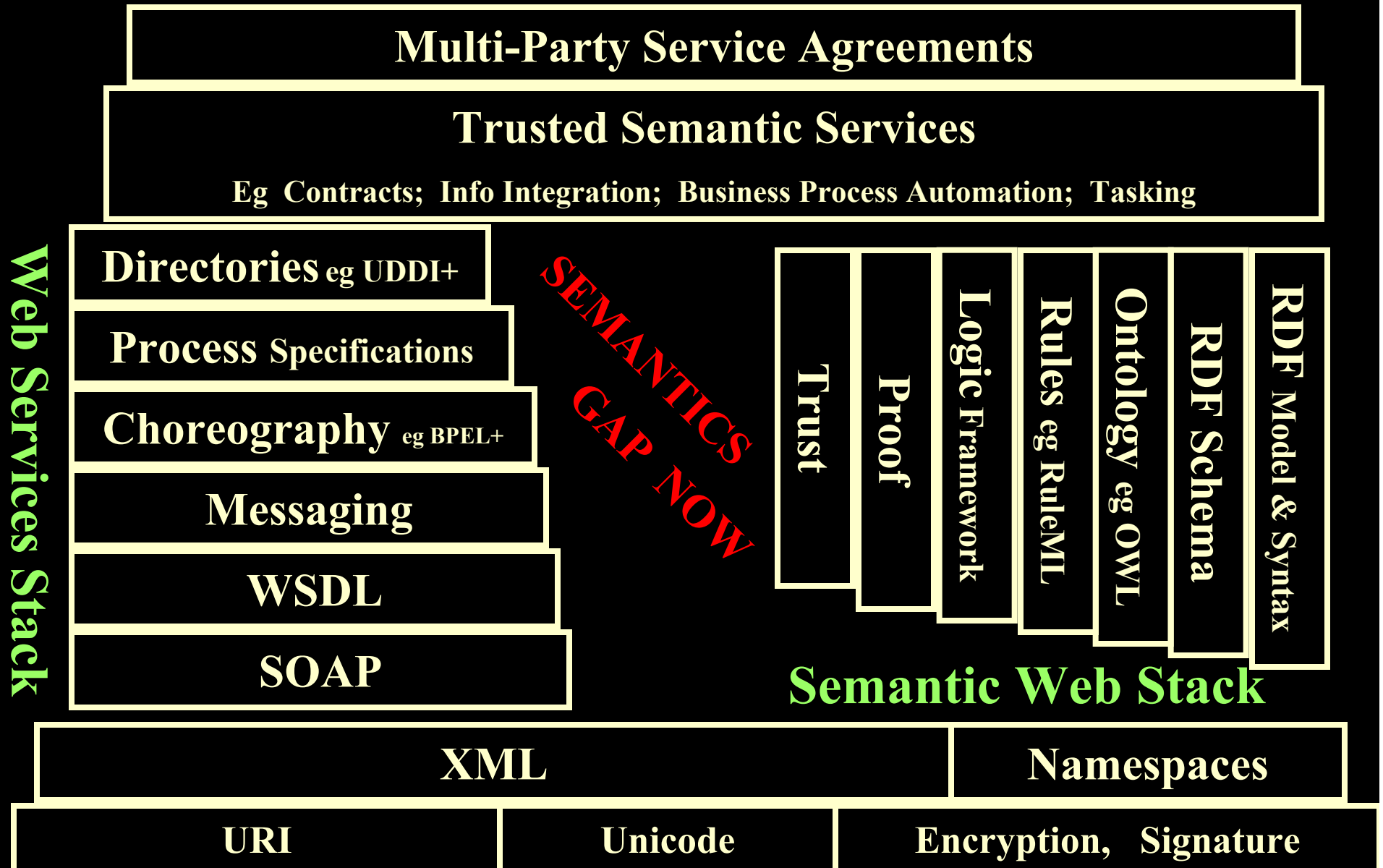
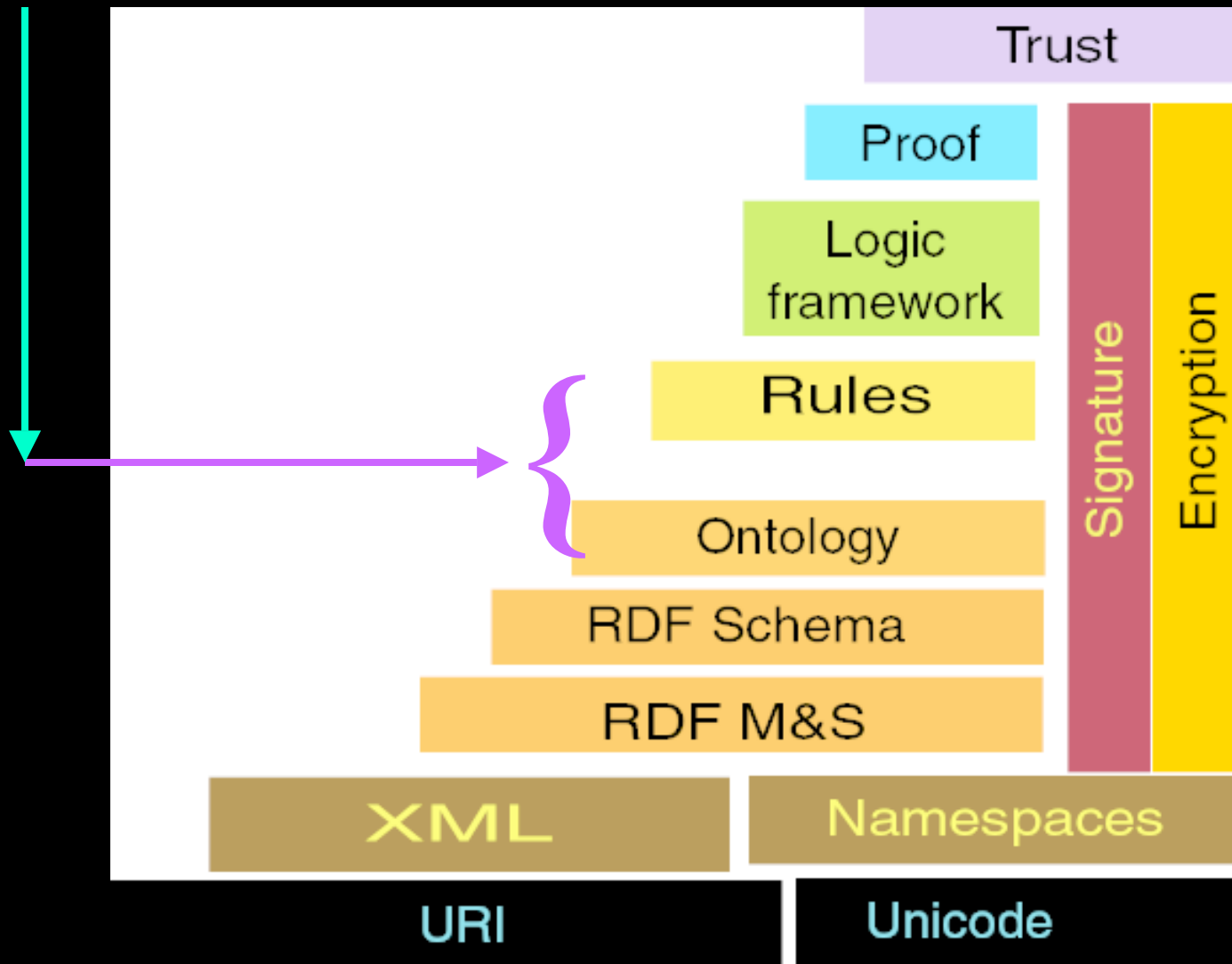4/14/2003   by Benjamin Grosof   copyrights reserved

Next Generation Web

Semantic Web Services

Semantic Web techniques   **Web Services techniques**

Existing Web

Semantic Web Services   Stack Diagram

Multi-Party Service Agreements

Trusted Semantic Services

Eg Contracts; Info Integration; Business Process Automation; Tasking

Web Services Stack

Directories eg UDDI+

Process Specifications

Choreography eg BPEL+

Messaging

WSDL

SOAP

SEMANTICS GAP NOW

Trust

Proof

Logic Framework

Rules eg RuleML

Ontology eg OWL

RDF Schema

RDF Model & Syntax

Semantic Web Stack

XML

Namespaces

URI

Unicode

Encryption, Signature

Motivation from Semantic Web "Stack"

END of SWS OPTIONAL SLIDES

by Benjamin Grosof

DLP OPTIONAL SLIDES FOLLOW

Candidate: First Order Logic

- FOL has practical and expressive drawbacks for <u>union</u> of DL and Rules:
  - 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)

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 $\subseteq$ $\exists$ hasSpeaker.Tuner

- Why not? Because: LP/Horn, and thus DLP, cannot represent a "disjunction 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)
            $$\leftarrow \text{Man(?X)} \wedge \text{Woman(?Y)}.$$
    - Chaining <small>(besides simple transitivity)</small> to derive values of Properties. E.g.,
        - 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.

DL Task Scenarios / Use Cases -- how well do they map to Rules?

- 1. Infer Categorization

  – Rules appear to often handle this well.

- 2. Infer Subsumptions

  – Rules appear to often be more awkward.

- 3. Configuration: seems to involve both categorization and subsumption.

Related Work to DLP

- CARIN [Halevy et al, late 90's] on extending DL with some aspects of LP. For DL-ish tasks.

- [Antoniou 2002] on Defeasible Logic rules + Description Logic (variant) ontologies

Some additional Bibliography

- Antoniou, Grigoris. "A Nonmonotonic Rule System using Ontologies". Proc. Intl. Wksh. On Rule Markup Languages for Business Rules on the Semantic Web, held 6/02 at the 1st Intl. Semantic Web Conf. (ISWC-2002).

- Firat, Aykut and Madnick, Stuart, and Grosof, Benjamin. "Knowledge Integration to Overcome Ontological Heterogeneity: Challenges from Financial Information Systems". Proc. Intl. Conf. on Information Systems (ICIS), 12/02.

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- Grosof, Benjamin. "Representing E-Business Rules for the Semantic Web: Situated Courteous Logic Programs in RuleML". Proc. Wksh on Information Technologies and Systems (WITS-01), held 2001 at the Intl. Conf. on Information Systems (ICIS). *Describes SweetRules tool as well as RuleML.*

- Grosof, Benjamin, Horrocks, Ian, Volz, Raphael, and Decker, Stefan. "Description Logic Programs: Combining Logic Programs with Description Logic". Proc. Intl. Conf. on World Wide Web (WWW-2003), held 5/03, Budapest.

Some additional Bibliography, cont.'d

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- Levy, Alon and Rousset, Marie-Christine. "CARIN: A Representation combining Horn Rules and Description Logic." *Artificial Intelligence* 104(1-2), 1998. (Note: Alon has since changed his surname to "Halevy".)

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