Standardization of Ontologies

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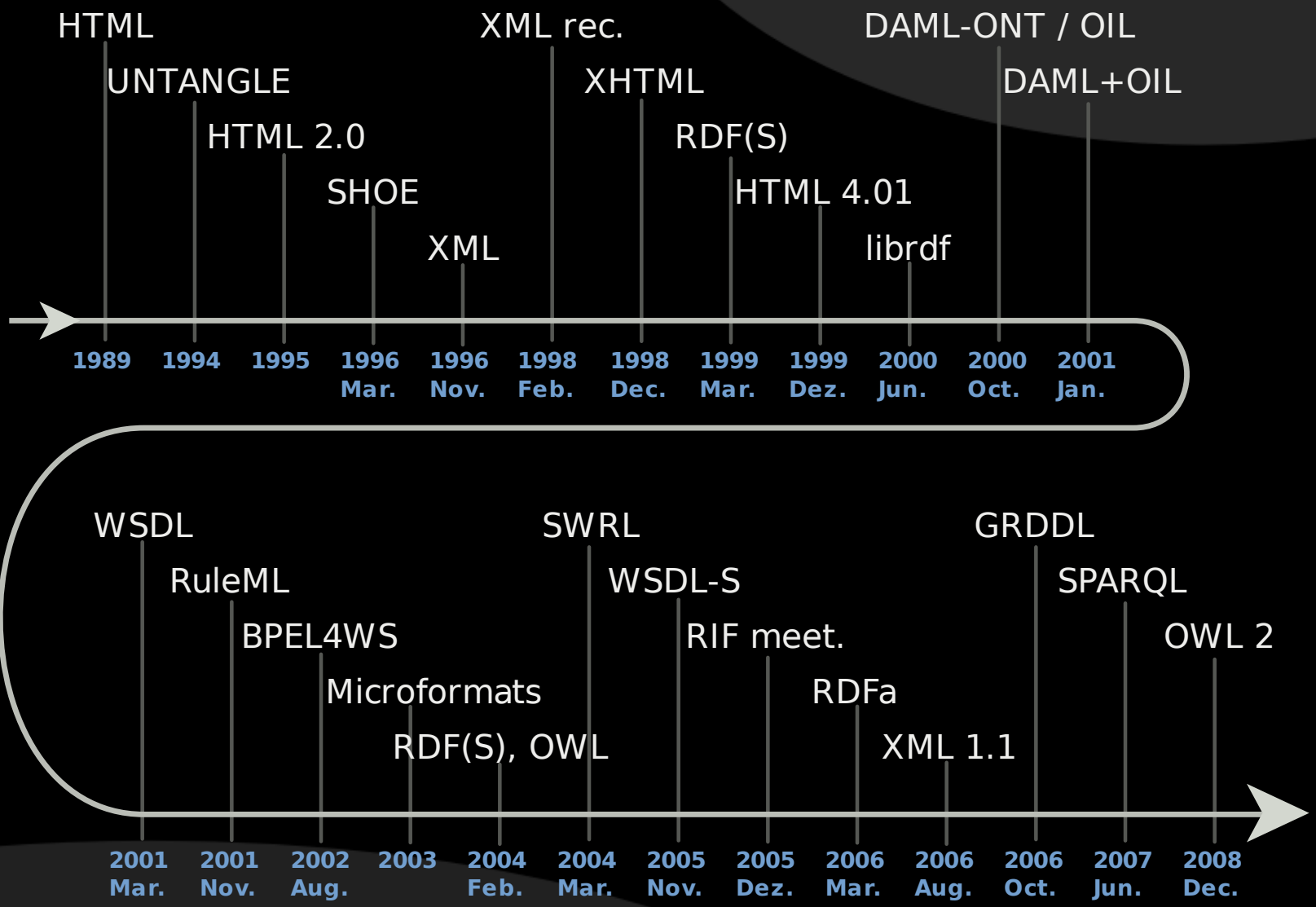
Outline

History

Related technologies

Ontology development

General history



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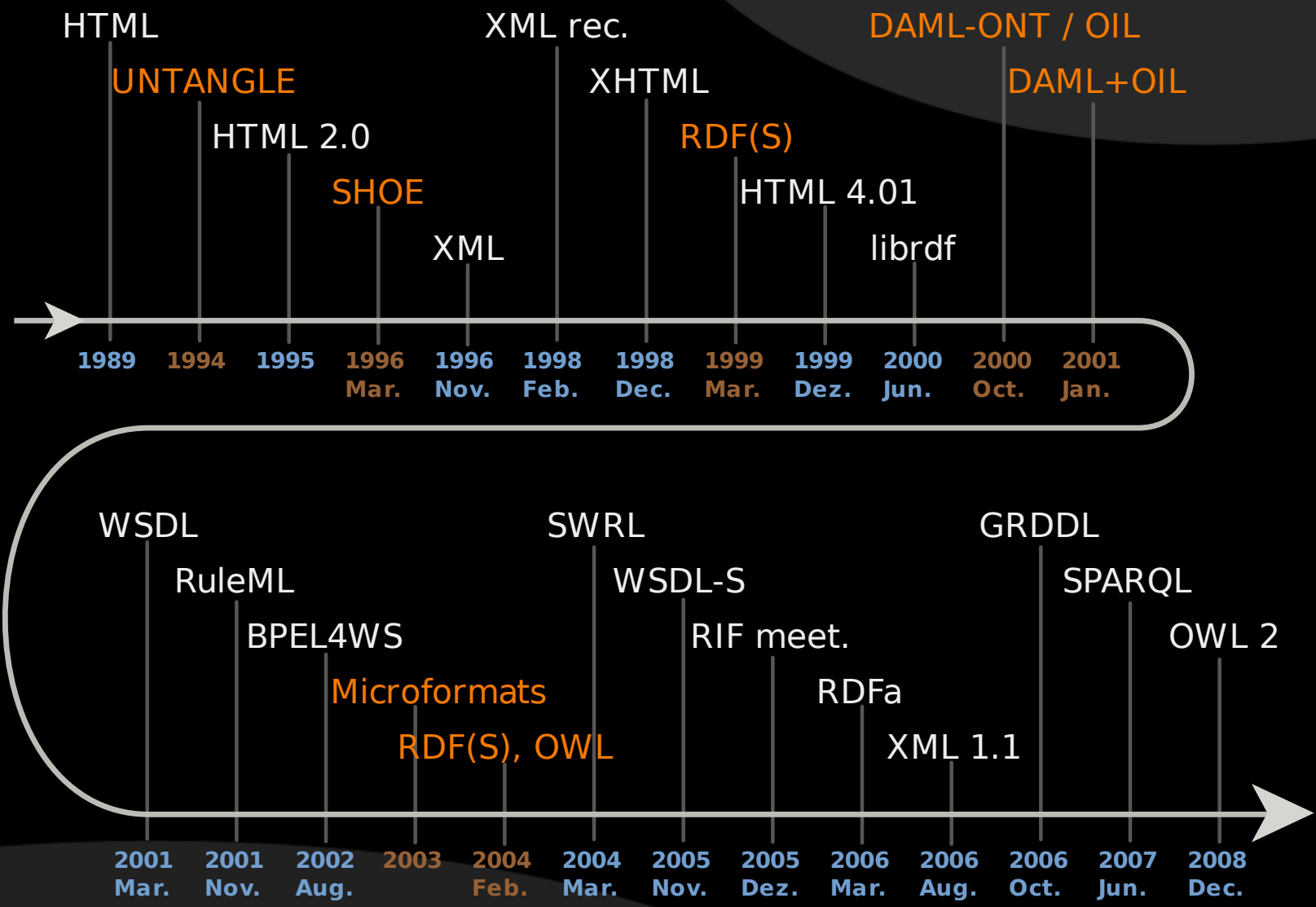

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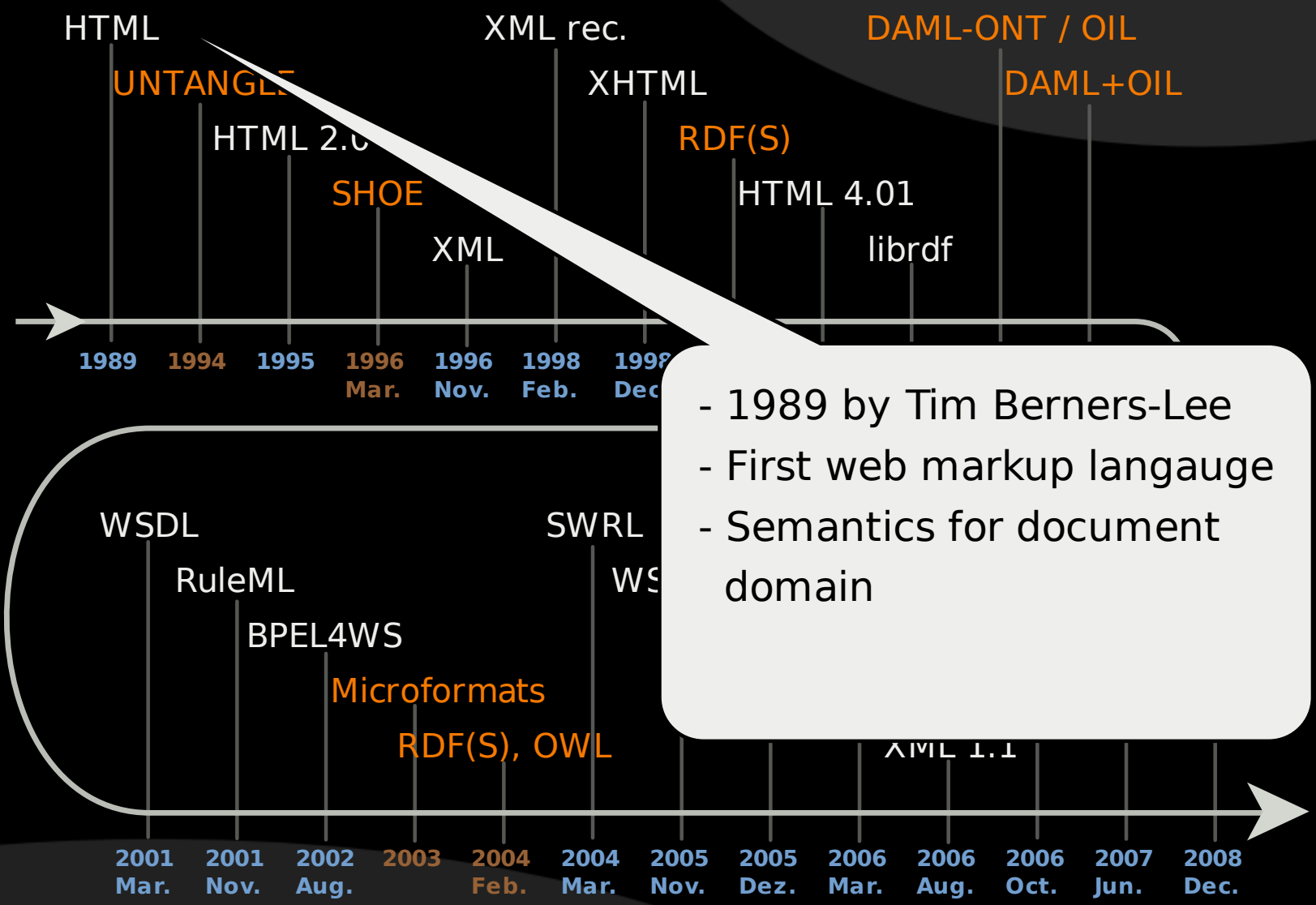

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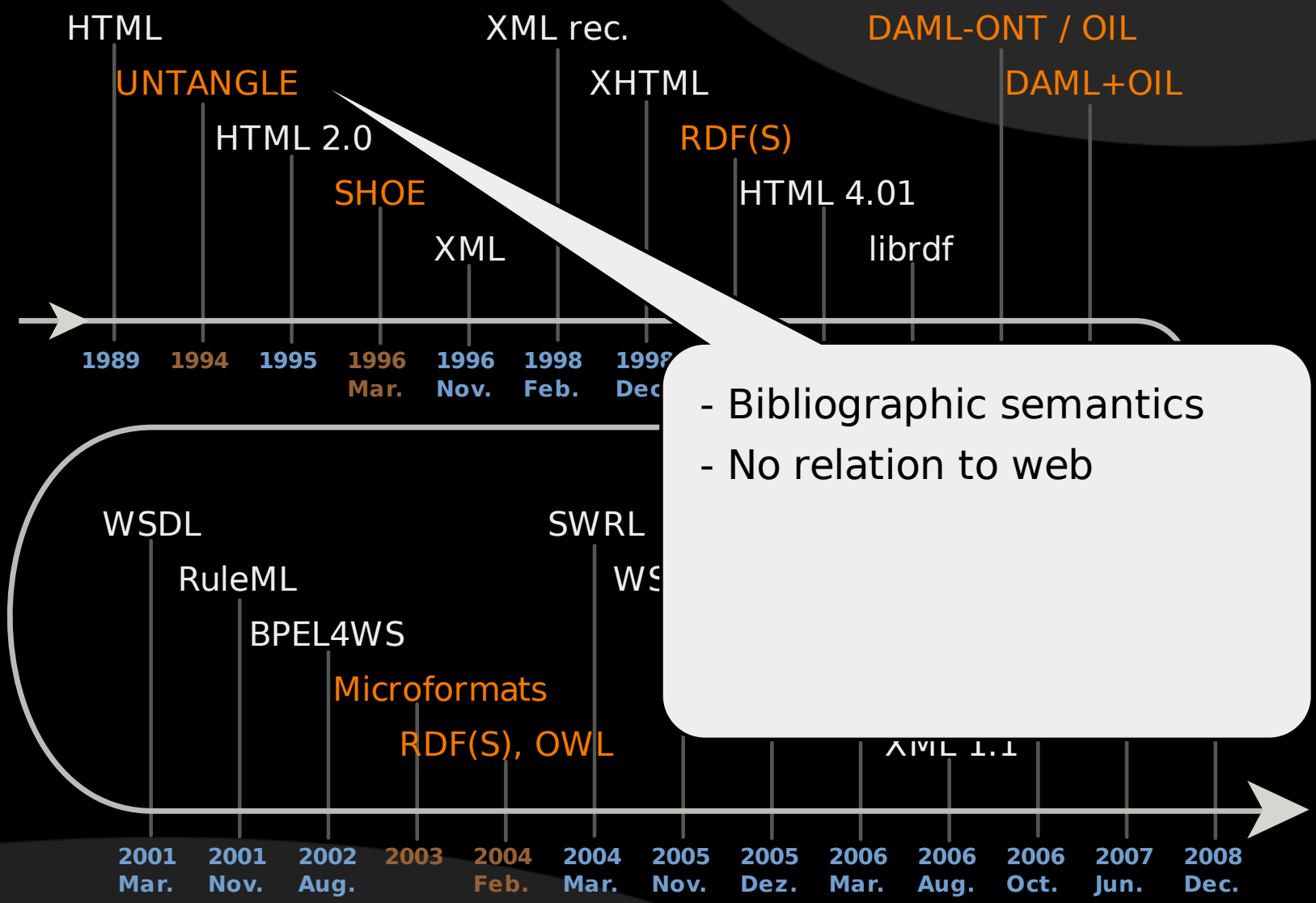

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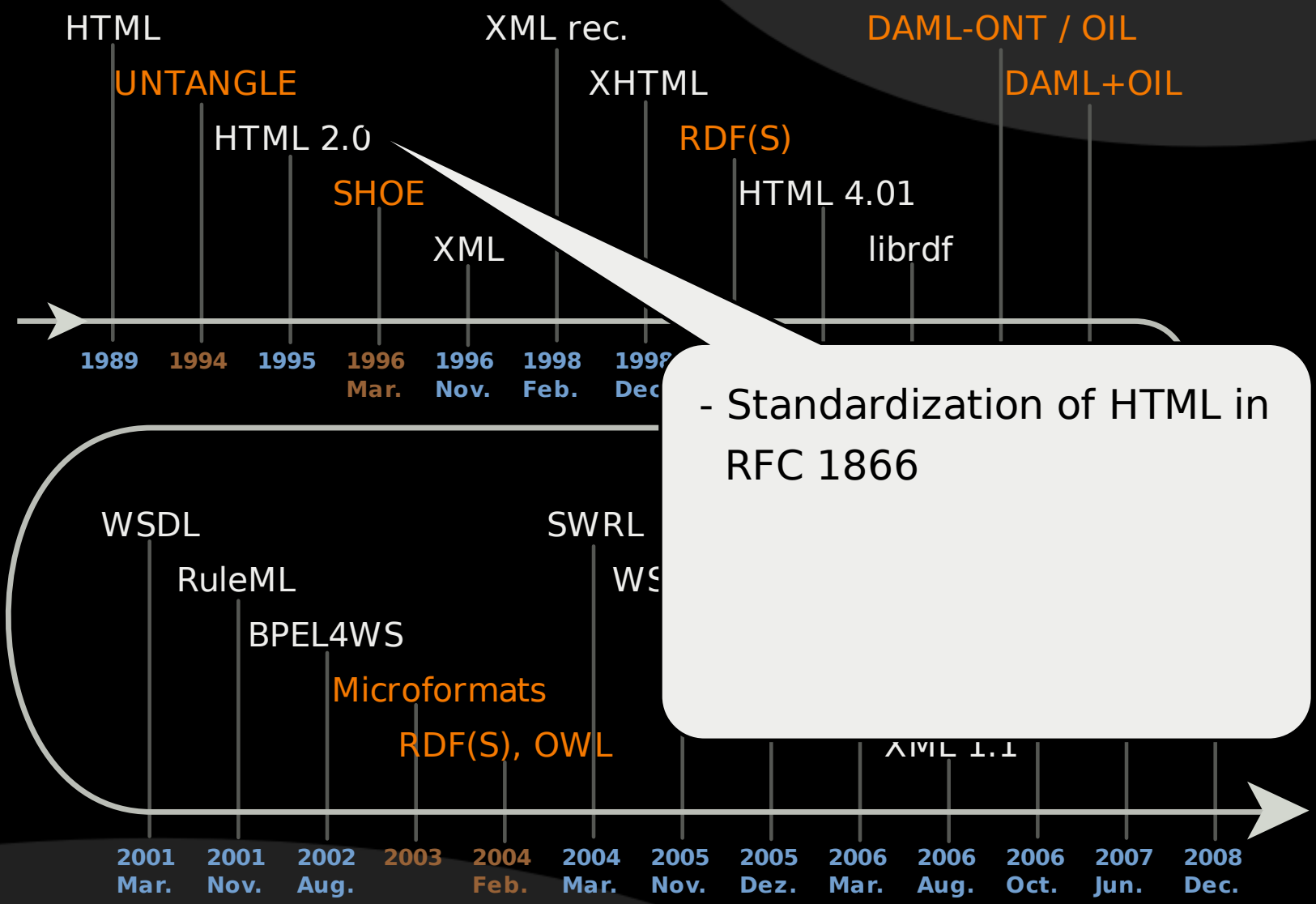

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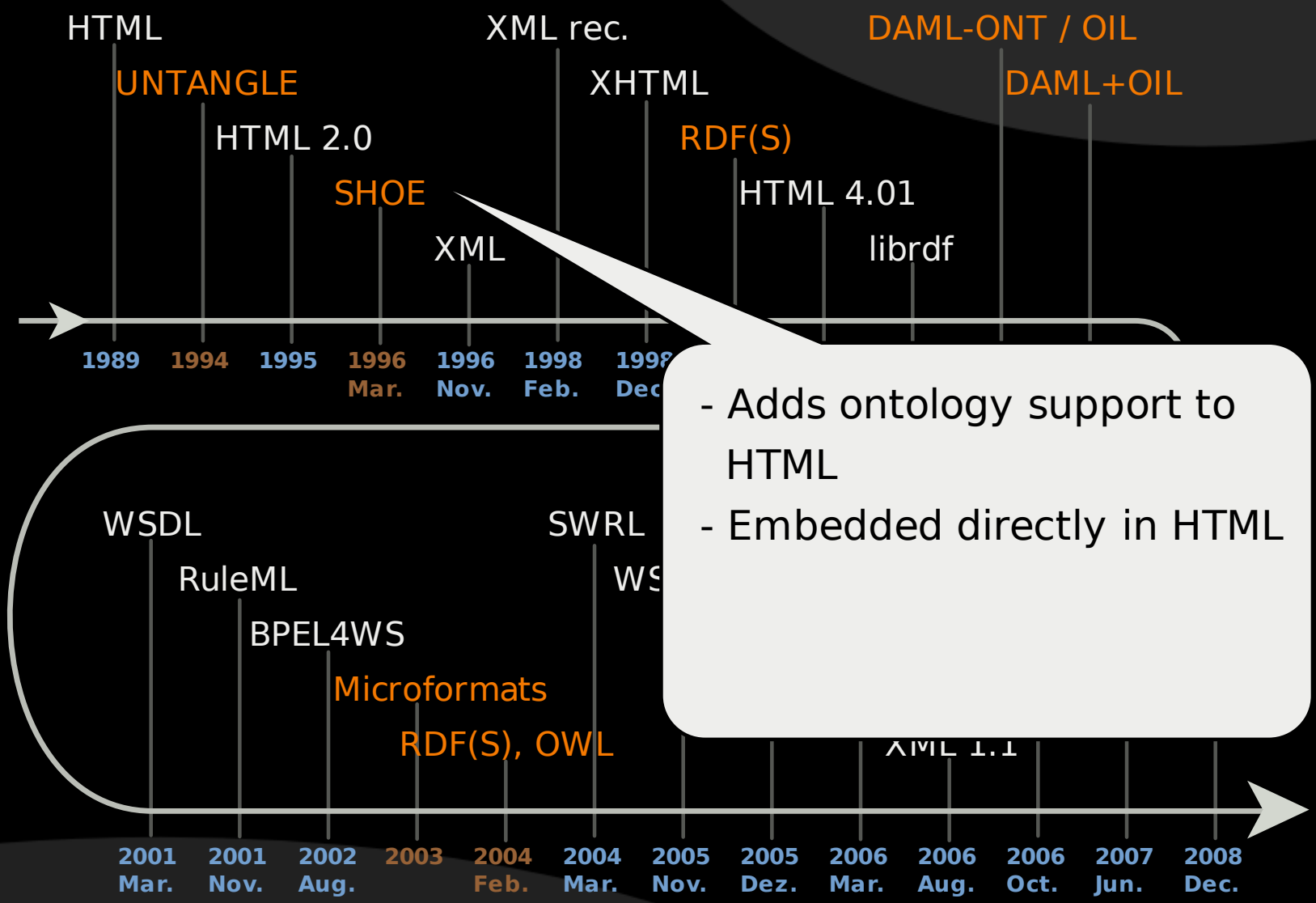

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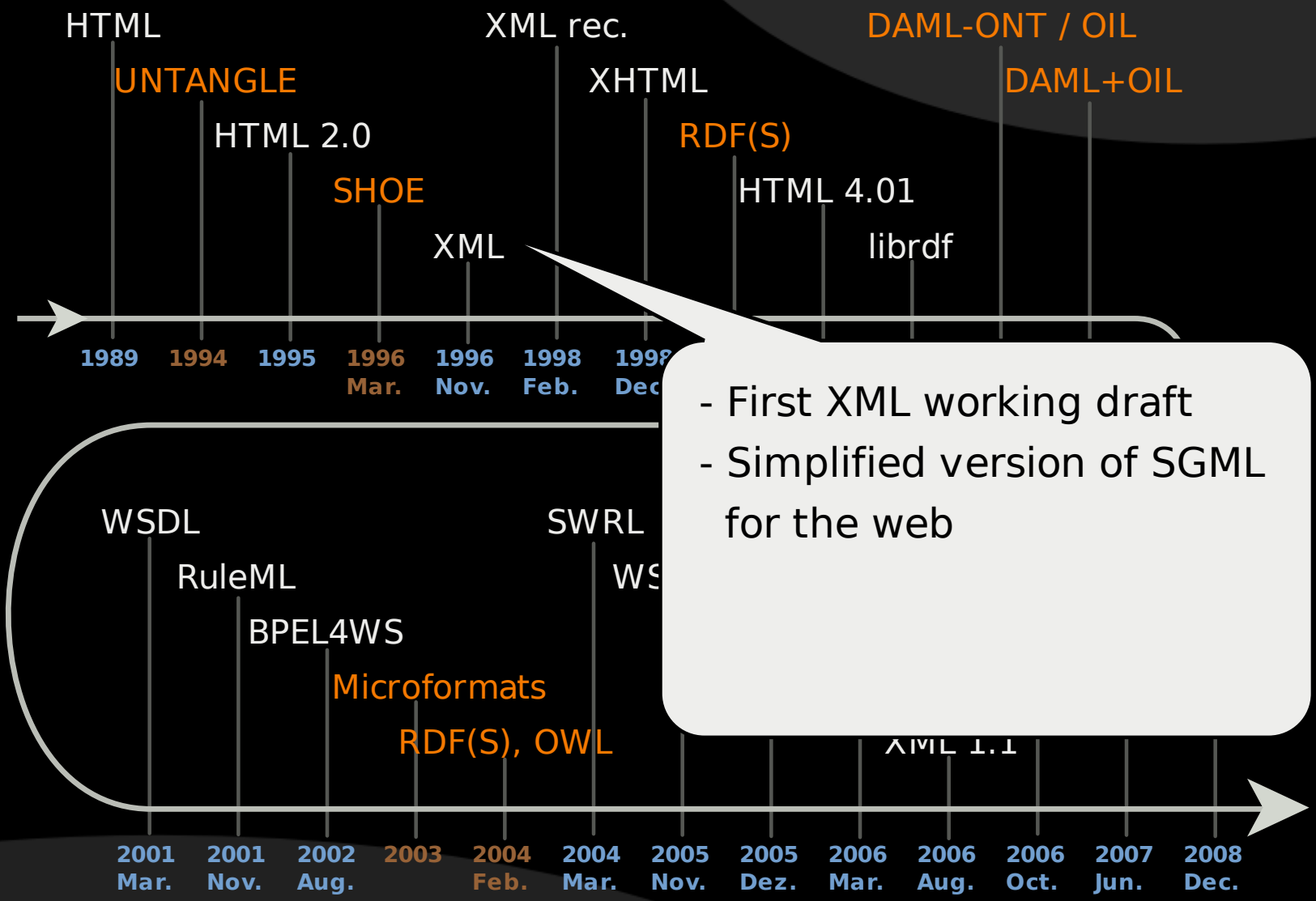

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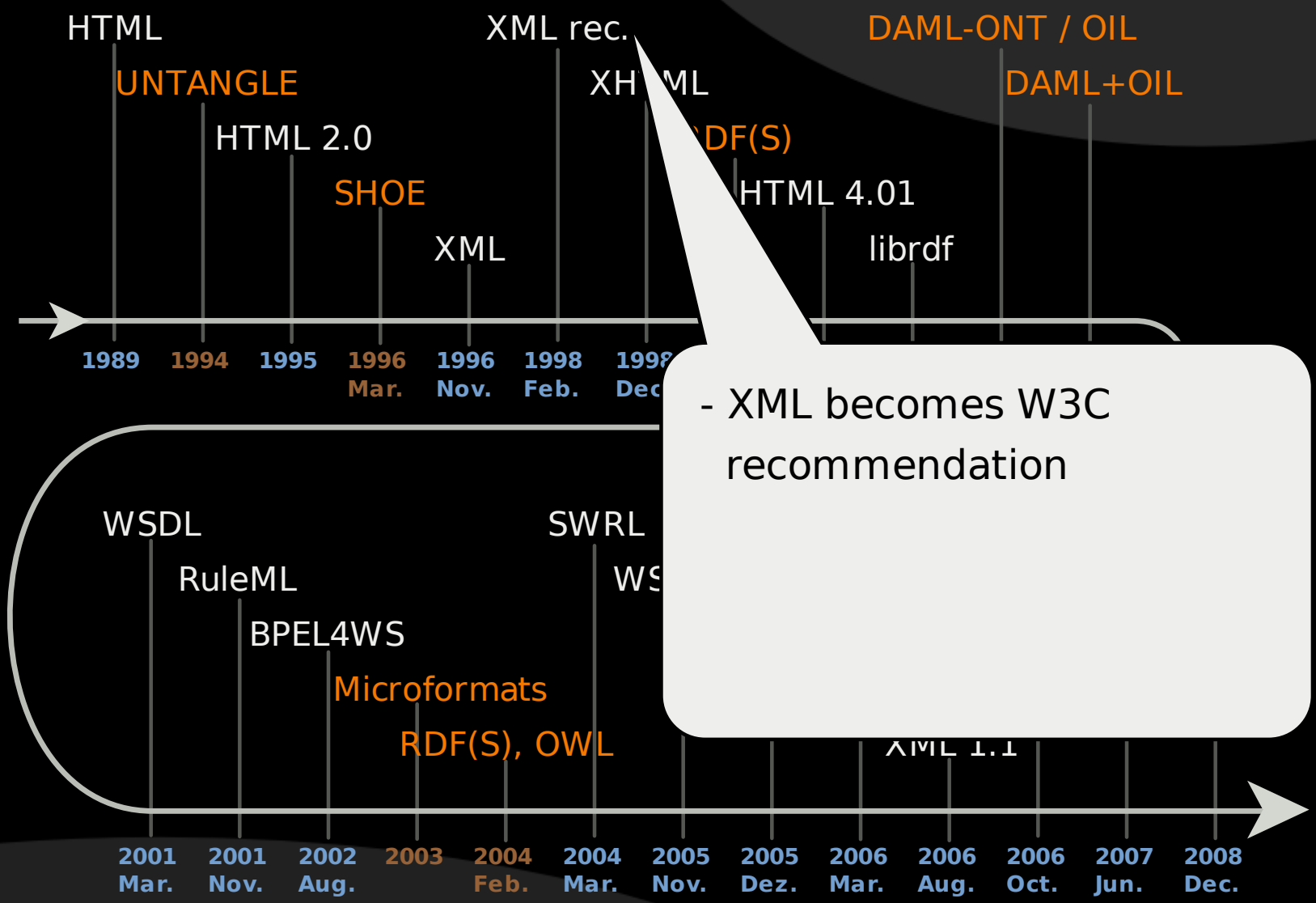

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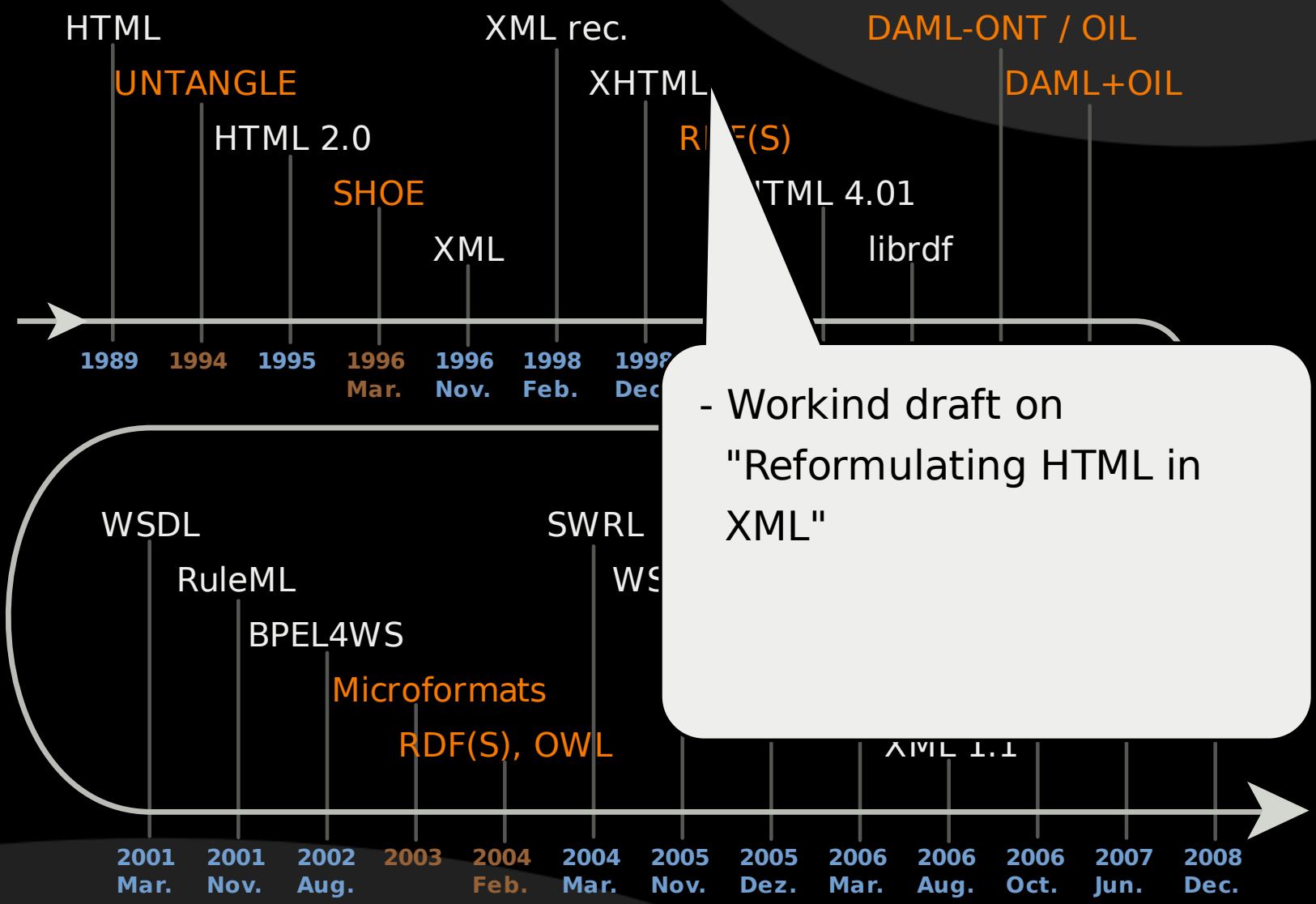

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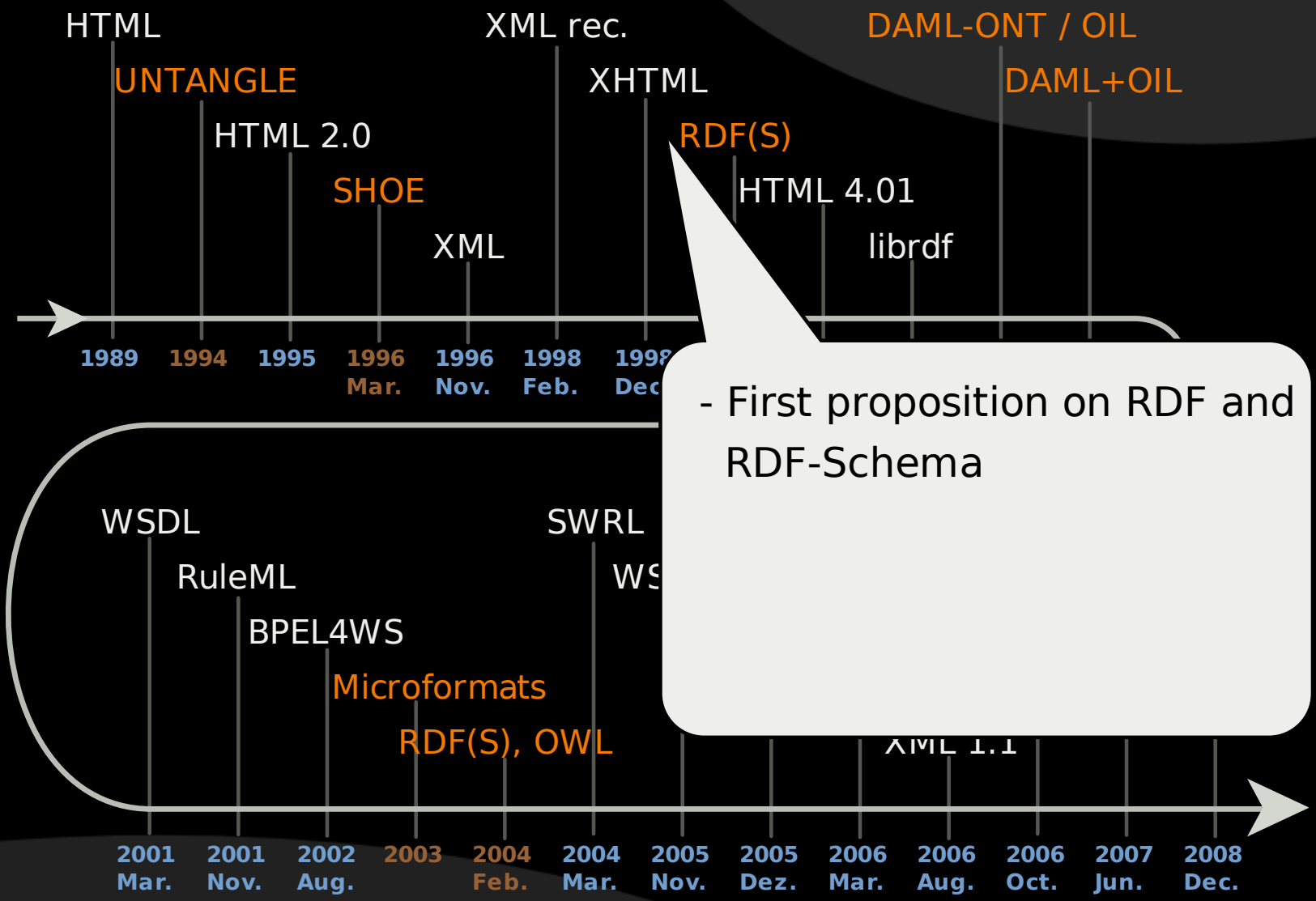

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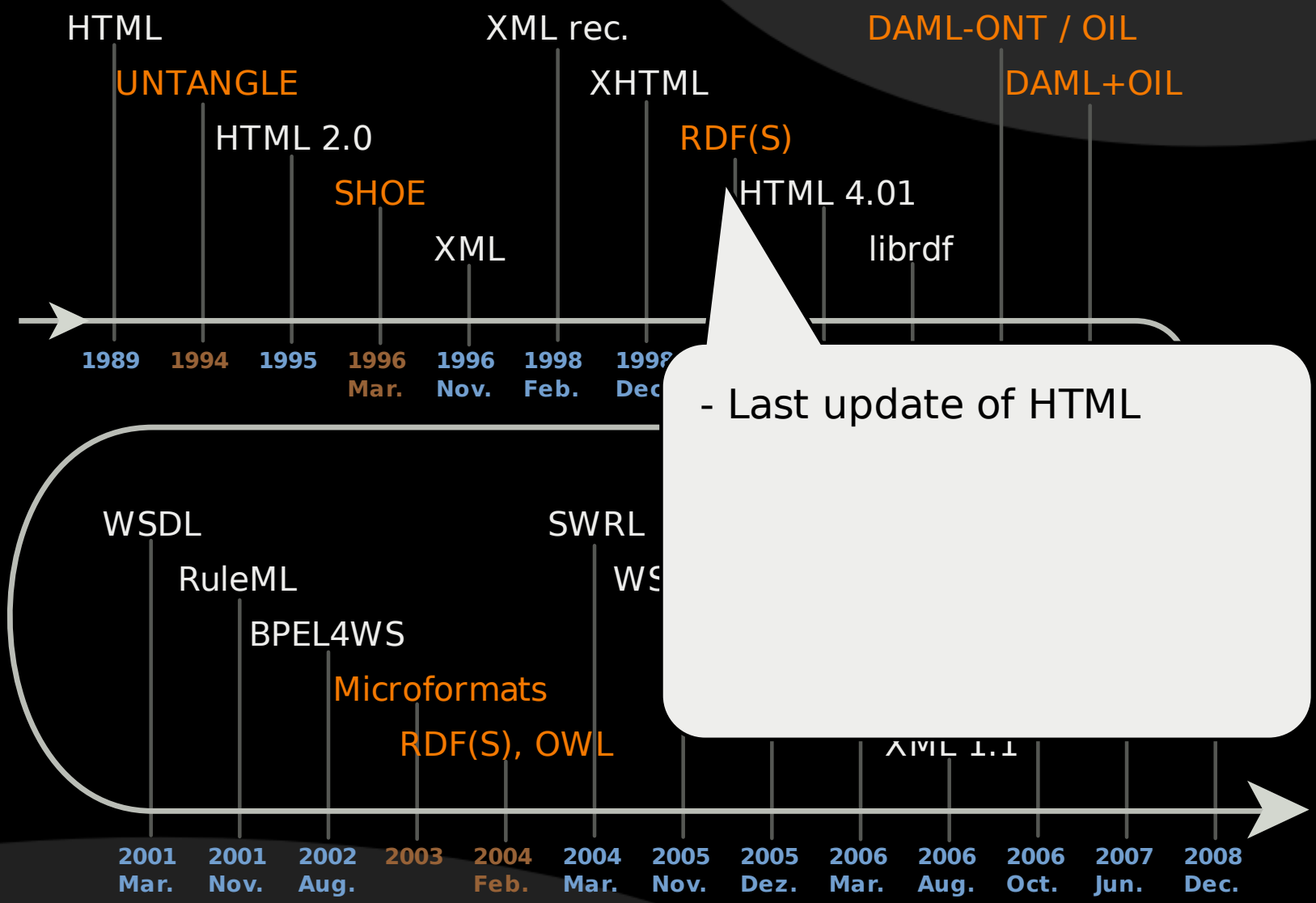

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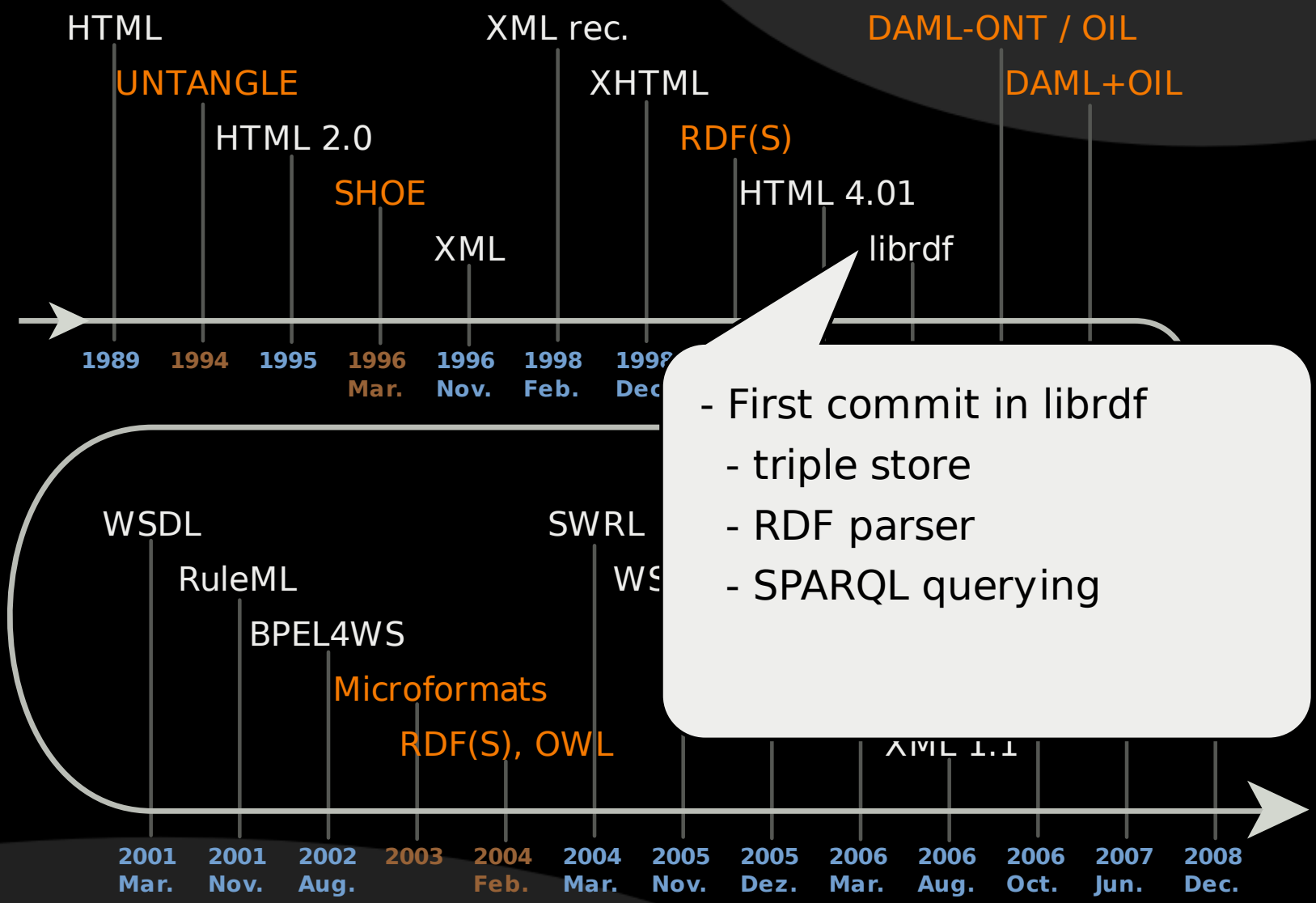

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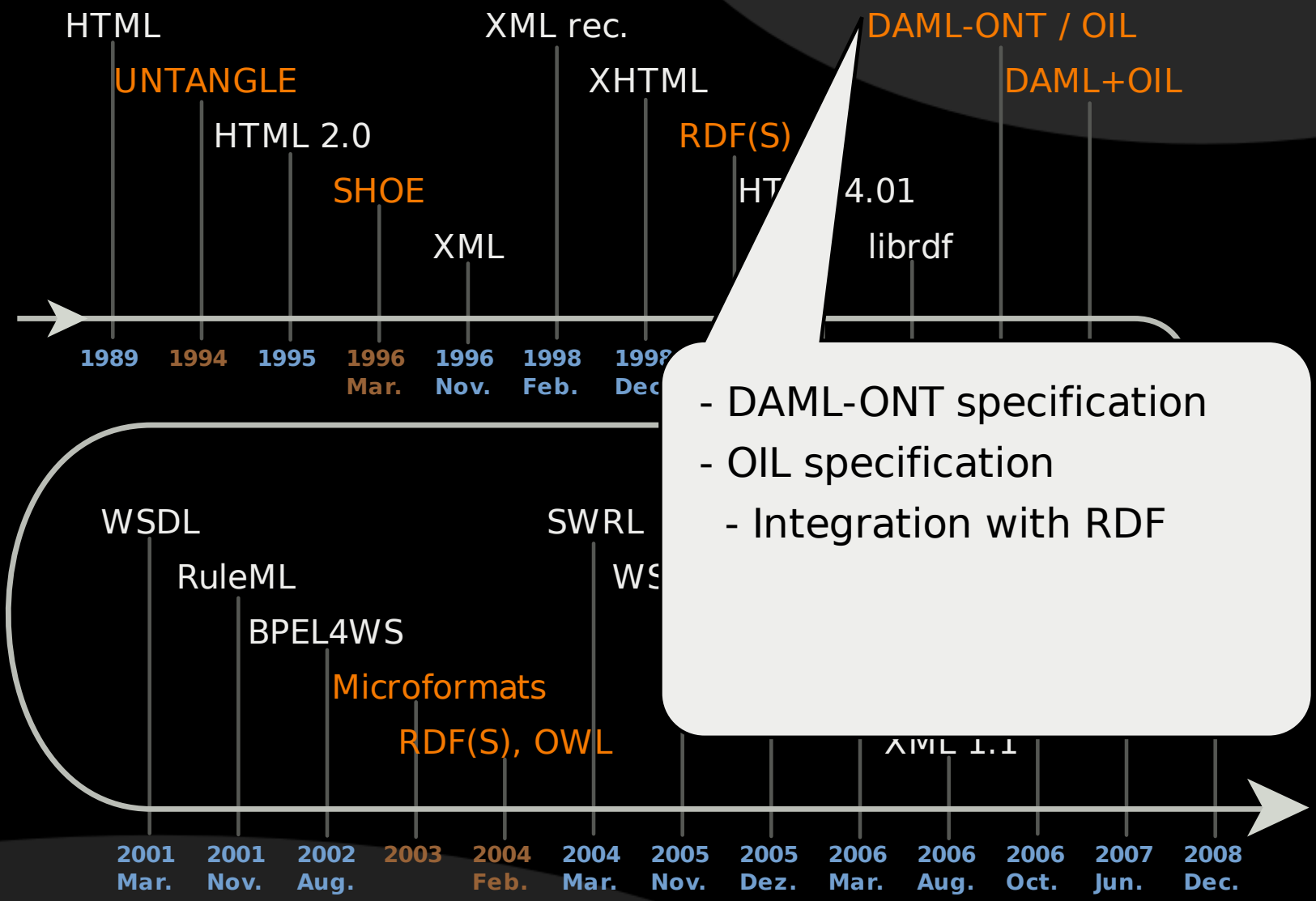

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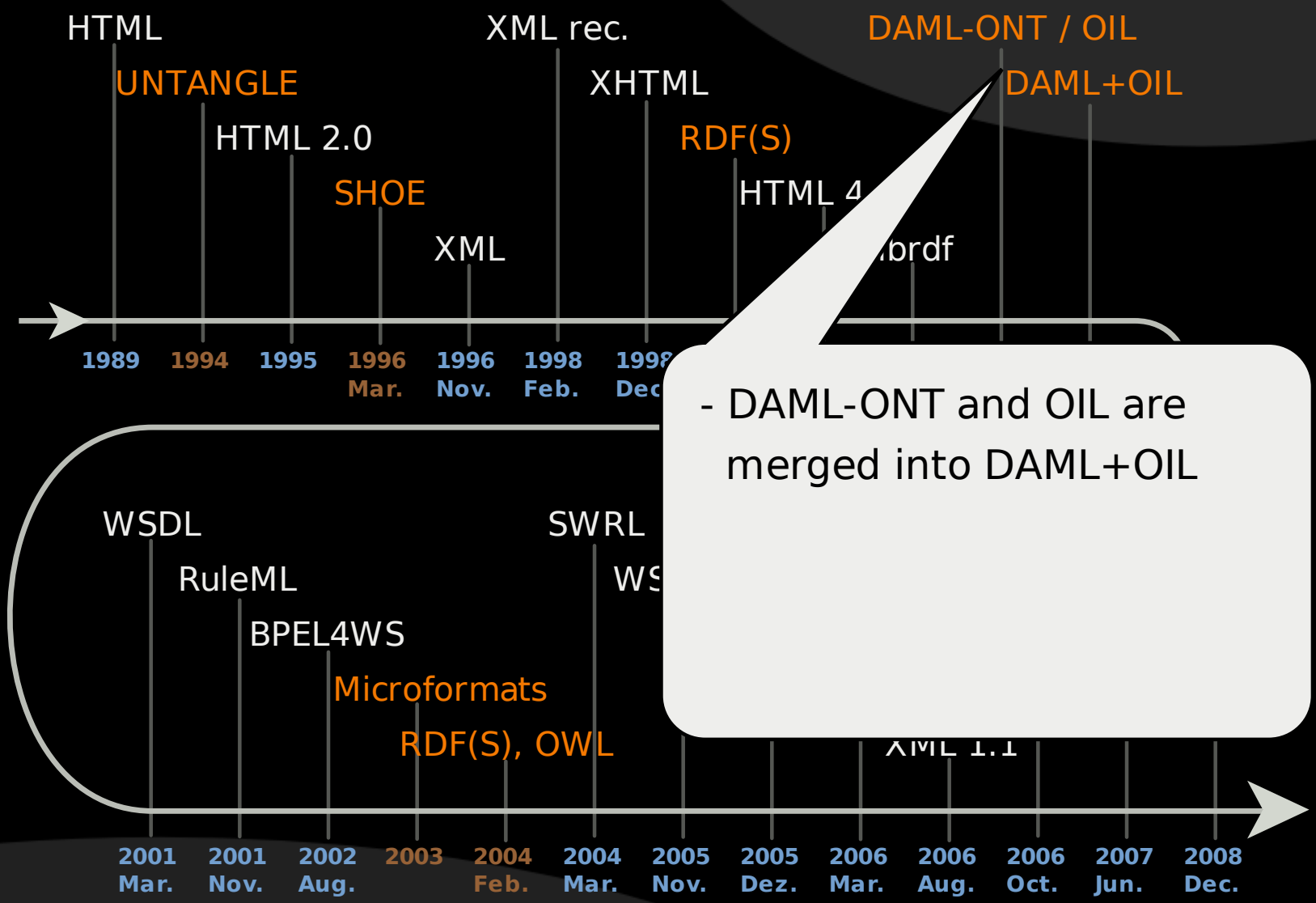

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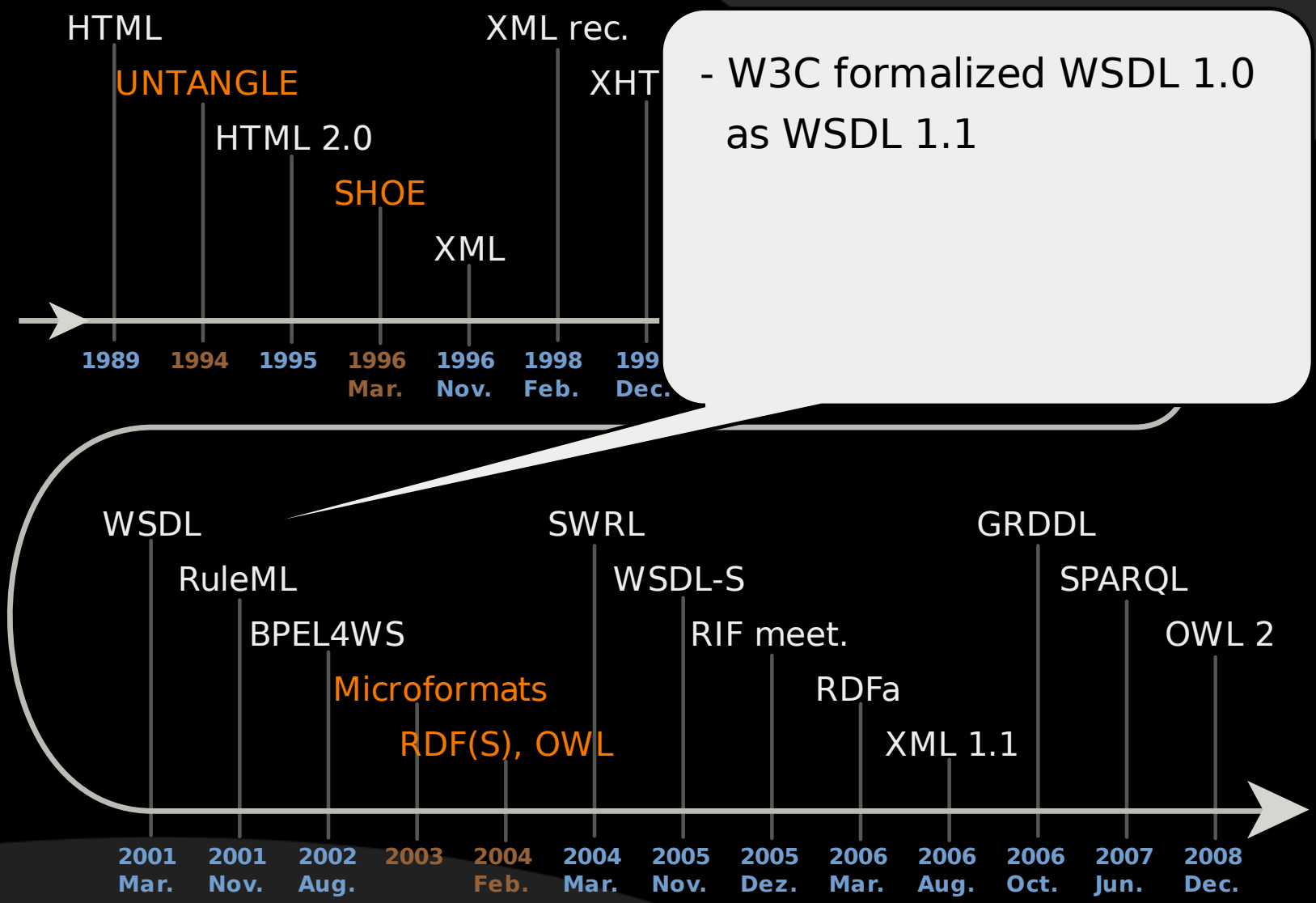

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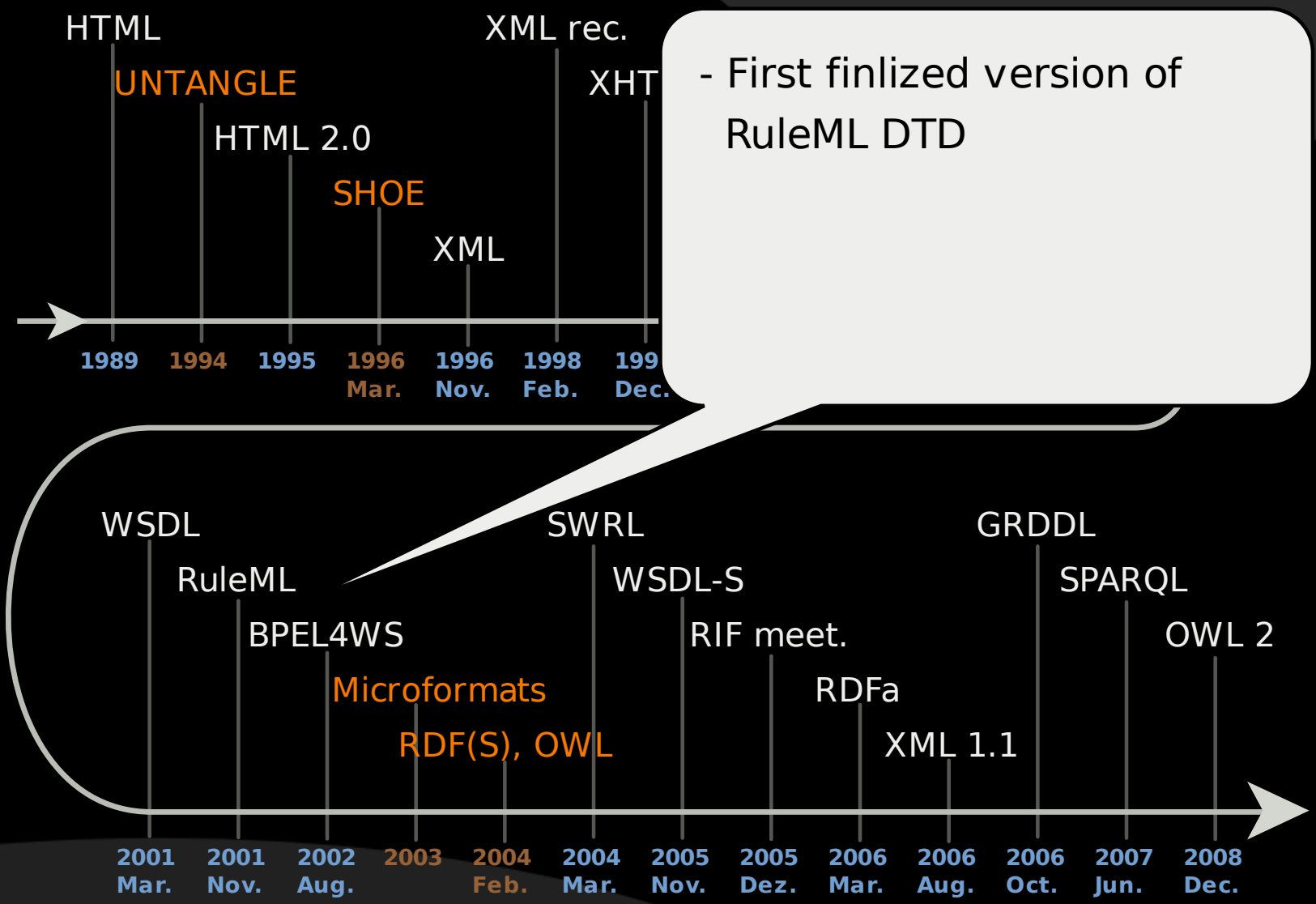

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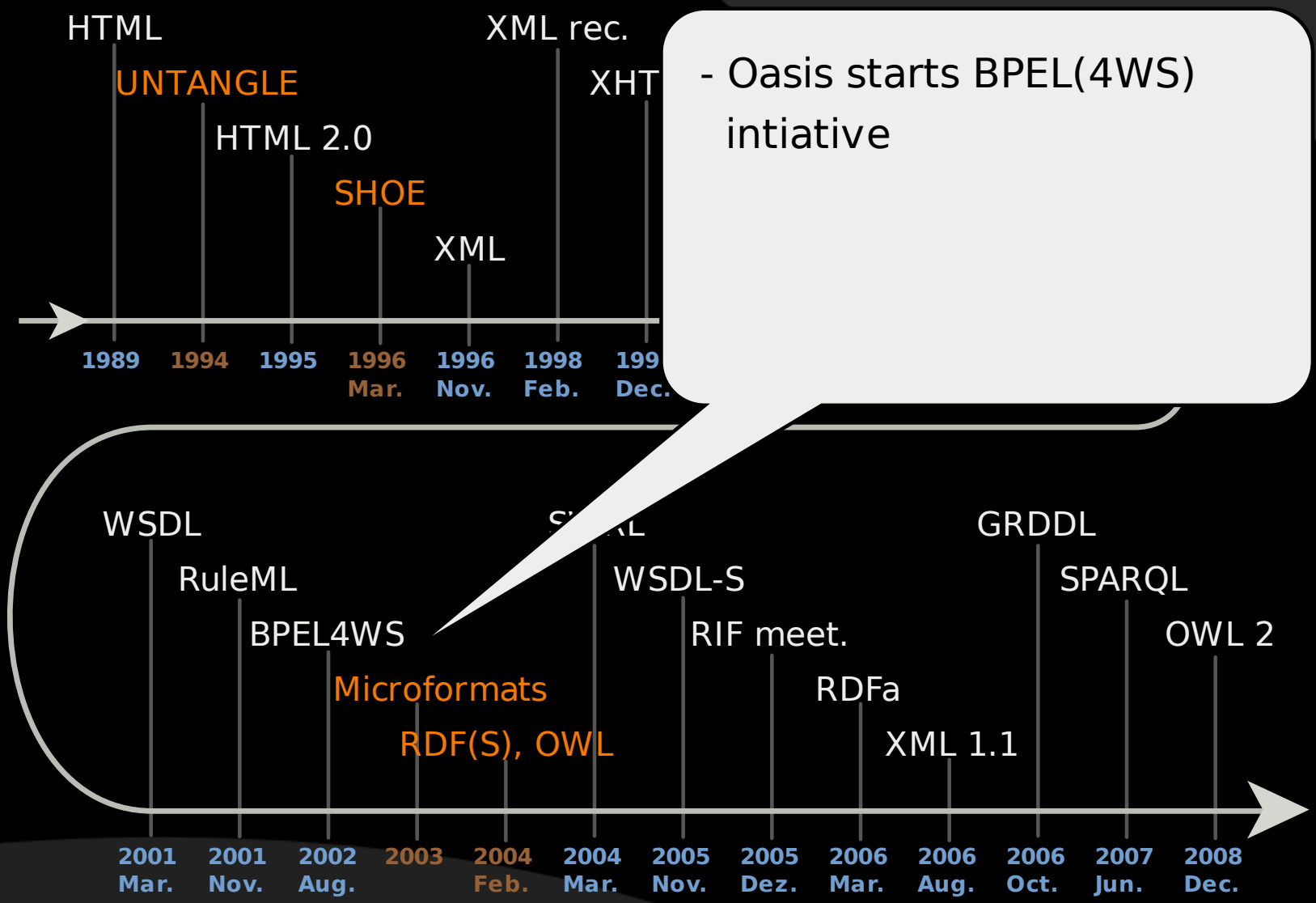

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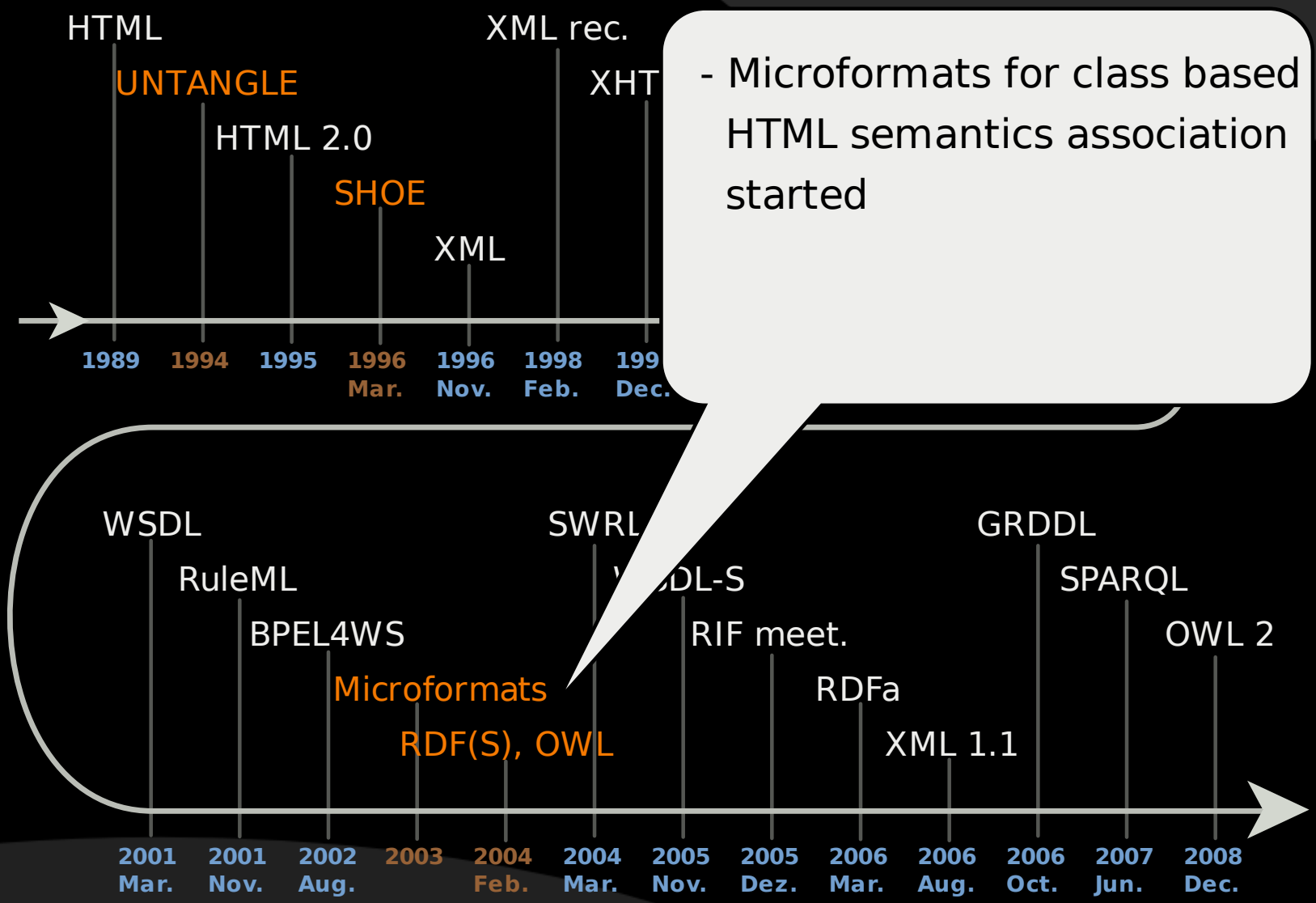

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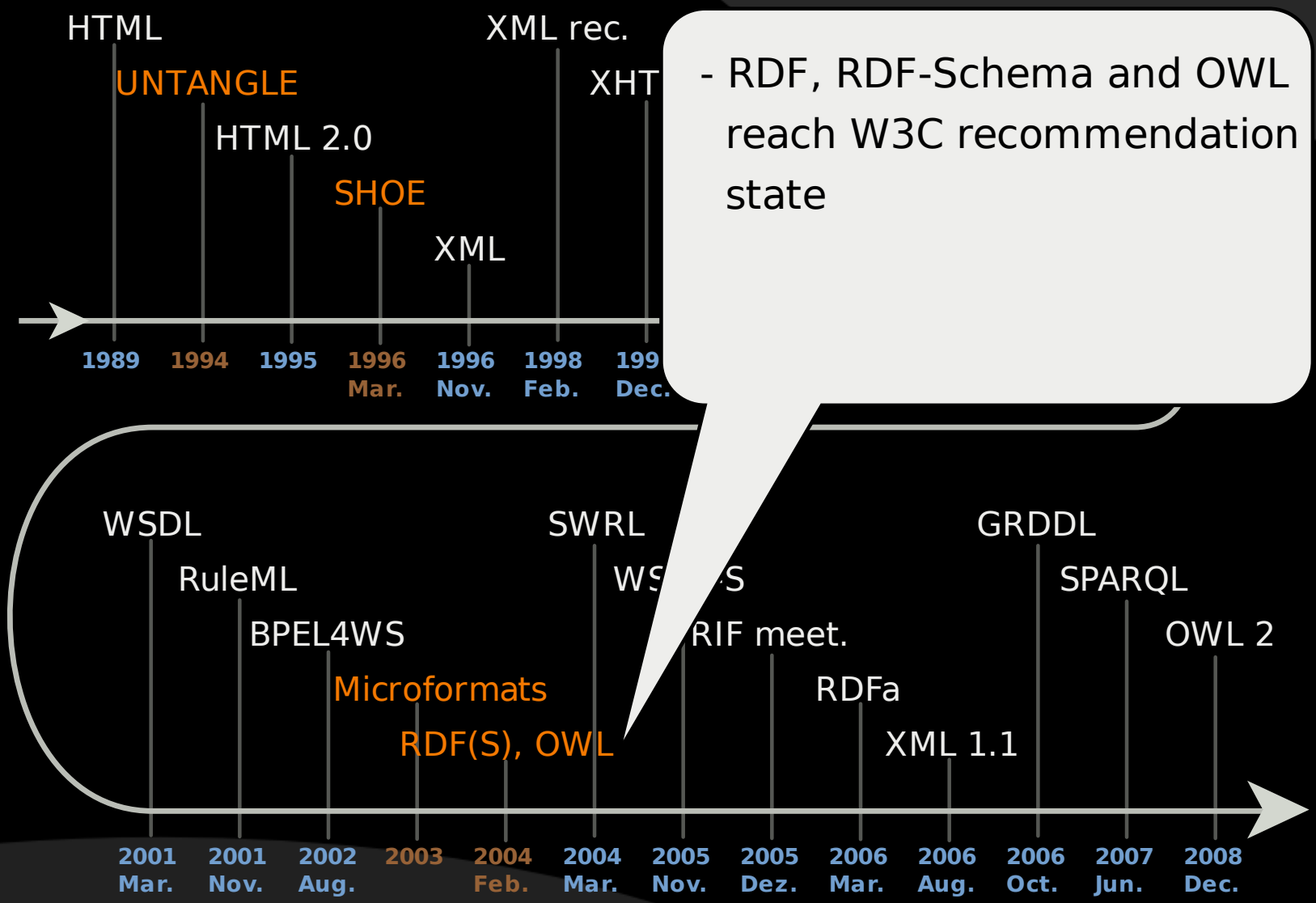

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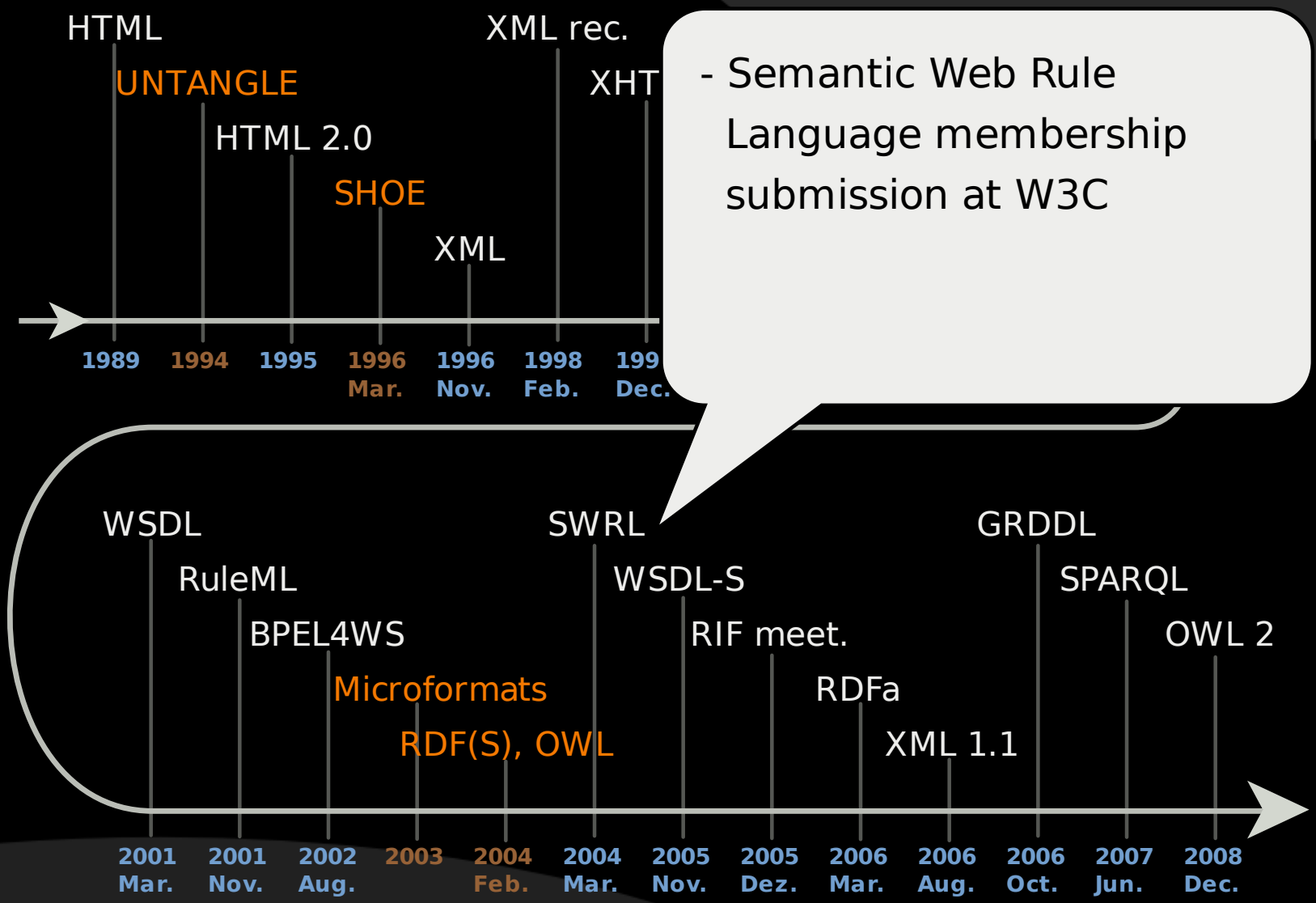

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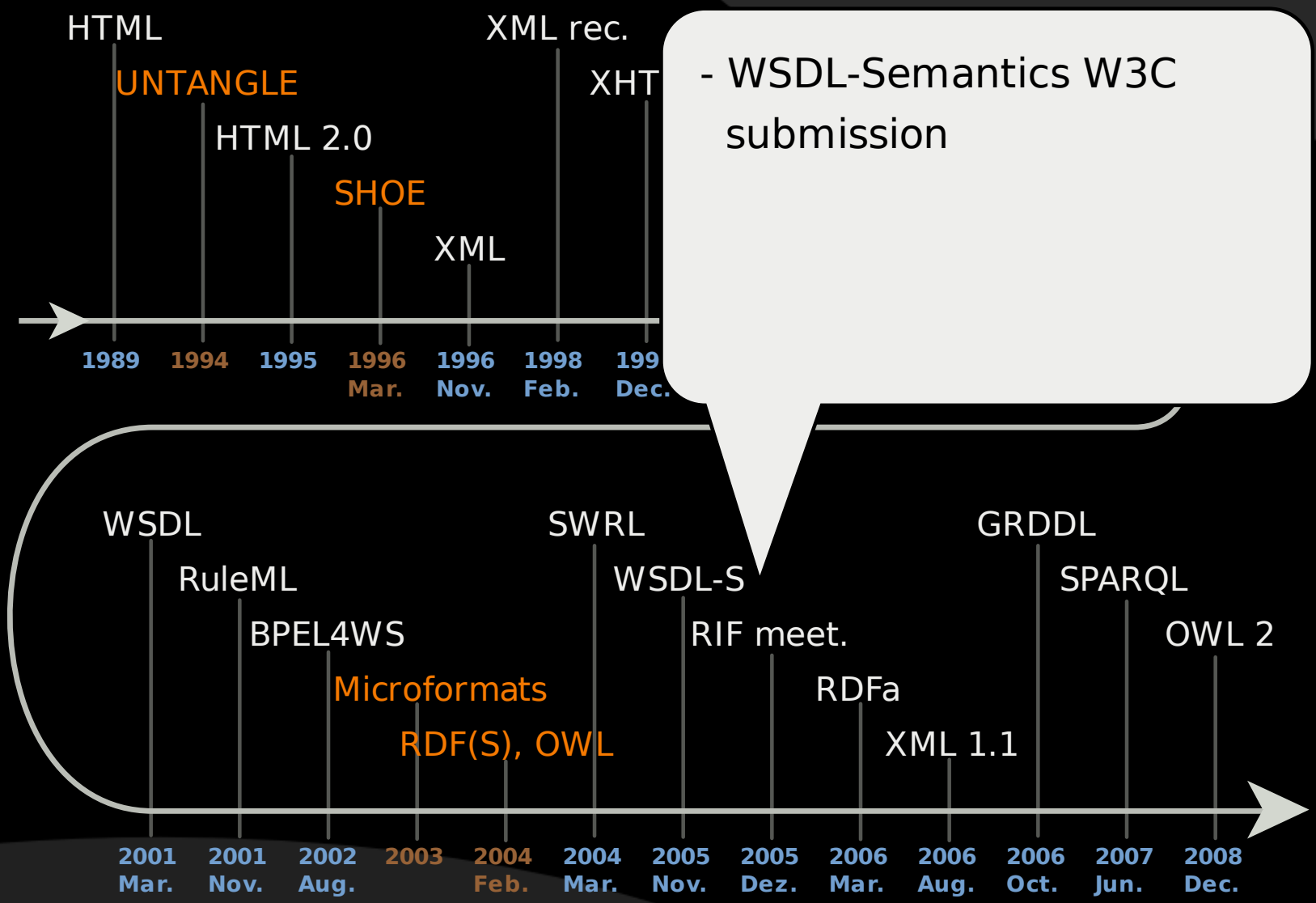

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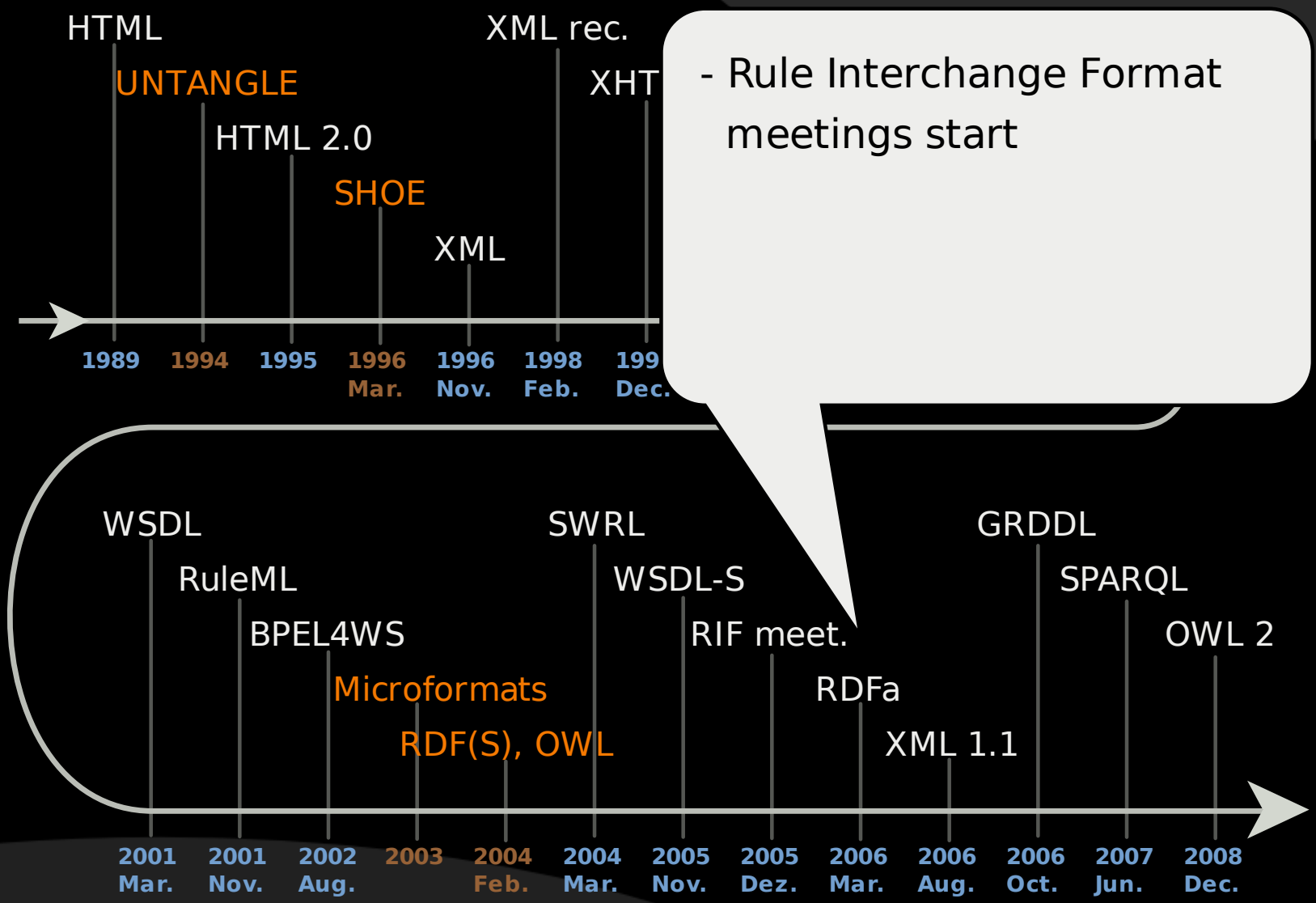

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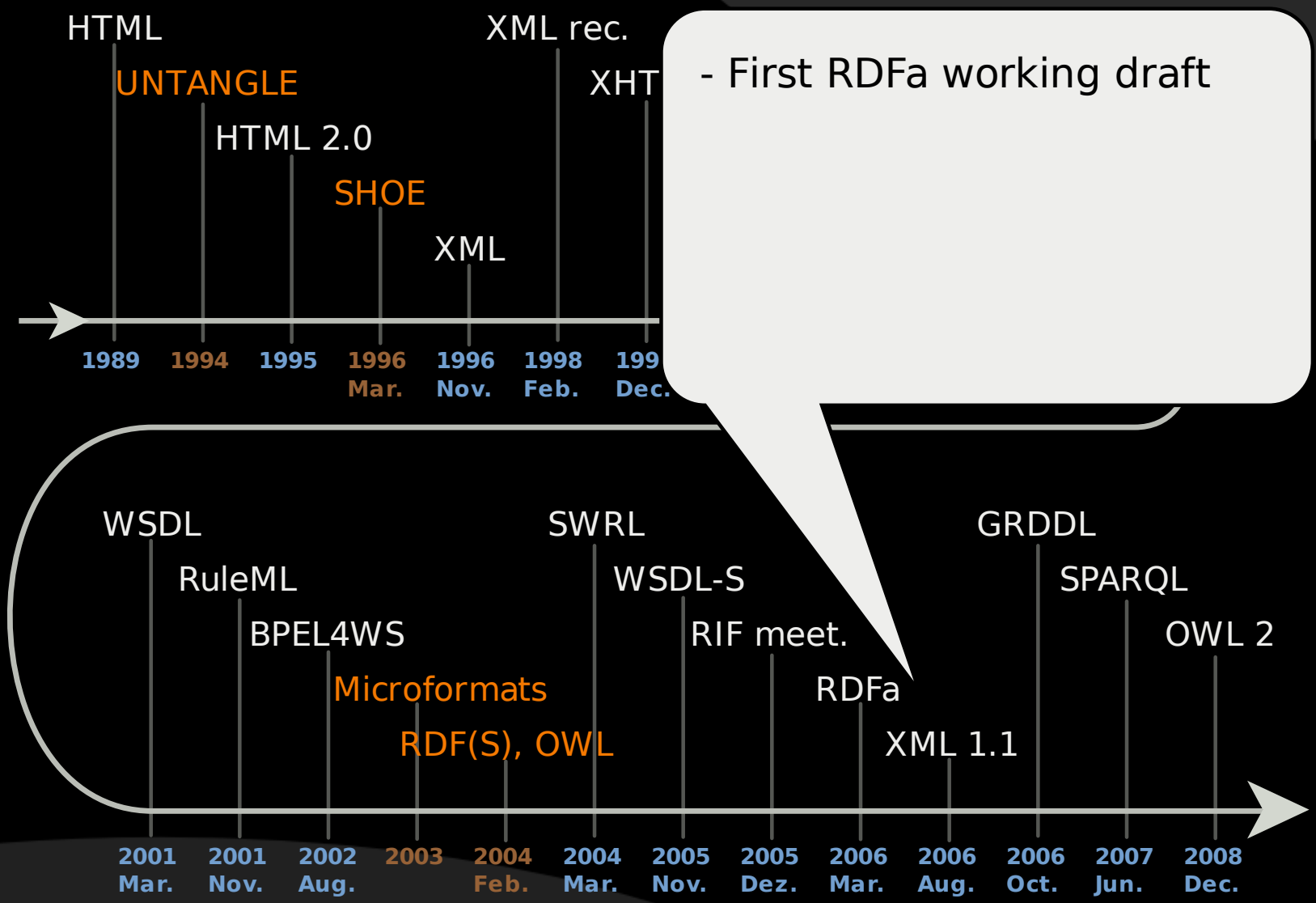

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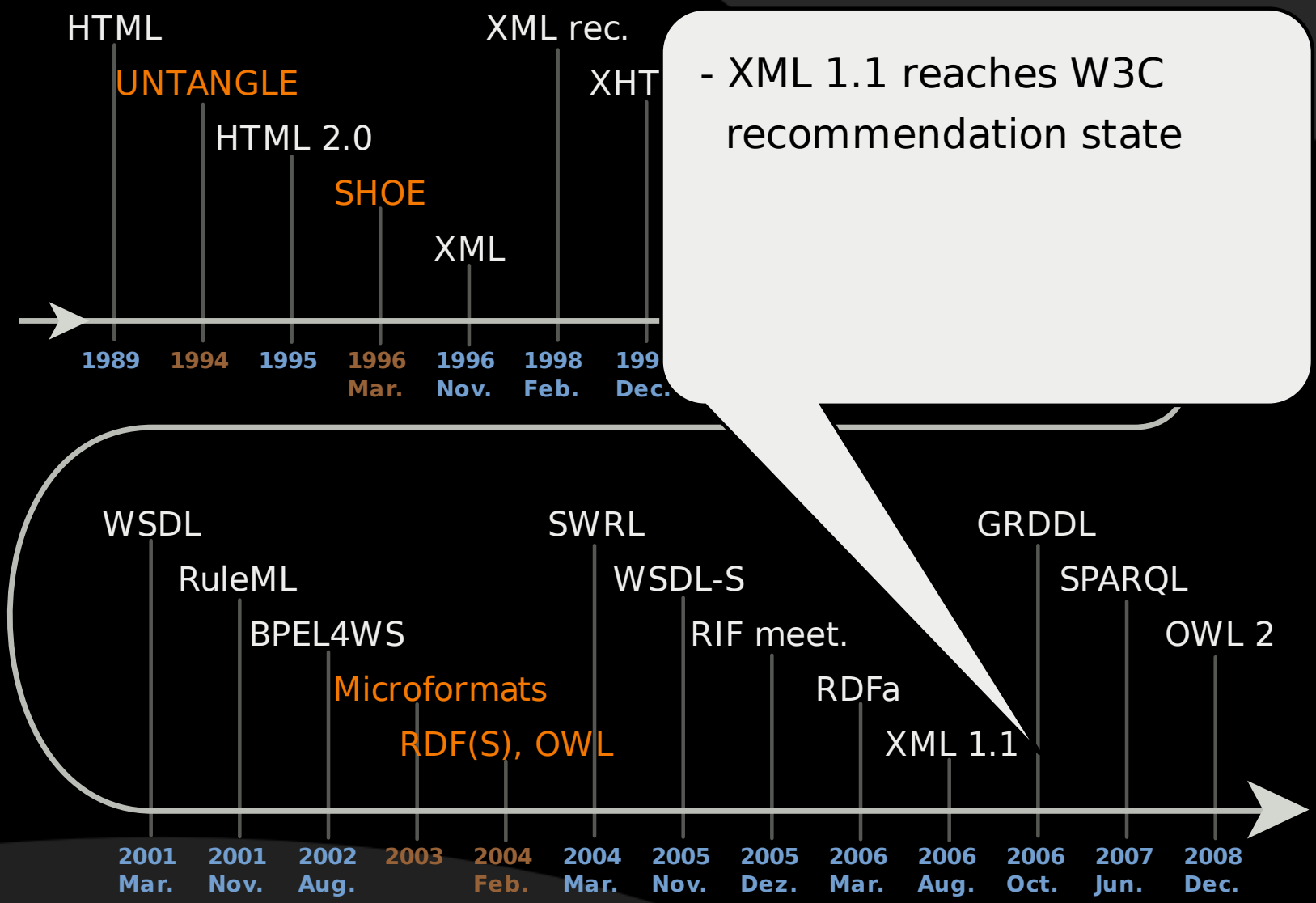

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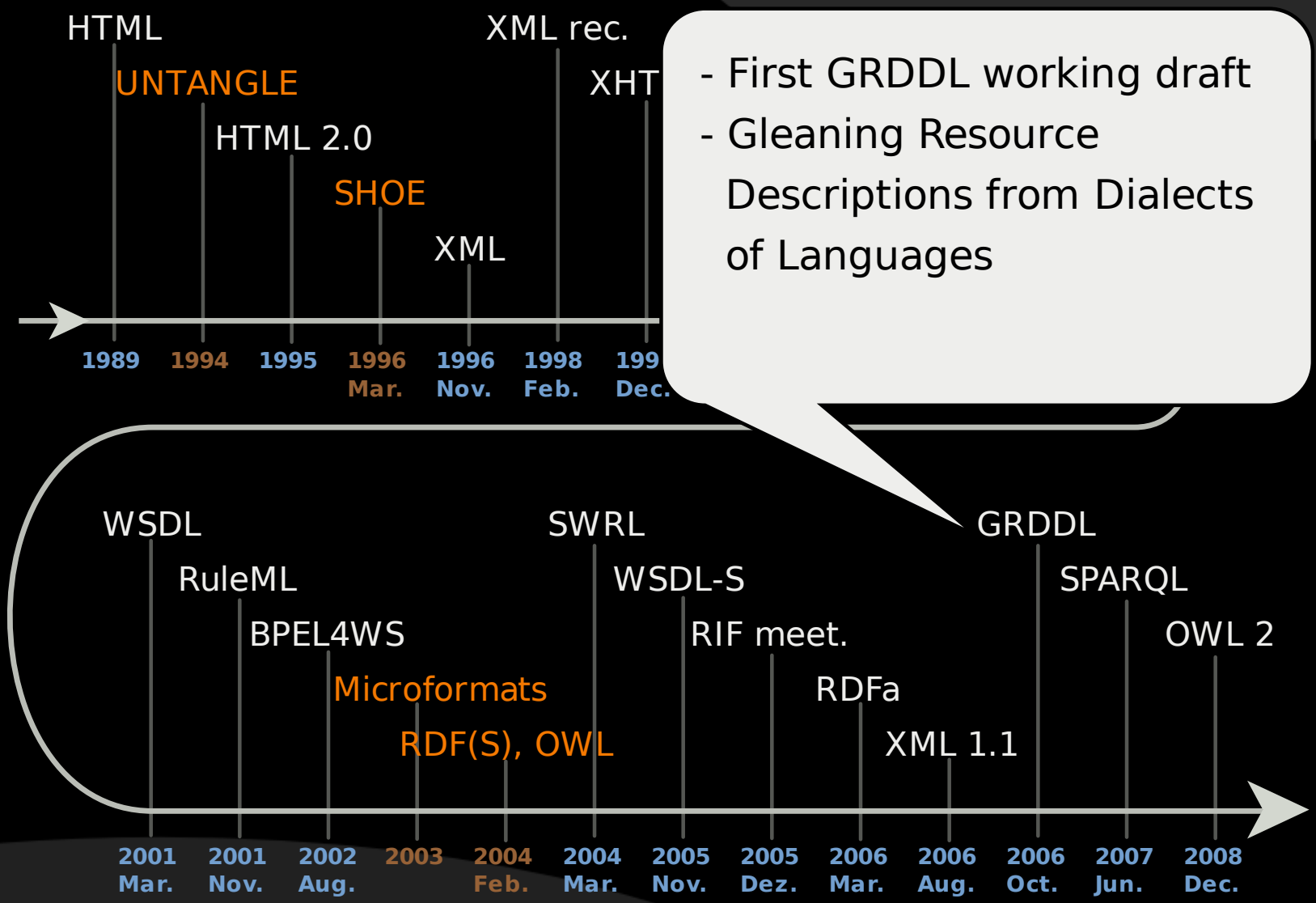

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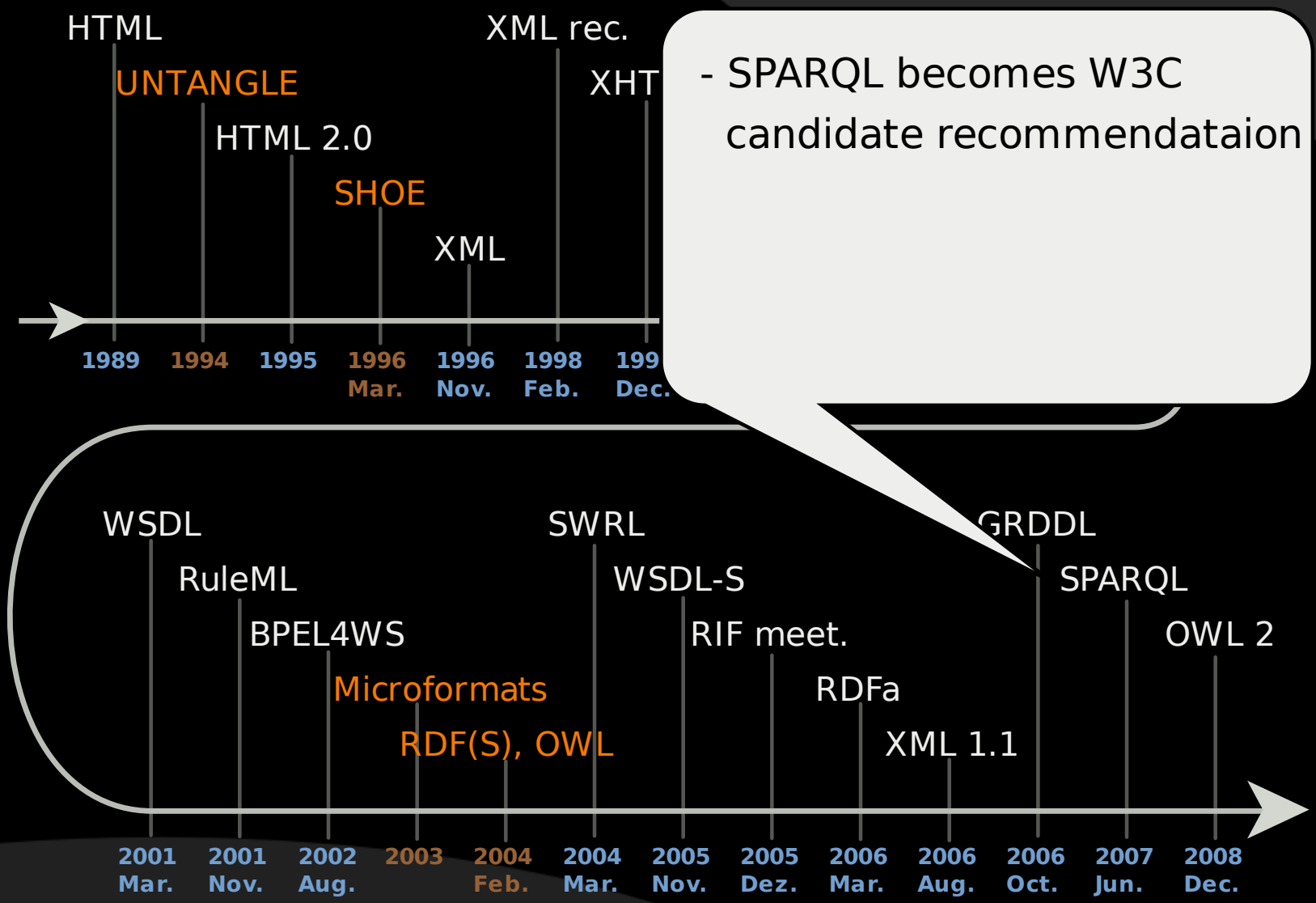

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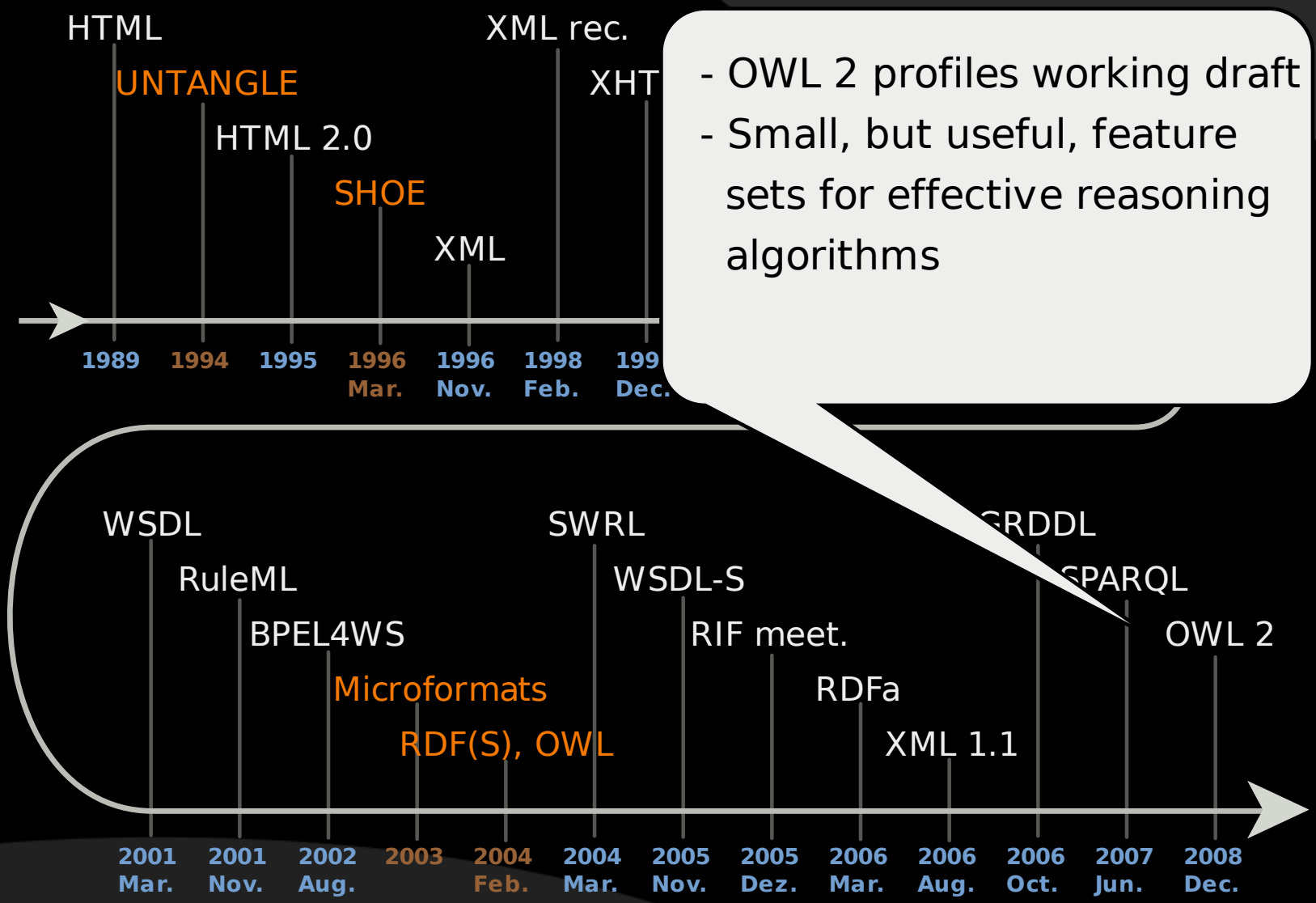

Outline

History

Related technologies

Ontology development

Microformats

- Reuse (X)HTML class attributes for trivial semantics association
- No support for namespaces
- No extensibility, or forward compability

```
1  <div class="vevent">
2      <span class="summary">Semantische Services</
           span>:
3      <abbr class="dtstart" title="2009-02-09">
           February 9th</abbr>-
4      <abbr class="dtend" title="2009-04-18">April 18
           th</abbr>,
5      at <span class="location">TU Dortmund</span>
6  </div>
```

RDF

- Resource Description Framework
- Using (Subject, Predicate, Object) tripels

```
1  @prefix dc: <http://purl.org/dc/elements/1.1/>.
2      </blog/the_long_way_to_semantic_web.html>
3          dc:title "The long way to a semantic web";
4          dc:publisher "Kore Nordmann".
```

RDF

- Resource Description Framework
- Using (Subject, Predicate, Object) tripels
  - Links and Resources may be "Subject"

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RDF

- Resource Description Framework
- Using (Subject, Predicate, Object) tripels
  - Links and Resources may be "Subject"
  - Reification: "Object" may again be a resource

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```

RDFa

- Embed RDF tripels directly in XHtml
- Still in draft state

```
1    <div xmlns:dc="http://purl.org/dc/elements/1.1/">
2        <h2 property="dc:title">Das semantische Web</h2
             >
3        <h3 property="dc:creator">Kore Nordmann</h3>
4    </div>
```

GRDDL

- Gleaning Resource Descriptions from Dialects of Languages [Dav06]
- Still in draft state
- Optain RDF tripels from XML / XHTML documents
- Handles XML-RDF and Microformats

GRDDL

- Gleaning Resource Descriptions from Dialects of Languages [Dav06]
- Still in draft state
- Optain RDF tripels from XML / XHTML documents
- Handles XML-RDF and Microformats
  - Will probably also handle RDFa

SPARQL

- RDF triple store query language

```
1   PREFIX dc: <http://purl.org/dc/elements/1.1/#>
2   SELECT ?title
3   WHERE {
4       ?doc dc.title ?title.
5       ?doc dc.creator "Kore Nordmann".
6   }
```

RuleML

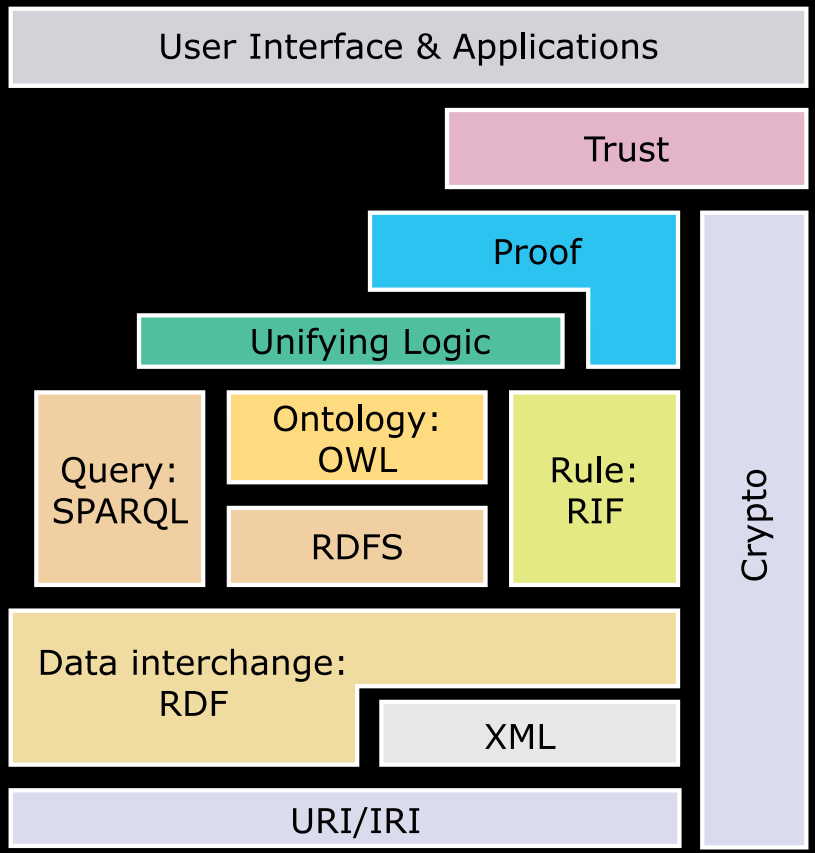
- Rule language operating on XML
  - reaction rules, transformation rules, derivation rules, facts, queries, integrity constraints
- Specification of explicit inference rules
- Integration in DAML-ONT planned, but not finished
- Integrated with OWL using SWRL

RIF

- Rule Interchange Format
- W3C working group
- Horn logic rule semantics, "well-studied sublanguage of First-Order Logic" [Haw05]
  - Low reasoning complexity PTIME
- Recommendation state scheduled for June 2009 [Haw05]

W3C map

W3C Semantic Web Activity "layercake" diagram [Her09]



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Related technologies

Ontology development

SHOE

- Embedding ontologies in HTML [HPsH03]
- Frame-based language

Frame languages

- Frames consist of
  - Name
  - More general class(es)
  - List of "slots", propery-value pairs or value constraints
- Similar to Object-Oriented-Software

SHOE - Example - Taxonomy

- Personal Ontology (draft) [Hef00]
- Categories followed by an asterisk are defined in another ontology but are provided with a local alias.

```
1   [gen.base.SHOEEntity]
2       Gender
3   Activity*
4       Process*
5       Recreation*
6       Work*
7   Address*
8   Image*
9   SocialGroup*
10      Organization*
11  Person*
12      Employee*
```

SHOE - Example - Relationships

```
addressCity(Address, .STRING)*
addressState(Address, .STRING)*
addressStreet(Address, .STRING)*
addressZip(Address, .STRING)*
age(Person, .NUMBER)
alumnus(Organization, Person)*
birthDate(Person, .DATE)
child(Person:"parent", Person:"child")
emailAddress(Person, .STRING)*
engagesIn(gen.Agent, Activity)*
father(Person:"child", Person:"father")
friend(Person, Person)
[...]
```

SHOE - Example - Inference rules

```
1       Child and parent are inverse relations.
2           If child(x,y) then parent(y,x). If parent(x,y)
                then child(y,x).
3       All fathers are parents.
4           If father(x,y) then parent(x,y).
5       All mothers are parents.
6           If mother(x,y) then parent(x,y).
7       The male parent of a child is their father.
8           If parent(x,y) and sex(y,Male) then father(x,y)
9       The female parent of a child is their mother.
10          If parent(x,y) and sex(y,Female) then mother(x,
                y)
11      Spouse is a symetric relation.
12          If spouse(x,y) then spouse(y,x).
13      Sibling is a symetric relation.
14          If sibling(x,y) then sibling(y,x).
```

RDF-Schema

- RDF-Schema, developed and proposed with RDF
- Defines the semantics of data models, modeled with RDF
- Frame-based

```
1  <rdf:RDF
2     xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns
          #"
3     xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
4
5     <rdfs:Class rdf:about="http:/example.org/#Location">
6  <rdfs:Label>Location</rdfs:Label>
7     </rdfs:Class>
8
9     <rdfs:Class rdf:about="http:/example.org/#City">
10 <rdfs:Label>City</rdfs:Label>
11 <rdfs:subClassOf rdf:resource="#Location" />
12    </rdfs:Class>
13 </rdf:RDF>
```

DAML-ONT

- Darpa Agent Markup Language
- Aimed to be more expressive then RDF-Schema
- Frame-based

OIL

- Ontology Inference Layer
- Combine elements from description logics (DL), frame languages and standards like XML and RDF
- Explicitely designed to match $\mathcal{SHIQ}$ [HPsH03], $\mathrm{NExpTime}$ [wTAiST01]

DAML+OIL

- Merges DAML-ONT and OIL
- "The DL derived language constructors of OIL were retained in DAML+OIL, but the frame structure was largely discarded in favour of DL style axioms, which were more easily integrated with RDF syntax." [HPsH03]
- Uses RDF as "syntax"

Description logics

- Formal knowledge representation [BCM+03]
  - Concept descriptions with inference logic
  - Can be translated to first-order predicate logic
  - Often limited in computational complexity, decidable
- Name given since 1980
  - Priorly known as: terminological systems, concept languages
- Terminology
  - Concepts reference to classes in OWL
  - Roles reference to properties in OWL

Description logics (1/2)

- Informal common naming conventions for expressiveness of DLs
- Computational complexity depends on DL features
- Software supporting reasoning for different levels of DLs [BCM+03]
  - $\mathcal{AL}$ Attributive language
  - $\mathcal{C}$ Complex concept negation
  - $\mathcal{S}$ An abbreviation for $\mathcal{ALC}$ with transitive roles

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  - $\mathcal{C}$ Complex concept negation
  - $\mathcal{S}$ An abbreviation for $\mathcal{ALC}$ with transitive roles
    - Ontology basics, as described in "Semantic Web: Grundlagen" [HKRS07]

Description logics (2/2)

- Additional properties
  - $\mathcal{F}$ Functional properties
  - $\mathcal{H}$ Role hierarchy
  - $\mathcal{O}$ Nominals
  - $\mathcal{I}$ Inverse properties / roles
  - $\mathcal{Q}$ Qualified cardinality restrictions
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  - $(\mathcal{D})$ Use of datatype properties, data values or data types

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    - Qualified cardinality restrictions, like $\leq nR$
  - $\mathcal{N}$ Cardinality restrictions
    - Unqualified cardinality restrictions, like $\forall$ or $\exists$
  - $(\mathcal{D})$ Use of datatype properties, data values or data types

RDF Sematics

- RDF semantics defined in 2003
- Conflicts with used properties in DAML+OIL [HPsH03]
- RDF tripels are monotone propositions like in model theory [Hay03]
- DAML+OIL properties like `oil:hasSlotConstraint` do not follow these semantics [HPsH03]

OWL

- Web Ontology Language, standardized by W3C
- Follows RDF sematics
- Superseeds DAML+OIL

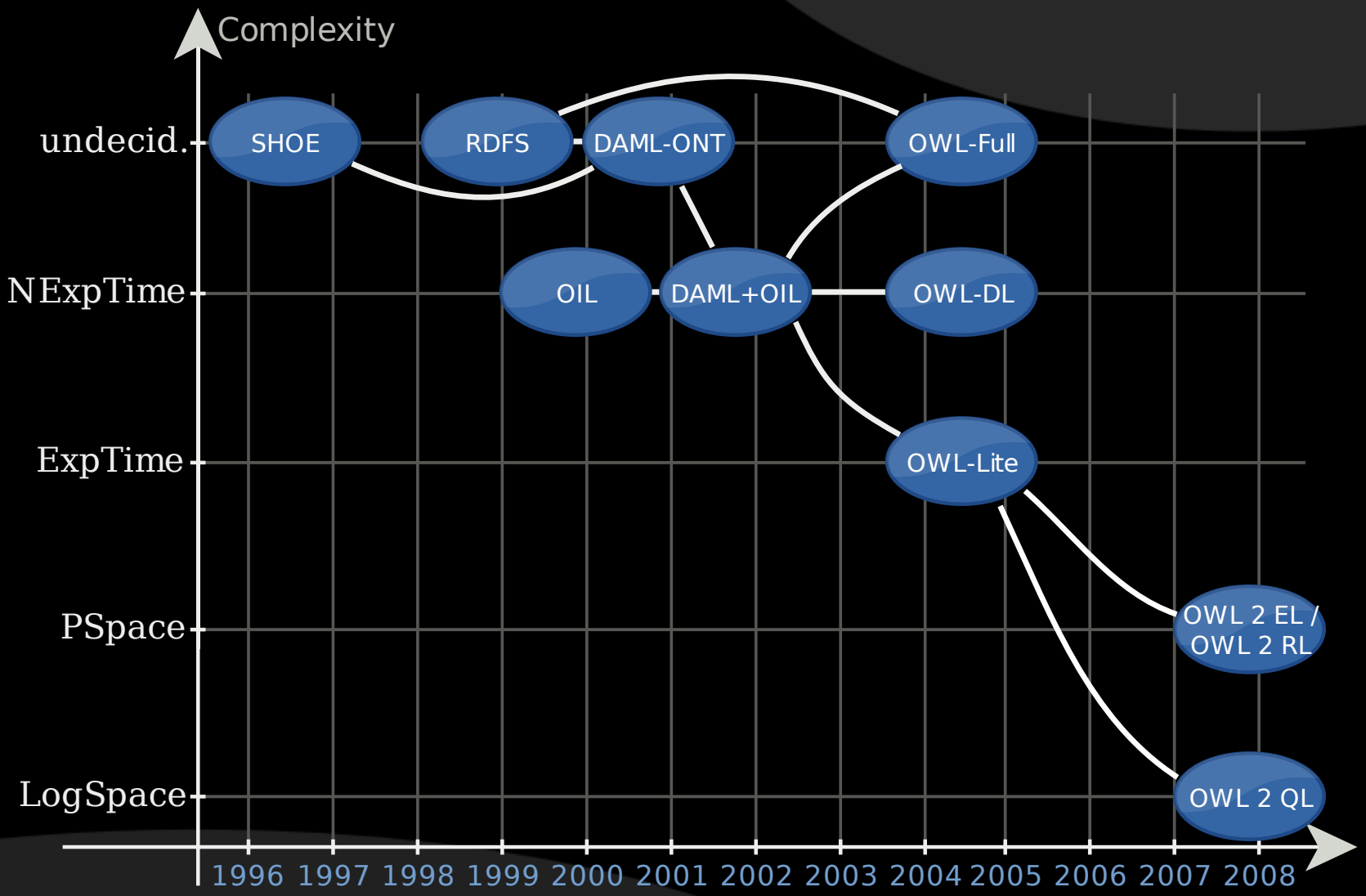
OWL

- Web Ontology Language, standardized by W3C
- Follows RDF sematics
- Superseeds DAML+OIL
- Different profiles for different applications
  - OWL Lite, $\mathcal{SHIF}(\mathcal{D})$ [HPsH03], $\mathrm{ExpTime}$ [wTAiST01]
  - OWL DL, $\mathcal{SHOIN}(\mathcal{D})$ [HPsH03], $\mathrm{NExpTime}$ [wTAiST01]
  - OWL Full, no DL equivalence, not decideable, extends RDF-Schema [HPsH03]

OWL 2

- Web Ontology Language 2, working draft
- Trades expression power for effective reasoning
- Different profiles
  - OWL 2 EL, PSPACE [BM08, BBL05]
  - OWL 2 QL, LOGSPACE [BM08]
  - OWL 2 RL, PSPACE [BM08]
- OWL Lite can be considered a OWL 2 profile

History, Complexity, Inheritance



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The end

- Open questions?
- Notes?
- Contact
  - Mail: kore@php.net
  - Web: http://kore-nordmann.de

Bibliography

[BBL05] Franz Baader, Sebastian Brandt, and Carsten Lutz, *Pushing the EL envelope*, IJCAI (Leslie Pack Kaelbling and Alessandro Saffiotti, eds.), Professional Book Center, 2005, pp. 364–369.

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