



## Integrating Adaptive Hypermedia Techniques and Open RDF-Based Environments

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## Outline

Motivation

Related Work

Open RDF-Based Environment and Adaptation

Metadata Standards (Learning Objects, Learners)

Putting It Together (Querying for Appropriate Resources)

Conclusions and Further Work



## Motivation

Educational material is distributed in the WWW

- Learning management systems
- Adaptive hypermedia
- Content providers

This material can be shared, retrieved and adapted to user needs

P2P approach investigated at our institute allow us

- To query distributed content and link metadata which resides at different peers
- To have peers with different services distributed and thus compute adaptation not only on one machine
- And thus to provide users with more possibilities to get educational material and to choose the appropriate one for them



## Motivation cont.

Content metadata seen as some constraints on use for learning objects

Learning object metadata are retrieved according to matching between learner profile and LO metadata

Rules determines how adaptation is performed based on the matching learner profile and LO metadata





## Related Work

### Adaptive (Open) Web-Based Systems

- Open adaptive hypermedia (Bailey et al.)
- Open corpus adaptive hypermedia (Henze, Nejdl)

### Adaptive Hypermedia Systems

- AHA! (De Bra et al.)
- Interbook (Brusilovsky et al.)
- SQL Tutor (Mitrović et al.)
- ...

➤ How to support these ideas in open network?



## Open RDF-Based Environments

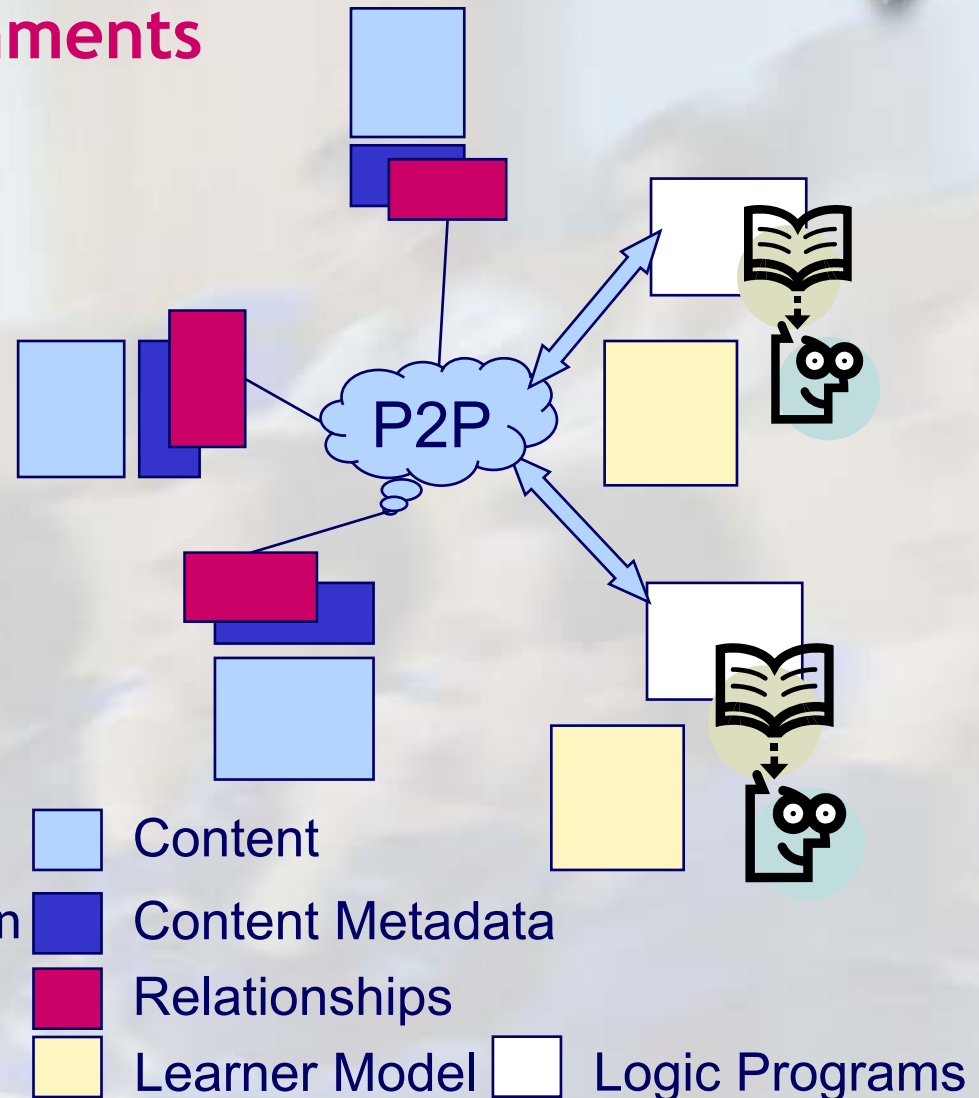
Distributed content

Distributed standard based  
metadata descriptions about:

- Content
- Relationships between the content
- Learner

Logic Programs

- Query and adapt content delivery and its links
- Visualize adaptive navigation support





## Metadata Standards

The aim is to provide standardized descriptions to improve interoperability and to support individuals by adaptation

Standards for:

- Learning Material Descriptions

- Learning Object Metadata (LOM) standard (IEEE LTSC P1484.12.1, 2002-6-12)
- Simple Dublin Core (v1.1, 2003-4-2), DC Terms -formerly dublin core qualified (2003-3-4)

- Learner Descriptions

- IEEE Public and Private Information (PAPI) for learner (IEEE P1484.2/D7, 2000-11-28)
- IMS Learner Information Profile (v1.0, 2001-3-9)



## LOM and DC

Metadata about content (learning objects):

### ■ DC

- Simple DC (15 attributes like title, relation, creator,...)
- DC terms - Additional elements which refine basic elements (e.g. name, comment, definition, label refine title; isVersionOf, and so on)

### ■ LOM

- Attributes are grouped into categories: *general, life cycle, meta-metadata, technical, educational, rights, relation, classification, annotation*

Using RDF bindings of LOM and DC in implementation





## Topic Ontologies for Content Classification

Content classified by topics (concepts) it covers

dc:subject - we assume that the topic is fully covered

Values from ACM CCS classification

Using *lom-cls:Taxonomy* instance in dc:subject

Topics can have different weights of covering (mentioned, introduced, covered)

More on this topic:

Jan Brase, Wolfgang Nejdl: [Ontologies for eLearning](#). In "*Handbook on Ontologies*" (Springer-Verlag 2003).



## ACM CCS part Example in RDF

```
<dcterms:SubjectScheme rdf:ID= ACM CCS >
<rdfs:label>ACM Computer Classification system
</rdfs:label>
</dcterms:SubjectScheme>
<lom_cls:Taxonomy>
  <lom_cls:rootTaxon>
    <ACM:ACM CCS rdf:about= http://www.kbs.uni-hannover.de/Uli/ACM
      CCS.rdf#D >
      <rdf:value>Software</rdf:value>
      <lom_cls:taxon>
        <ACM:ACM CCS rdf:about= http://www.kbs.uni-hannover.de/Uli/ACM
          CCS.rdf#D.1>
        <rdf:value>PROGRAMMING TECHNIQUES
        </rdf:value>
      ...
    </lom_cls:taxon>
  </lom_cls:rootTaxon>
</lom_cls:Taxonomy>
```



## LOM Accessibility Constraints

Explicitly saying which learner profile is well suited to consume particular resource:

```
...  
<lom-cls:accessibilityRestrictions  
  rdf:resource="http://www.kbs.../S5T2.pdf"/>  
  <papi:performance>  
    <rdf:Description rdf:ID="performance_1">  
      <papi:learning_competency rdf:resource= "http://www.kbs.uni-  
hannover.de/Uli/ACM_CCS.rdf#D.1"/>  
      <papi:granularity>topic</papi:granularity>  
      <papi:performance_coding>number</papi:performance_coding>  
      <papi:performance_metric>0-1</papi:performance_metric>  
  
      <papi:performance_value>greater_than(0.5)</papi:performance_value>  
    </papi:performance>  
  </lom-cls:accessibilityRestrictions>
```

...



## Other fields

Requires from DC terms (for prerequisites)

Intended user role from LOM educational category (e.g. Manager)

Context from LOM educational category (e.g. School, vocational training)

Audience from DC terms

Language from educational categories





## Describing Users

Why: To be able to customize (adapt) information to specific person

Different user characteristics can support personalization

Personalization in adaptive educational hypermedia is based on learner performance mostly

- Level of knowledge
- Task solved, and so on



## Learner Profile Standards

### IEEE PAPI:

- Categories: personal information, relations, security, preference, performance, portfolio

### IMS LIP:

- Categories: identification, QCL, accessibility, activity, goal, competency, interest, transcript, affiliation, security key, relationship

More about in:

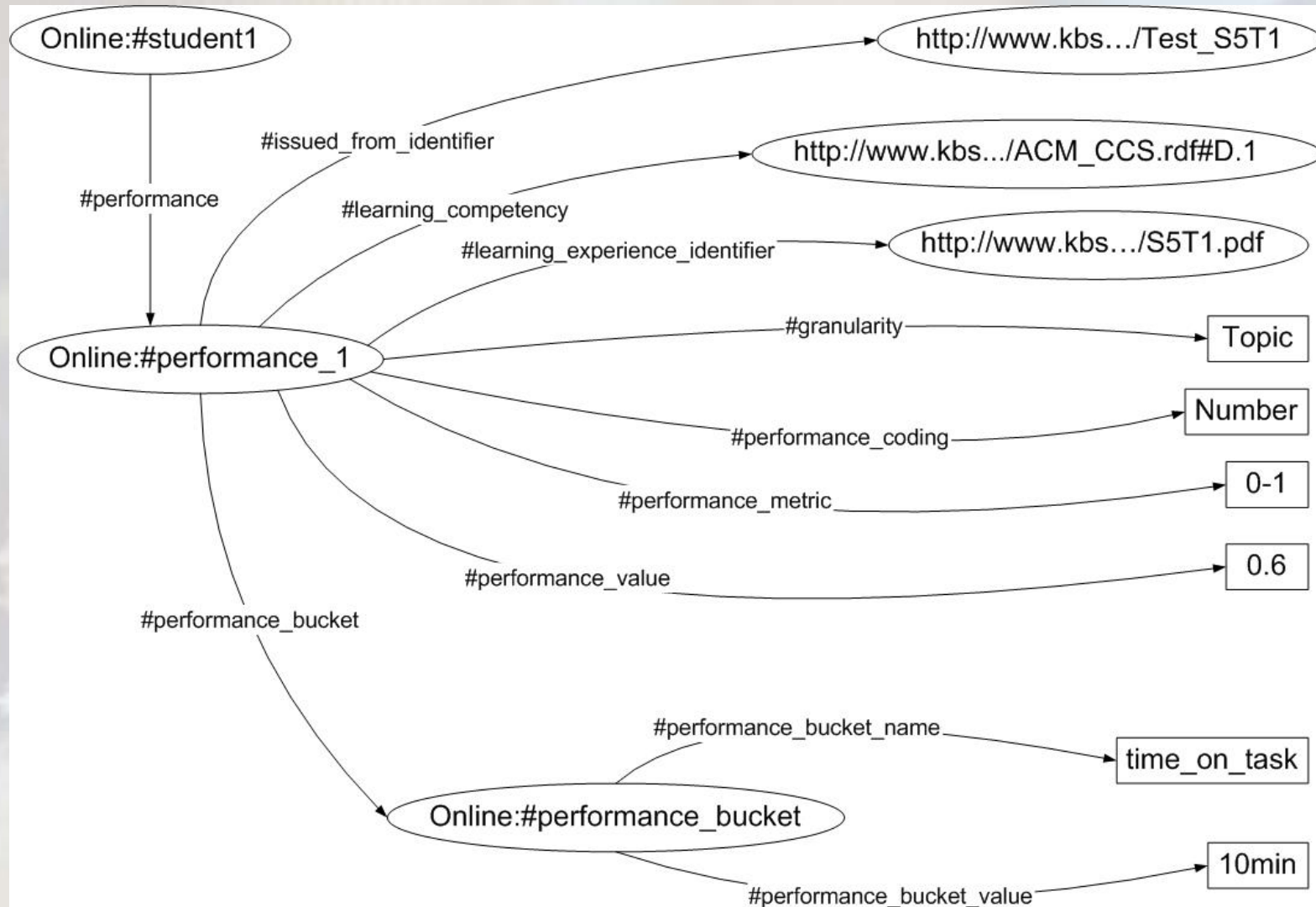
Peter Dolog and Wolfgang Nejdl:

Challenges and Benefits of the Semantic Web for User Modelling.

In Proc. of AH2003 workshop.

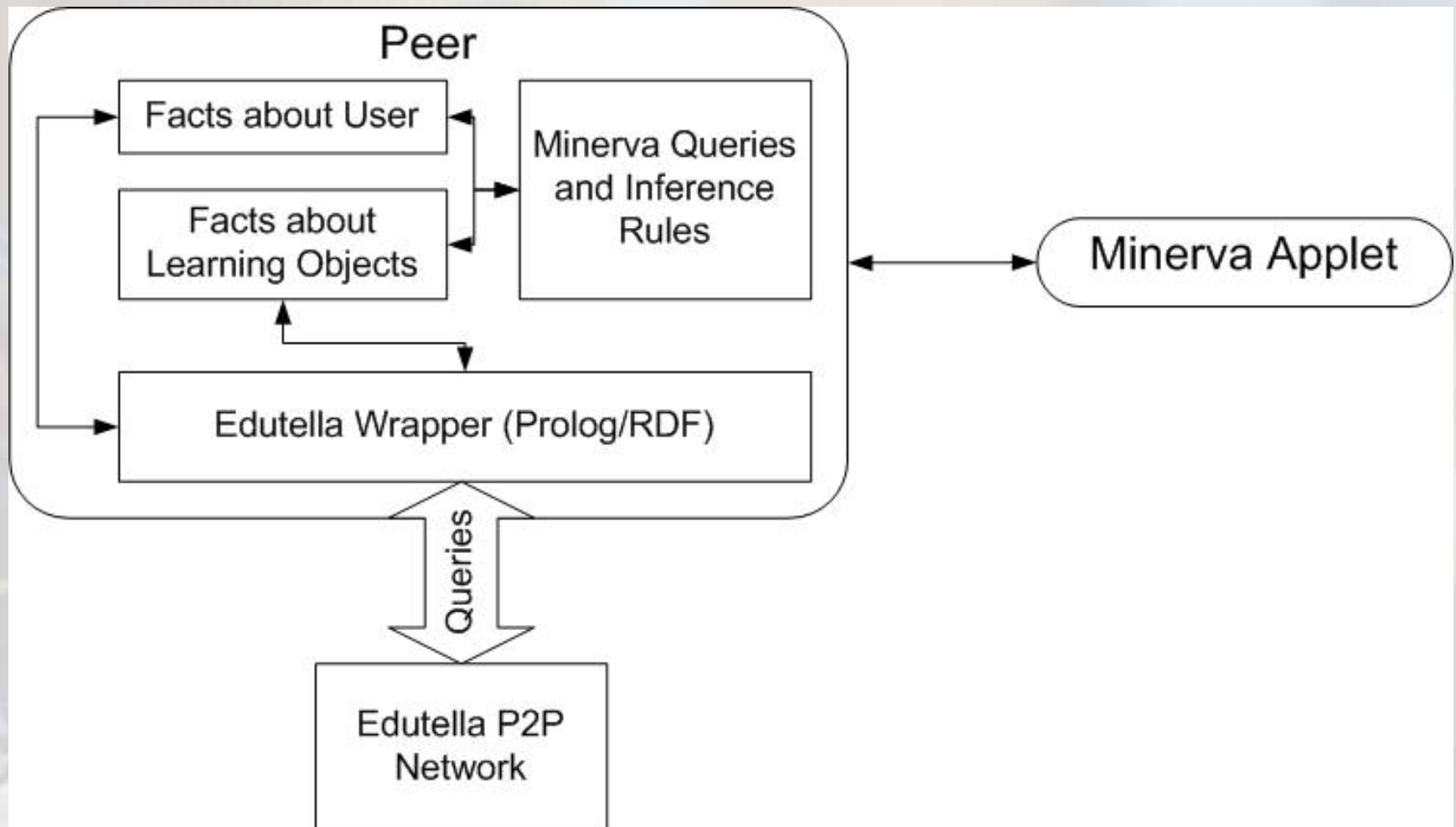


## Example: Performance (using RDF bindings of PAPI)





## Putting it together - Peer architecture







## Querying in Edutella P2P

Datalog- and RDF-Based QEL

Common internal data model for Queries

Several wrappers implemented (file based, relational database, concept base, ...) to support several metadata storage types

Two kinds of wrappers:

- Implementing provision service
- Implementing consumer (query) service



## Query example

### Recommendation:

```
recommended(Page, User) :-  
    not_understood_page(Page, User),  
    prerequisites(Page, Prereq),  
    not (member(P, Prereq),  
        not_understood_page(P, User)).
```

```
?- recommended(Page, student1)
```

### User Profile:

```
query(student1, X, Z) :-  
    performance(student1, X),  
    performance_value(X, Z).
```

```
?- query(student1, X, Z)
```



## User Interface

http://www.kbs.uni-hannover.de/~gavriloa/DIPLOMA/minerva/Applet8/ - Microsoft Internet Explorer

Adresse: http://www.kbs.uni-hannover.de/~gavriloa/DIPLOMA/minerva/Applet8/

Google Search Web Search Site PageRank Page Info Up Highlight

Open Link

- 1. Vorlesung 22.10.2001
- 2. Vorlesung 29.10.2001
- 3. Vorlesung 05.11.2001
- 4. Vorlesung 12.11.2001
  - <http://www.kbs.uni-hannover.de/Lehre/SWT1/OLR/Vorlesung4.htm>
  - <http://www.kbs.uni-hannover.de/Lehre/SWT1/OLR/S4T1.pdf>
  - <http://www.kbs.uni-hannover.de/Lehre/SWT1/OLR/S4T2.pdf>
  - <http://www.kbs.uni-hannover.de/Lehre/SWT1/OLR/UseCasDD.htm>
  - <http://www.kbs.uni-hannover.de/Lehre/SWT1/OLR/Function-Poin.htm>
- 5. Vorlesung 19.11.2001
- 6. Vorlesung 26.11.2001
  - <http://www.kbs.uni-hannover.de/Lehre/SWT1/OLR/Vorlesung6.htm>
  - Alternative Pages
    - <http://www.kbs.uni-hannover.de/Lehre/SWT1/OLR/S6T1.pdf>
    - <http://www.kbs.uni-hannover.de/Lehre/SWT1/OLR/S6T2.pdf>
  - Alternative Pages
    - <http://www.mml.uni-hannover.de/meta/kbs.cgi?SWT1WS>
  - Topics
    - Topic -- swtOnt\_LingConMethods3 / Rating -- 0.0 from
- 7. Vorlesung 03.12.2001
  - <http://www.kbs.uni-hannover.de/Lehre/SWT1/OLR/Vorlesung7.htm>
  - <http://www.kbs.uni-hannover.de/Lehre/SWT1/OLR/S7T1.pdf>
  - <http://www.kbs.uni-hannover.de/Lehre/SWT1/OLR/S7T2.pdf>
  - <http://www.kbs.uni-hannover.de/Lehre/SWT1/OLR/goto.pdf>
  - <http://www.kbs.uni-hannover.de/Lehre/SWT1/OLR/Object-Z.pdf>
- 8. Vorlesung 10.12.2001
- 9. Vorlesung 17.12.2001
- 10. Vorlesung 07.01.2002

145% 1 of 5 7.1 x 9.44 in Internet

Applet.com: ifcomputer.minerva.gui.Gui started

### B2R2

- Buzzword to reality ratio
- Indikator, daß etwas nicht in Ordnung ist
- „generic concepts“, „reusable building blocks“
- „business procedures“
- „knowledge engineering“

Quelle: H. Dörfler, Einführung in die Software-Technik, Software-Entwicklungs-Systeme, Akademischer Verlag 2001.  
© Springer, Geschäftsplan der Softwareentwicklung / 1. Semester / SS 2001 / WS 2001/2002

### Anwendungsfalldiagramme

Quelle: H. Dörfler, Einführung in die Software-Technik, Software-Entwicklungs-Systeme, Akademischer Verlag 2001.  
© Springer, Geschäftsplan der Softwareentwicklung / 1. Semester / SS 2001 / WS 2001/2002

### Generalisierung

Quelle: H. Dörfler, Einführung in die Software-Technik, Software-Entwicklungs-Systeme, Akademischer Verlag 2001.  
© Springer, Geschäftsplan der Softwareentwicklung / 1. Semester / SS 2001 / WS 2001/2002

### Darstellung eines Gesamtsystems

Quelle: H. Dörfler, Einführung in die Software-Technik, Software-Entwicklungs-Systeme, Akademischer Verlag 2001.  
© Springer, Geschäftsplan der Softwareentwicklung / 1. Semester / SS 2001 / WS 2001/2002

### Anzahl Anwendungsfälle

### Zusammenfassung



## Conclusions and Further Work

We described:

- How to build on standards in open RDF-Based environments to support:
  - Course composed from resources distributed in the network
  - Adaptive navigation in the course

We will further investigate:

- Adaptation in heterogeneous environments
- Personalization services
- Improvements of RDF bindings for learner profiles





**Thank you for your attention!!!**

This work was done in the context of three projects. Visit their web sites:

Elena: <http://www.elena-project.org>

PADLR: <http://www.learninglab.de/padlr/index.html>

ULI-Campus: <http://www.uli-campus.de/english/project.html>

Visit L3S web site: <http://www.learninglab.de>