

# Semantic Web (Part II)



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32

## Summary Part I

- ✍ Three generations Web
- ✍ Problems with 2<sup>nd</sup> generation Web
- ✍ Languages for 3<sup>rd</sup> generation Web
  - † XML
  - † RDF(S)
- ✍ Do we need RDF, or is XML sufficient?

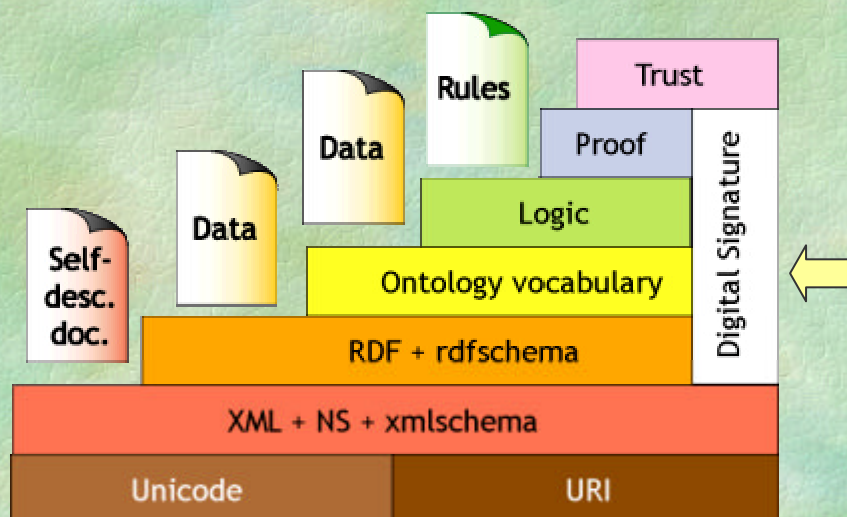
33

## Talk overview

- ✍ Three generations of the Web
    - † Problems with the current 2<sup>nd</sup> generation
    - † The Semantic Web: a vision of the 3<sup>rd</sup> generation
  - ✍ Semantic Web technology
    - † XML, RDF tutorial
- 
- † **DAML+OIL tutorial**
  - ✍ 2<sup>nd</sup> generation multimedia
    - † Cuyper
  - ✍ Towards 3<sup>rd</sup> generation multimedia

34

## The semantic pyramid again



35

## What is an ontology?

- ✍ "Specification of a conceptualisation"
  - † commonly agreed-upon set of *concepts*
  - † along with the *relationships* among them
  - † often emphasis on taxonomies
  - † "rich KR-version of an E-R diagram"
- ✍ Used for communicating knowledge *within* communities
  - † Need for common interchange language
  - † Communication *among* communities still needs ontology mappings

36

## Beyond RDF: DAML + OIL

- ✍ **OIL** extends RDF Schema to a fully-fledged knowledge representation language.
  - † logical expressions
  - † data-typing
  - † cardinality
  - † quantifiers
  - † <http://www.ontoknowledge.org>
- ✍ **DAML** = US sister of OIL
- ✍ Now merged as **DAML+OIL**

37

## WebOnt and OntoWeb

- ✍ W3C **WebOnt** working group set up 1 Nov 2001  
Work continuing where DAML+OIL left off  
<http://www.w3.org/2001/sw/WebOnt/charter>
- ✍ WebOnt is part of W3C Semantic Web activity  
which also includes RDF
- ✍ **OntoWeb**  
EU funded thematic network  
> 80 partners, including CWI, UvA and VU  
<http://www.ontoweb.org>

38

## Semantic Web: main players

### Academic in Europe:

- † VU, Amsterdam
- † Karlsruhe
- † Manchester
- † INRIA
- † SWI@UvA

### Academic in US:

- † Stanford
- † Maryland
- † MIT/W3C
- † Florida
- † CMU

### Not ✍ (yet?)

- † IBM
- † Microsoft
- † Sun

### Industrial:

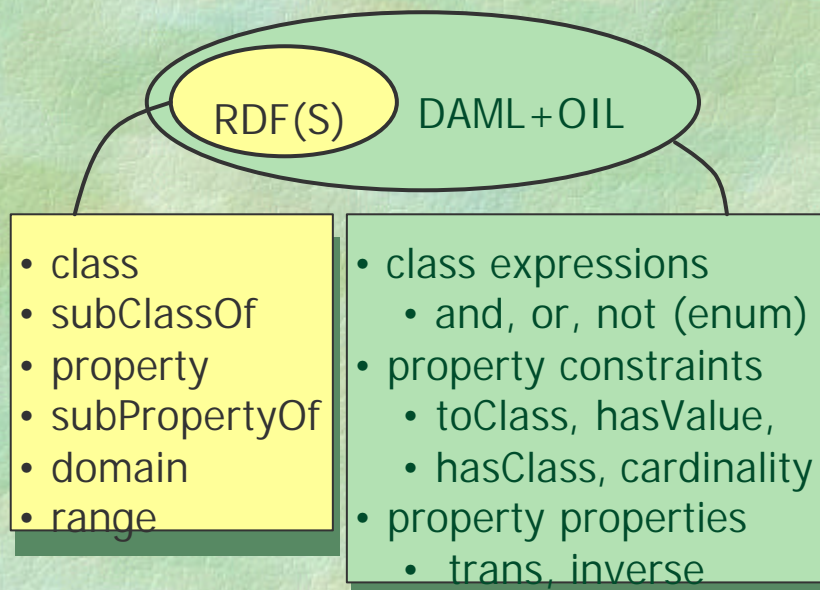
- Lucent
- Philips
- Nokia
- HP
- Intel
- Daimler-Chrysler
- Fujitsu
- lots of start-ups (NL, UK, G, N, US)

## DAML+OIL as RDF(S) extension

```
< rdfs:Class rdf:ID=" AbstractPainting" >  
  < rdfs:subClassOf rdf:resource="#Painting"/>  
  < rdfs:subClassOf >  
    < daml:complementOf >  
  
</rdfs:Class>
```

40

## DAML+OIL as RDFS extension



## DAML+OIL: Classes

```
<daml:Class rdf:ID="Artifact"/>
<daml:Class rdf:ID="Artist" />
  <daml:disjointWith rdf:resource="#Artifact"/>
</daml:Class>
<daml:Class rdf:ID="Painting">
  <rdfs:subClassOf rdf:resource="#Artifact"/>
</daml:Class>
<daml:Class rdf:ID="Painter">
  <rdfs:subClassOf rdf:resource="#>
</daml:Class>
<daml:Class rdf:ID="BodyPaint"
  <rdfs:subClassOf rdf:resource="#Painter"/>
  <rdfs:subClassOf rdf:resource="#Painting"/>
</daml:Class>
```

Will have no instances

42

## Class-Building Operations

### Relation to other Classes

- + rdfs:subClassOf
- + daml:disjointWith
- + daml:disjointUnionOf
- + daml:sameClassAs
- + daml:equivalentTo

### Contained Elements:

- + daml:oneOf (enumeration)

### Boolean combinations:

- + daml:intersectionOf
- + daml:unionOf
- + daml:complementOf

43

## DAML + OIL: Properties

```
<daml:ObjectProperty rdf:ID="painted-by">
  <daml:inverseOf
    rdf:resource="#painted"/>
</daml:ObjectProperty>

<daml:UniqueProperty rdf:ID="exhibited-by">
  <rdfs:range rdf:resource="#Museum"/>
</daml:UniqueProperty>
```

44

## Property-Building Operations

### Basic Types

- † daml:ObjectProperty
- † daml:DataTypeProperty

### Special Types

- † daml:TransitiveProperty
- † daml:UniqueProperty
- † daml:UnambiguousProperty

### Further Restrictions

- † rdfs:subPropertyOf
- † rdfs:domain
- † rdfs:range
- † daml:samePropertyAs
- † daml:inverseOf

45

## DAML+OIL: Property Restrictions

```
<daml:Class rdf:ID="Painter">
  <rdfs:subClassOf rdf:resource="#Artist"/>
  <rdfs:subClassOf>
    <daml:Restriction daml:minCardinality="1">
      <daml:onProperty
        rdf:resource="#painted"/>
    </daml:Restriction>
  </rdfs:subClassOf>
</daml:Class>
```

46

## DAML+OIL: Property Restrictions

```
<daml:Class rdf:ID="Painter">
  <rdfs:subClassOf rdf:resource="#Artist"/>
  <rdfs:subClassOf>
    <daml:Restriction daml:minCardinalityQ="1">
      <daml:onProperty rdf:resource="#made"/>
      <daml:hasClassQ rdf:resource="#Painting"/>
    </daml:Restriction>
  </rdfs:subClassOf>
</daml:Class>
```

47



# Restrictions

## General

- † `daml:Restriction`
- † `daml:onProperty`

## Number Restrictions

- † `daml:cardinality`
- † `daml:maxCardinality`
- † `daml:minCardinality`

## Value and Type Restrictions

- † `daml:toClass`
- † `daml:hasValue`
- † `daml:hasClass`

## Combinations

- † `daml:cardinalityQ`
- † `daml:maxCardinalityQ`
- † `daml:minCardinalityQ`
- † `daml:hasClassQ`

48

# DAML+OIL: Individuals

```
<Painting rdf:ID="musicalAllegory"/>
<Painting rdf:ID="apostlePaul">
  <daml:differentIndividualFrom
    rdf:resource="#musicalAllegory"/>
</Painting>

<rdf:Description rdf:ID="selfPortrait">
  <daml:sameIndividual
    rdf:resource="#apostlePaul"/>
  <costs>
    <xsd:integer rdf:value="700.000.000"/>
  </costs>
</rdf:Description>
```

49

## DAML+OIL: Defined Datatypes

```
<xsd:simpleType name="overMillion">
  <xsd:restriction
    base="xsd:positiveInteger">
    <xsd:minInclusive value="1000000"/>
  </xsd:restriction>
</xsd:simpleType>

<daml:Class rdf:ID="ExpensivePainting">
  <daml:intersectionOf
    rdf:parseType="daml:collection">
    <daml:Class rdf:resource="#Painting"/>
    <daml:Restriction>
      <daml:onProperty
        rdf:resource="#costs"/>
      <daml:hasClass
        rdf:resource="#overMillion"/>
    </daml:Restriction>
  </daml:intersectionOf>
</daml:Class>
```

## DAML+OIL: more info.

📖 DAML+OIL home page  
<http://www.daml.org/>

📖 Language tutorial  
<http://www.daml.org/2001/03/daml+oil-walkthru.html>

## SW isn't just KR in XML/RDF

- ✍ the Web is large
- ✍ it's even larger
- ✍ no referential integrity
- ✍ many authors, distributed authority, trust
- ✍ high variety in quality of knowledge
- ✍ diverse vocabularies
- ✍ decentralized
- ✍ high change rate, time-dependent content
- ✍ need local containment of inconsistencies

52

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- ✍ Semantic Web technology
  - † XML, RDF and DAML+OIL tutorial
- ✍ **2<sup>nd</sup> generation multimedia**
  - † **Cuypers**
- ✍ Towards 3<sup>rd</sup> generation multimedia

53

## Multimedia on the Web

- ✍ Real multimedia Web content is still rare
  - † Mostly bells & whistles to enhance HTML text ...
  - † ... or mono-media AV-streams
- ✍ Virtually all presentations are hand-authored
  - † proprietary formats that are hard to generate
  - † limited support for dynamic content and multichanneling
  - † most Web technology is text/page-oriented ...
  - † ... with SMIL as one of the few exceptions

✍ Conclusion:

**Multimedia has hardly caught up with the 1st generation Web!**

54

## Example scenario



- ✍ User is interested in Rembrandt and wants to know about about the "chiaroscuro" technique
- ✍ System responds with textual explanation of the technique and a number of example images of its application in Rembrandt's paintings

55

## 2<sup>nd</sup> generation multimedia

- ✍ Adapt to end-user's platform capabilities
  - † PC, PDA, mobile, voice-only, ...
- ✍ Adapt to the network resources available
  - † bandwidth and other quality of service parameters
- ✍ Personalization
  - † language, abilities, level of expertise, ..
- ✍ Problem: current 2<sup>nd</sup> generation Web tools **do not work for multimedia**

56

## Multimedia differs from text

- ✍ Different document and presentation abstractions
  - † hard to separate style from structure
- ✍ Formatting is not based on text flow
  - † no pages or scrollbars, no line-breaking or hyphenation
  - † templates often do not work well either
- ✍ Feedback from the formatting back-end required
  - † need to check whether proposed layout is feasible
  - † layout of media items is less flexible than text layout
- ✍ Transformations are hard in a functional language
  - † need to try out designs and backtrack when necessary

57

# Cuypers multimedia generation engine

📄 Demo time



📄 Acknowledgements:

- + Demonstrator developed in the context of the ToKeN2000 project
- + Media database used with permission, courtesy Rijksmuseum Amsterdam.

58

## Cuypers – the bad news

Currently all our design knowledge is:

- 📄 implicit and hidden in the generation rules
- 📄 lost in the generated Web presentation
- 📄 not reusable for other Web applications/sites

**We need the Semantic Web**

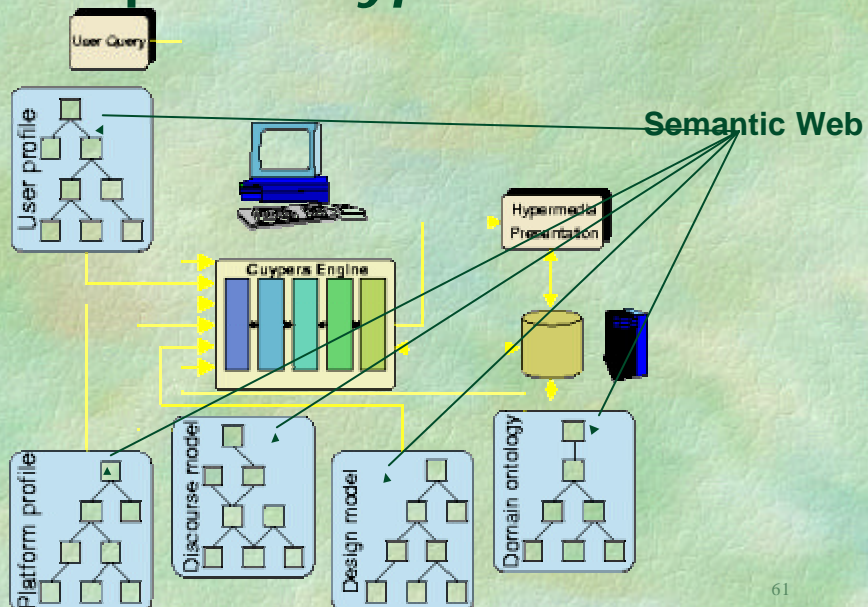
59

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  - † XML, RDF and DAML+OIL tutorial
- ✎ 2<sup>nd</sup> generation multimedia
  - † Cuypers
- ✎ **Towards 3<sup>rd</sup> generation multimedia**

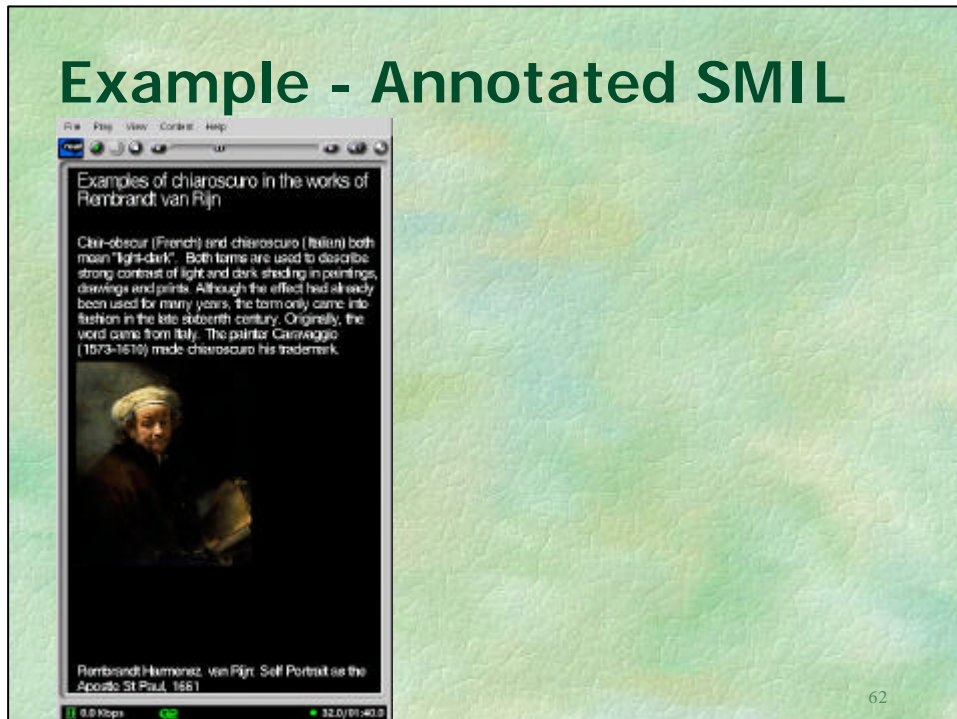
60

## Example: "Cuypers NG"



61

## Example - Annotated SMIL



## Using an existing ontology

See <http://www.cwi.nl/~media/semantics/>

```
<?xml version="1.0"?>
```

```
<!-- taken from
```

```
http://www.ics.forth.gr/proj/isst/RDF/RQL/rql.html
```

```
-->
```

```
<rdf:RDF xml:lang="en"
```

```
xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#" 
```

```
xmlns:rdfs="http://www.w3.org/TR/2000/CR-rdf-schema-20000327#" 
```

```
xmlns="">
```

```
<rdfs:Class rdf:ID="Artist"/>
```

```
<rdfs:Class rdf:ID="Artifact"/>
```

```
<rdfs:Class rdf:ID="Museum"/>
```

```
<rdfs:Class rdf:ID="Painter">
```

```
<rdfs:subClassOf rdf:resource="#Artist"/>
```

```
</rdfs:Class>
```

```
<rdfs:Class rdf:ID="Painting">
```

```
<rdfs:subClassOf rdf:resource="#Artifact"/>
```

```
</rdfs:Class>
```

```
...
```

```
</rdf:RDF>
```

63



## Embedding RDF in SMIL - I

```
<smil xmlns="http://www.w3.org/2000/SMIL20/CR">
  <head>
    <meta name="generator" content="CWI/Cuyppers 1.0"/>
    <metadata>
      <rdf:RDF xml:lang="en"
        xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
        xmlns:oil="http://www.ontoknowledge.org/oil/"
        xmlns:museum="http://ics.forth.gr/.../museum.rdf"

        <museum:Museum rdf:ID="Rijksmuseum" />

        <museum:Painter rdf:ID="Rembrandt">
          <museum:fname>Rembrandt</museum:fname>
          <museum:lname>Harmenszoon van Rijn</museum:lname>
          <museum:paints rdf:resource="#apostlePaul" />
        </museum:Painter>

        <museum:Painting rdf:about="#apostlePaul">
          <museum:exhibited rdf:resource="#Rijksmuseum" />
          <museum:technique>chiaroscuro</museum:technique>
        </museum:Painting>
      </rdf:RDF>
    </metadata>
    . . .
  </head>
  <body>
    . . .
  </body>
</smil>
```

64

## Embedding RDF in SMIL - II

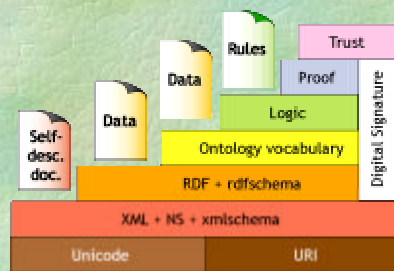
```
<museum:Painting rdf:about="#apostlePaul">
  <museum:exhibited rdf:resource="#Rijksmuseum" />
  <museum:technique>chiaroscuro</museum:technique>
  <token:painting-by rdf:resource="#Rembrandt" />
</museum:Painting>
</rdf:RDF>
</metadata>
...
</head>
<body>
  <par>
    <text region="title" src="...query to MM DBMS..."/>
    <text region="descr" src="..."/>
    <seq>
      <par dur="10"> ... 1st painting+title ... </par>
      <par dur="10"> ... 2nd painting+title ... </par>
      <par dur="10"> ... 3rd painting+title ... </par>
      <par dur="10"> ... 4th painting+title ... </par>
      <par dur="10" id="apostlePaul">
        
        <text region="ptitle" src=".."/>
      </par>
    </seq>
  </par>
</body>
</smil>
```

65



# Conclusions

- ✎ 3 generations Web
- ✎ Machine understandable Web content
- ✎ Will we ever eat our wedding cake?



68