Wirtschaftsuniversität Wien

Designing the Semantic Web for Higher Education -

Technological and Socio-economical Challenges

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Outline

- What is the Semantic Web all about?
- How do Use Cases of the Semantic Web look like and how can we realize them?
- What is missing from the socio-economical point of view?

What is the Semantic Web all about?

Defining the Semantic Web

“The vision of the semantic web aims to have distributed data and services defined and linked in such a way that they can be used by machines not just for display purposes, but for automation, integration and reuse of data and services across various applications.“

Berners-Lee, Hendler, Lassila 2001

High Expectations

“What we‘re seeing is just the first version of the Web. The next version will be even bigger and more powerful...“

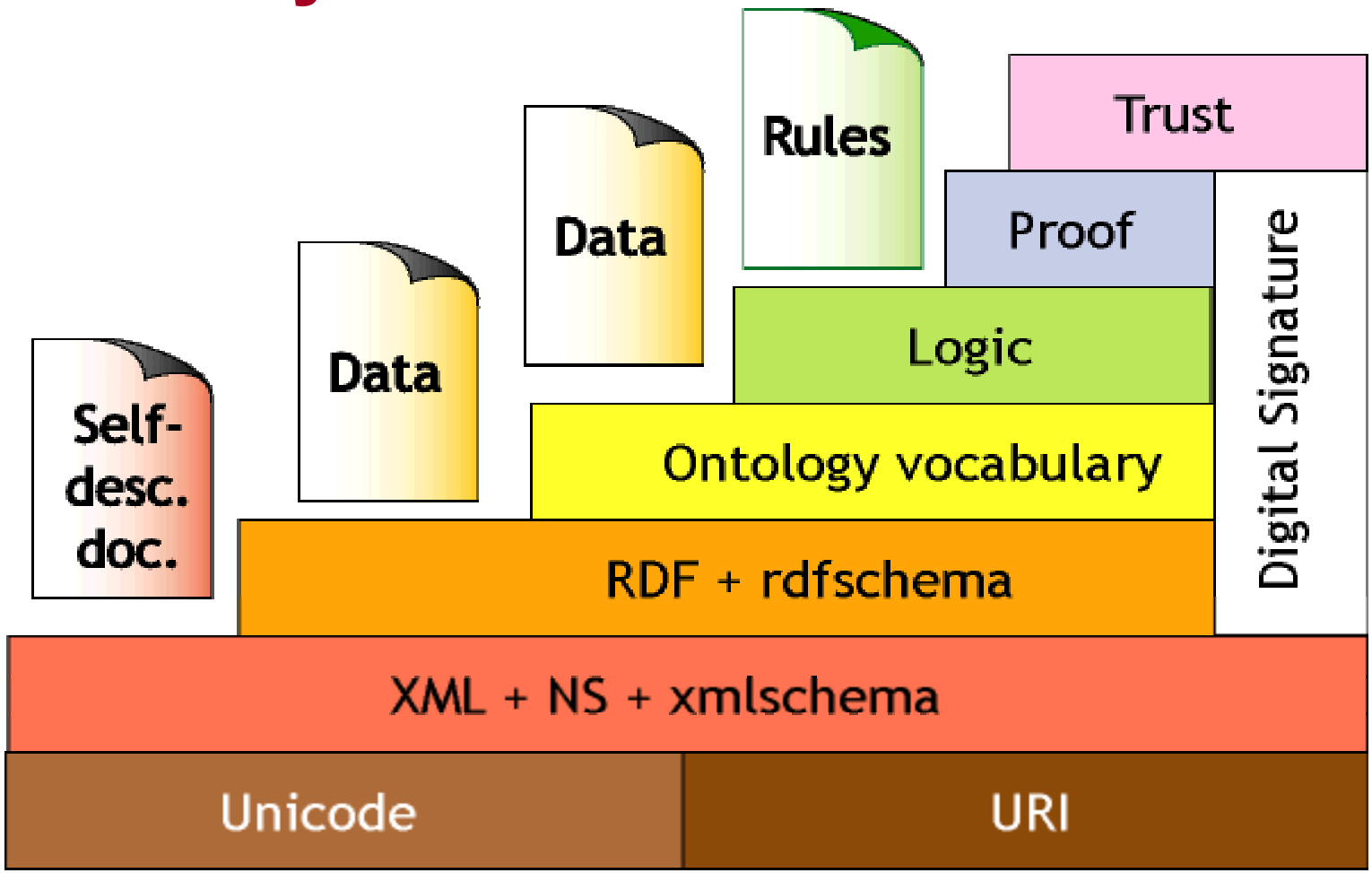
Fensel, Musen 2001

Emphasize on Services

McIlraith et al.,2001

- Automatic Web service discovery: automatic web service discovery involves the automatic location of Web services that provide a particular service.
- Automatic Web service invocation: Automatic Web service invocation involves the automatic execution of an identified Web service.
- Automatic Web service monitoring: Once a web service has been invoked, one may want to know the status of the service.
- Automatic Web service composition: This task involves the automatic composition and interoperation of Web services to perform some task, given a high-level description of an objective.

Semantic Web Stack - The Layer Cake



Berners-Lee, 2000

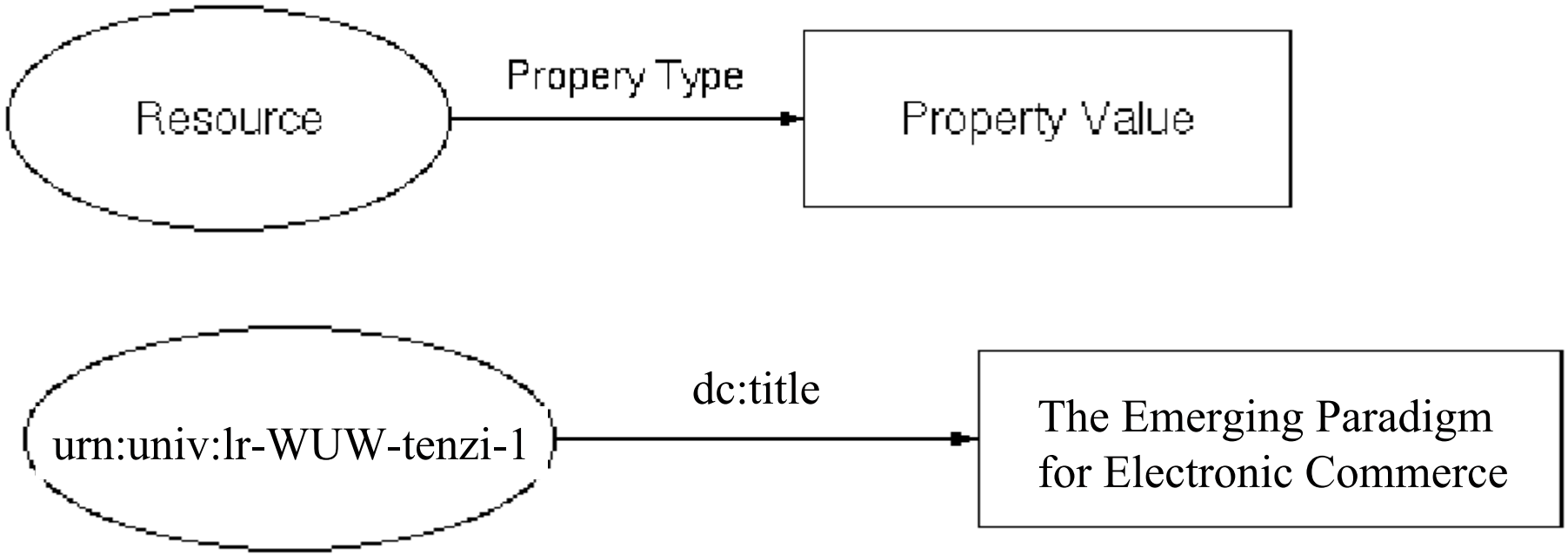
Example of an XML Schema

```
<?xml version="1.0"?>
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema"
    targetNamespace="http://www.books.org"
     xmlns="http://www.books.org">
  <xsd:element name="BookStore">
   <xsd:complexType>
      <xsd:sequence>
         <xsd:element ref="Book" minOccurs="1" maxOccurs="unbounded"/>
      </xsd:sequence>
   </xsd:complexType>
  </xsd:element>
  <xsd:element name="Book">
   <xsd:complexType>
      <xsd:sequence>
         <xsd:element ref="Title" minOccurs="1" maxOccurs="1"/>
         <xsd:element ref="Author" minOccurs="1" maxOccurs="unbounded"/>
   </xsd:sequence>
   </xsd:complexType>
  </xsd:element>
  <xsd:element name="Title" type="xsd:string"/>
  <xsd:element name="Author" type="xsd:string"/>
</xsd:schema>
```

XML Instance

```
<?xml version="1.0"?>
<BookStore xmlns ="http://www.books.org"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.books.org BookStore.xsd">
  <Book>
    <Title>My Life and Times</Title>
    <Author>Paul McCartney</Author>
   </Book>
       etc...
</BookStore>
```

Resource Description Framework (RDF)



RDF Instance

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<rdf:RDF
        xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
        xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
        xmlns:dc="http://purl.org/dc/elements/1.1/">

        <rdf:Description rdf:ID="urn:univ:lr-WUW-tenzi-1">
                <dc:title>
                        The Emerging Paradigm for Electronic Commerce
                </dc:title>
                <dc:creator rdf:resource="urn:univ:us-1"/>
                <dcq:created>
                        <dcq:W3CDTF>
                                <rdf:value>2000-05-07</rdf:value>
                        </dcq:W3CDTF>
                </dcq:created>
        </rdf:Description>
</rdf:RDF>
```

Differences between XML and RDF Schema

- XML Schema is used for describing the valid syntax of an XML document
- RDF Schema is used for describing differences between concepts (RDF Schema vocabulary: class, property, subclass, type,

Differences between XML and RDF

- XML focuses on syntax and document structure, RDF on semantic.
- RDF supports the creation of self-describing documents.
- RDF namespaces are part of tags providing a semantic identifier at an attribute level.
- RDF has its foundations in logic.
- RDF provides a „complete“ Framework: graphical representation, XML serialization, triples.

Using XML and RDF to describe services

- Web Service Description Language (WSDL)
- SOAP: Remote Procedure Calls via Web
- Universal Description, Discovery and Integration (UDDI): white, yellow and green pages (uses WSDL and SOAP).
- DAML (Darpa Agent Markup Language) provides means for expressing knowledge of a service:
  - What does the service require?
  - How does it work?
  - How is it used?

Ontologies

Ontologies provide an explicit, formal specification of how to represent the objects, concepts and other entities that are assumed to exist in a domain and the relationships that hold among them.

Sample Ontology: African Wildlife

```
class-def animal                                    % animals are a class
class-def plant                                     % plants are a class
      subclass-of NOT animal                        % that is disjoint from animals
class-def tree
      subclass-of plant                             % trees are a type of plants
class-def branch
       slot-constraint is-part-of                   % branches are parts of trees
            has-value tree
class-def leaf
       slot-constraint is-part-of                   % leaves are parts of branches
            has-value branch
class-def defined carnivore                         % carnivores are animals
       subclass-of animal
       slot-constraint eats                         % that eat only other animals
            value-type animal
class-def defined herbivore                         % herbivores are animals, but not carnivores
       subclass-of animal, NOT carnivore
       slot-constraint eats                         % that eat only plants or parts of plants
            value-type plant
            OR (slot-constraint is-part-of has-value plant)
class-def giraffe                                   % giraffes are herbivores
       subclass-of herbivore
       slot-constraint eats                         % and they eat leaves
            value-type leaf
class-def lion
       subclass-of animal                           % lions are also animals
       slot-constraint eats                         % but they eat herbivores
            value-type herbivore
class-def tasty-plant                               % tasty plants are plants that are eaten by
       subclass-of plant                            % both herbivores and carnivores
       slot-constraint eaten-by
            has-value herbivore, carnivore
```

Decker, et al. 2000

Ontology Engineering

- ... develops and uses techniques for accumulating knowledge within reasonable size of stratified domains. The product of such a study is a catalog of the types of things that are assumed to exist (Sowa, 2000).
- Ontology discovery (Maedche and Staab, 2001) extends ontology-engineering environments by using semiautomatic ontology-construction tools.

How do Use Cases of the Semantic Web look like and how can we realize them?

Designing Smart Spaces for Learning and Teaching - Definition

- Smart Spaces are defined as peer-to-peer networks (spaces) that mediate learning and teaching services (e.g. delivery of courses or educational material)
- Take advantage of distributed, intelligent user profiling services in order to support the service and artefacts selection process.

Services for Learning and Teaching

Accreditation Services

Curriculum Evaluation Services

Development Tools, e.g. AuthorWare, PowerPoint, RealPresenter, Quest

Content Brokerage Platforms, e.g. The Gateway, LydiaLearn, Merlot, Universal

CRM Components of ERP Systems e.g. SAP Virtual Campus

Competence Management Systems, e.g. SABA Learning, Clixx

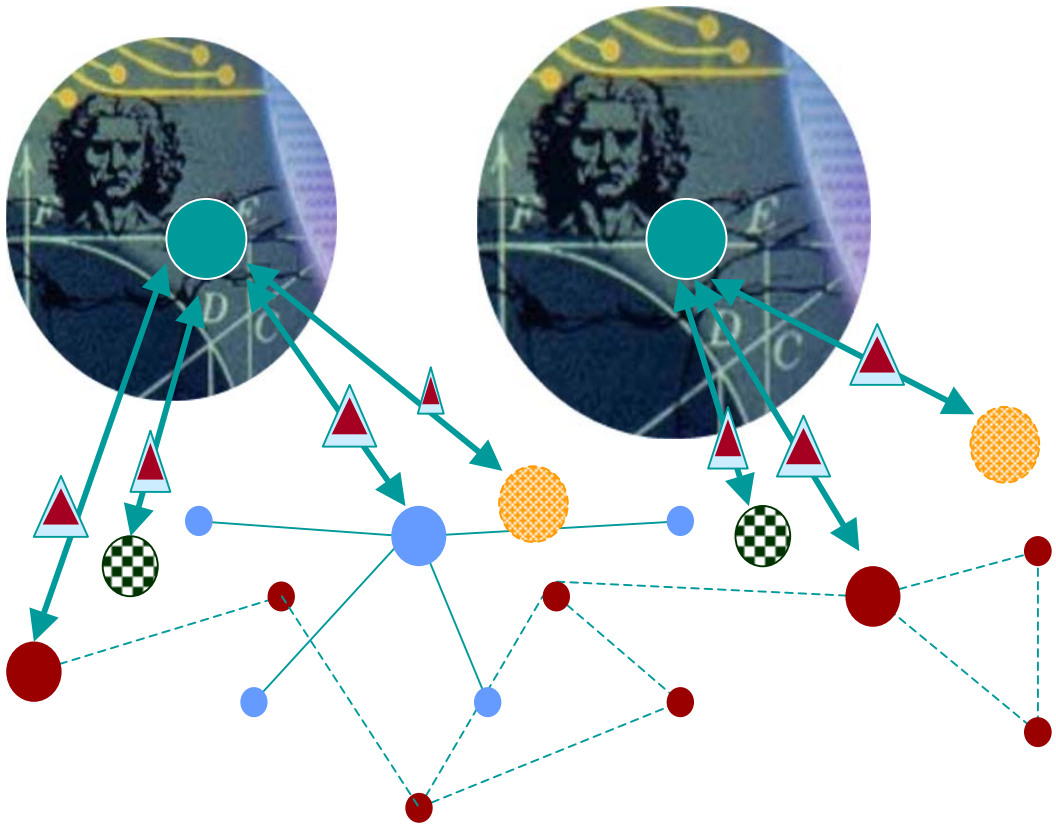
Learning Management Systems, e.g. Hyperwave ELS, Lotus Learning Space, WebCT, Blackboard

Collaborative Teaching Tools, e.g. Isabel

Learner Assessment & Certification Services

Evaluation Tools, e.g. Zoomerang

Interaction Scenarios within Smart Spaces



Nodes of Content Brokerage Network

Network of Video Conferencing Devices

Assessment Services Site

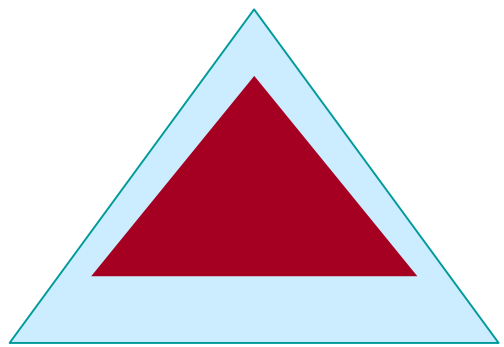
Human Resources Management Systems

Smart Space for Learning & Teaching

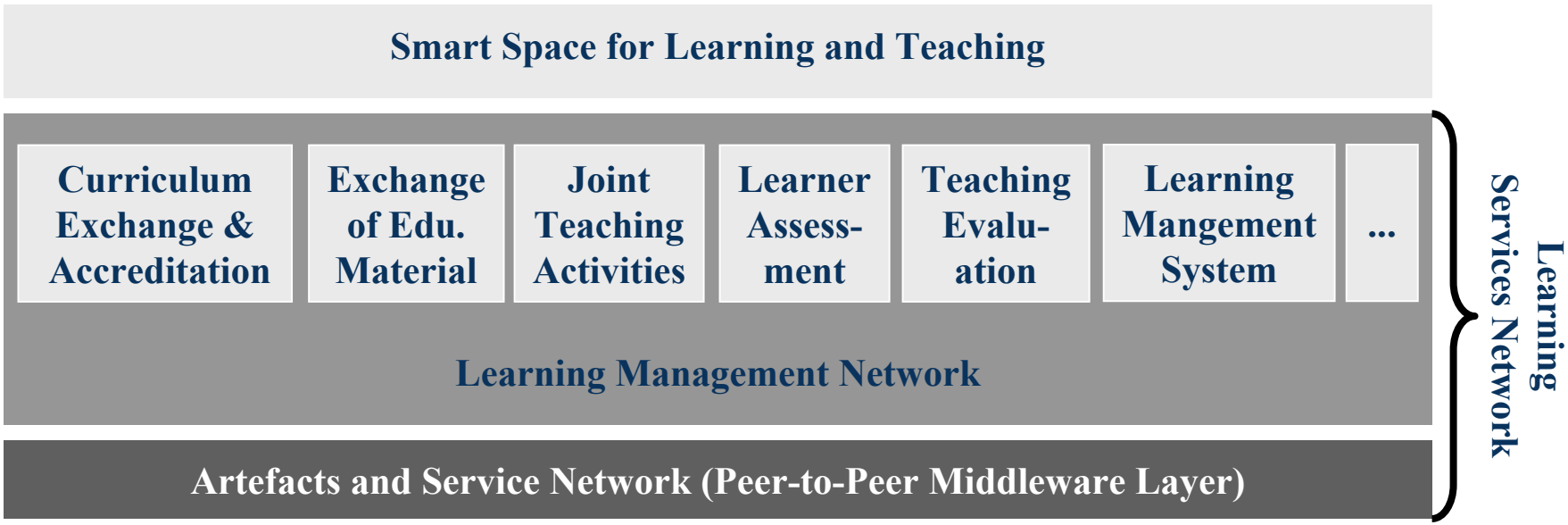
Services delivering artefacts for learning

Artefacts involved

- Educational Material, e.g. case studies, text books, support material, simulations, ...
- Educational Activities, e.g. lectures, tutoring sessions, online courses, ...
- Accreditation and Assessment data of ed. activities and ed.material
- Learner profiles and personal development plans
- Instructor track records, …



Envisioning a Communication Framework



What is missing from a technical point of view?

- Mobile network connectivity
- Standards for all artefacts involved
- Ontologies for learning resources (ed. material + ed. activities)
- Ontologies for learning services

What is missing from a technical point of view?

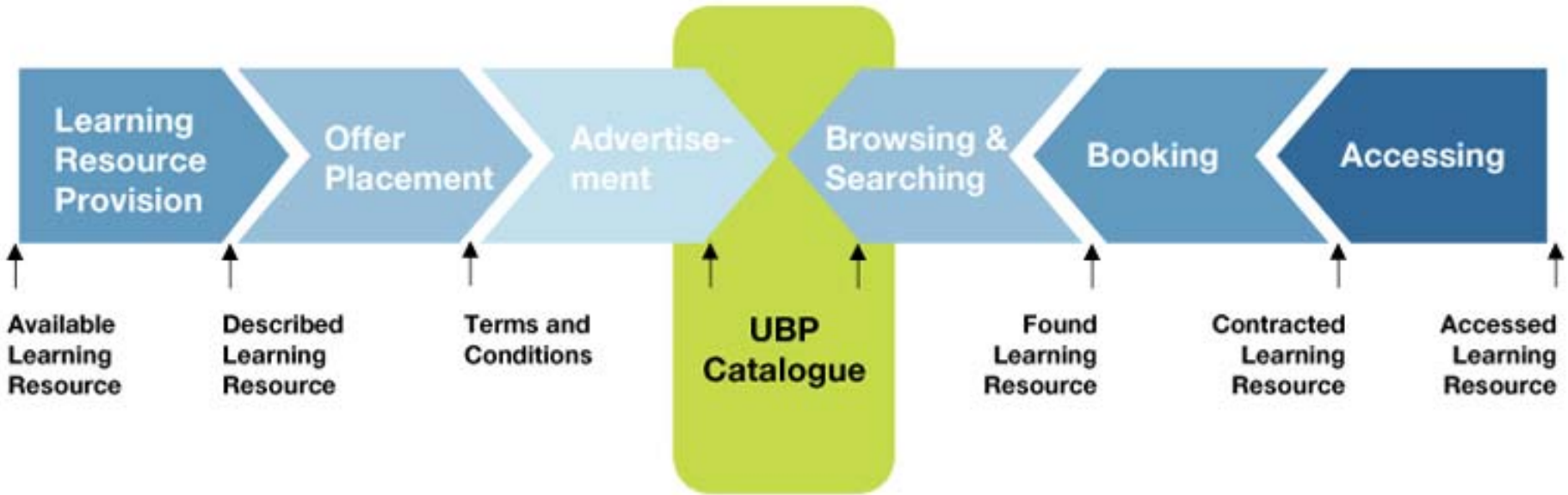
- Standards for Peer-to-Peer integration providing peer authentication and communication (early research: http://edutella.jxta.org)
- Remote Query Interfaces for metadata repositories (early research: Nejdl, et al 2002)
- Replication of repositories describing artefacts descriptions (early research: Nejdl, et al 2002)

What is missing from the socio-economic point of view? - A Case Study from the Universal Project

Envisioning a Smart Space for Teaching

- Alternative Concepts: Electronic Education(al) Markets, Knowledge/Learning Media, Knowledge Warehouse/System, Digital Library for Learning Resources
- Examples: Edutella, Universal (http://www.ist-universal.org),
- Based on traditional Web technology: Gateway to Educational Material, Merlot, dSpace @ MIT, Virtual University @ Wirtschaftsuniversität Wien

The UNIVERSAL Value Chain



Why a smart space for teaching?

Benefits for the provider of learning resources

- **Share** the creativity of your work with others who might be desperately looking for exactly the kind of learning objects you have created;
- **Get feedback** from your learning object consumers, which will enable you to enhance your own material;
- **Gain reputation** in a growing community;
- **Access** new academic distribution channels;
- **Encourage others** to put material online, from which you might benefit as well.

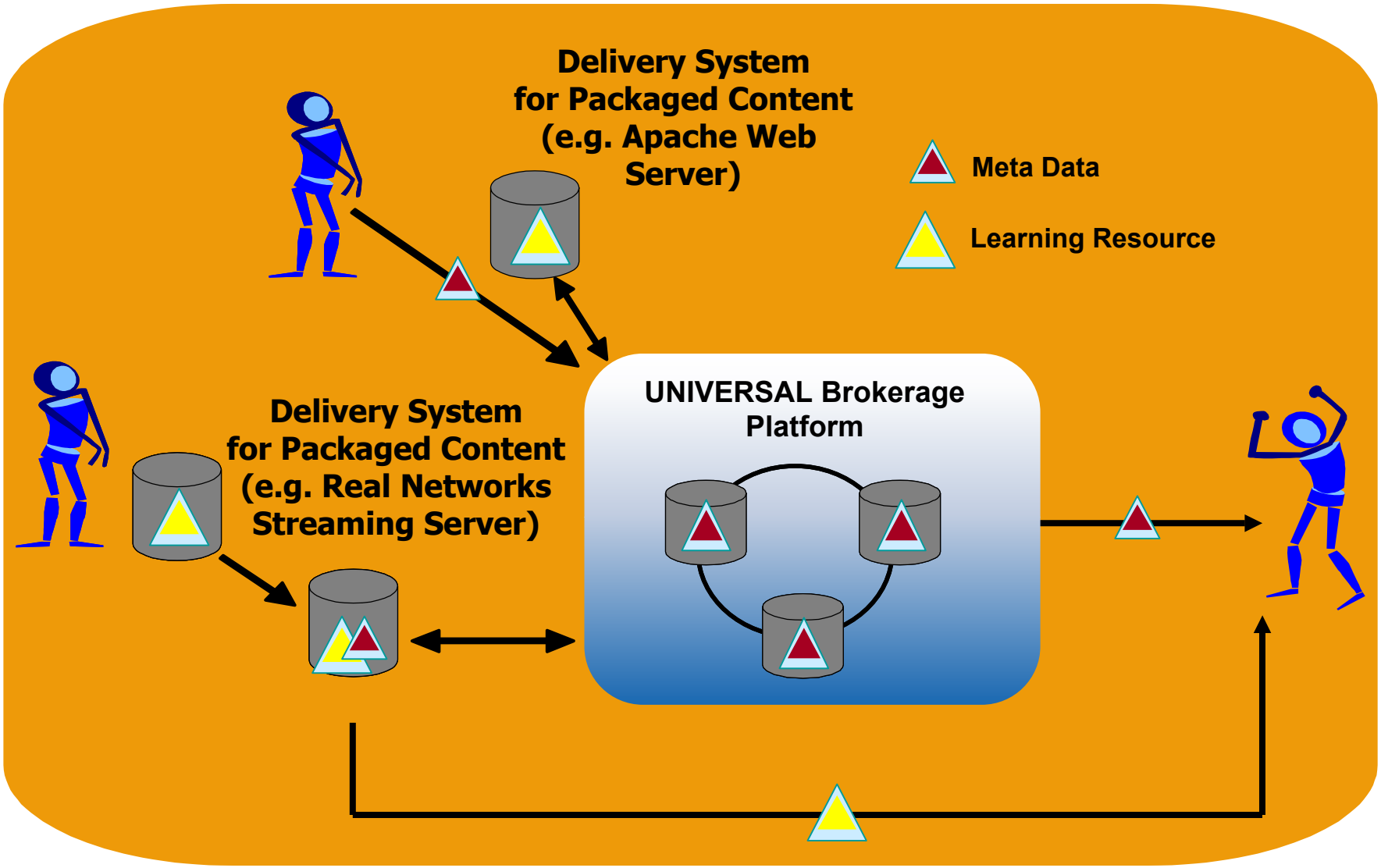
Proved by User Survey

Benefits for the consumer of learning resources

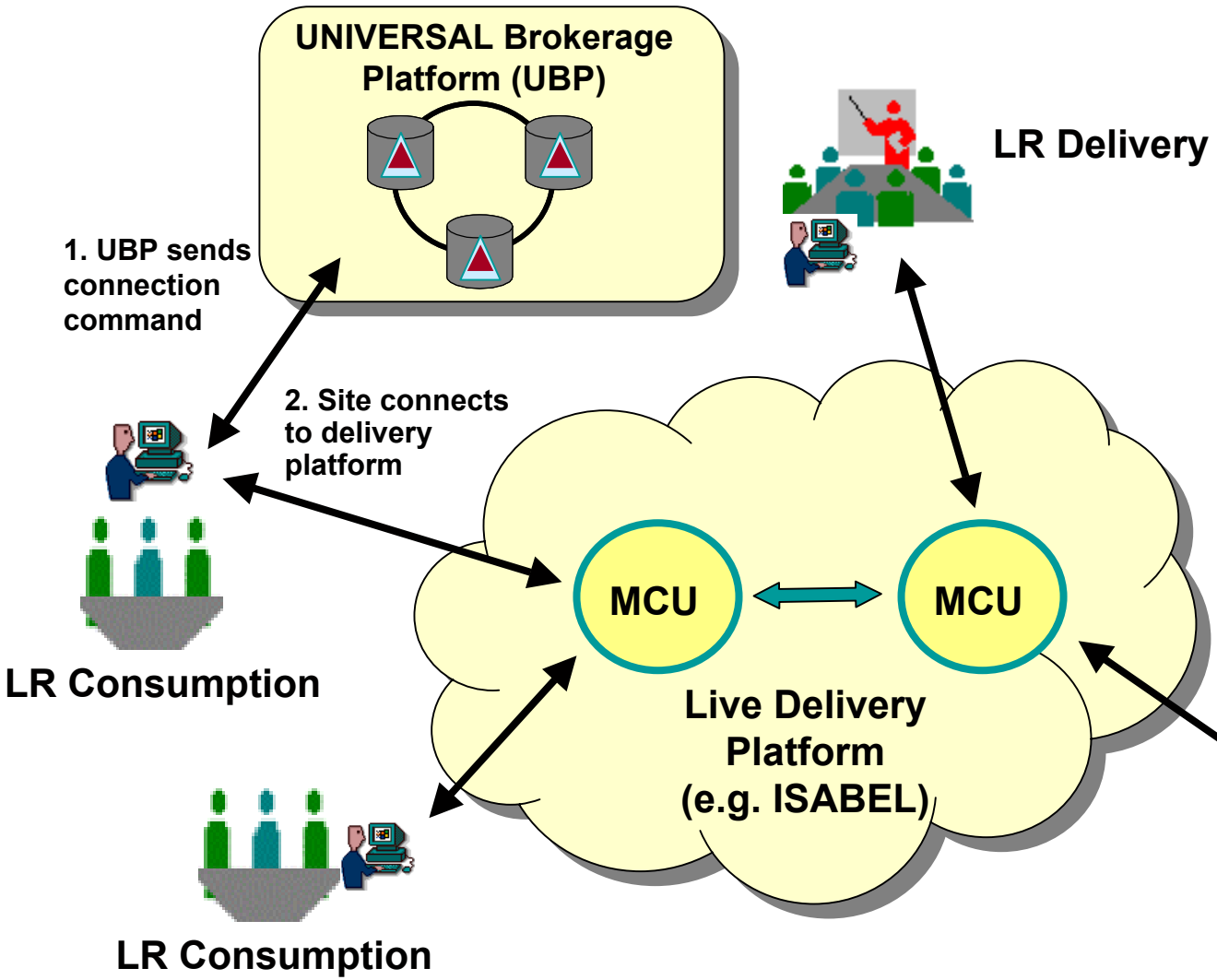
- **Reuse** existing material instead of paying the costly price of developing it on your own;
- **Contribute** to a community of scholars through interaction with instructors, experts and peers;
- **Enhance** quality teaching;
- **Foster** national and international academic **alliances** and exchanges;
- **Enable partnerships** between faculty members.

Proved by User Survey

UNIVERSAL System Architecture I



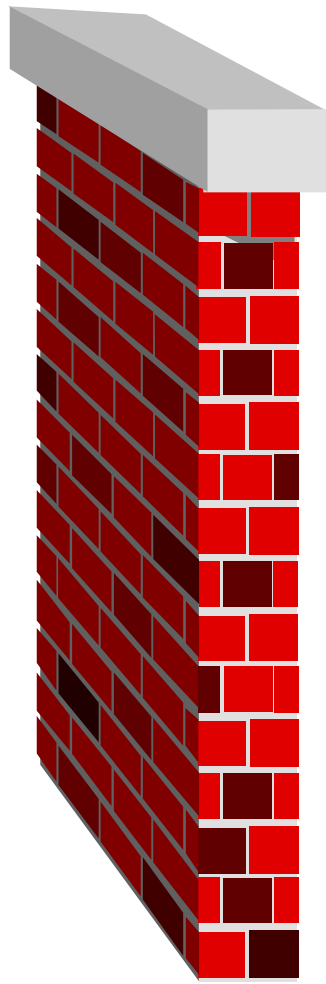
UNIVERSAL System Architecture II



Procedure:

1. UBP sends a connection command to all registered end-user sites before a session starts
2. A terminal connects the end-user site to the delivery platform

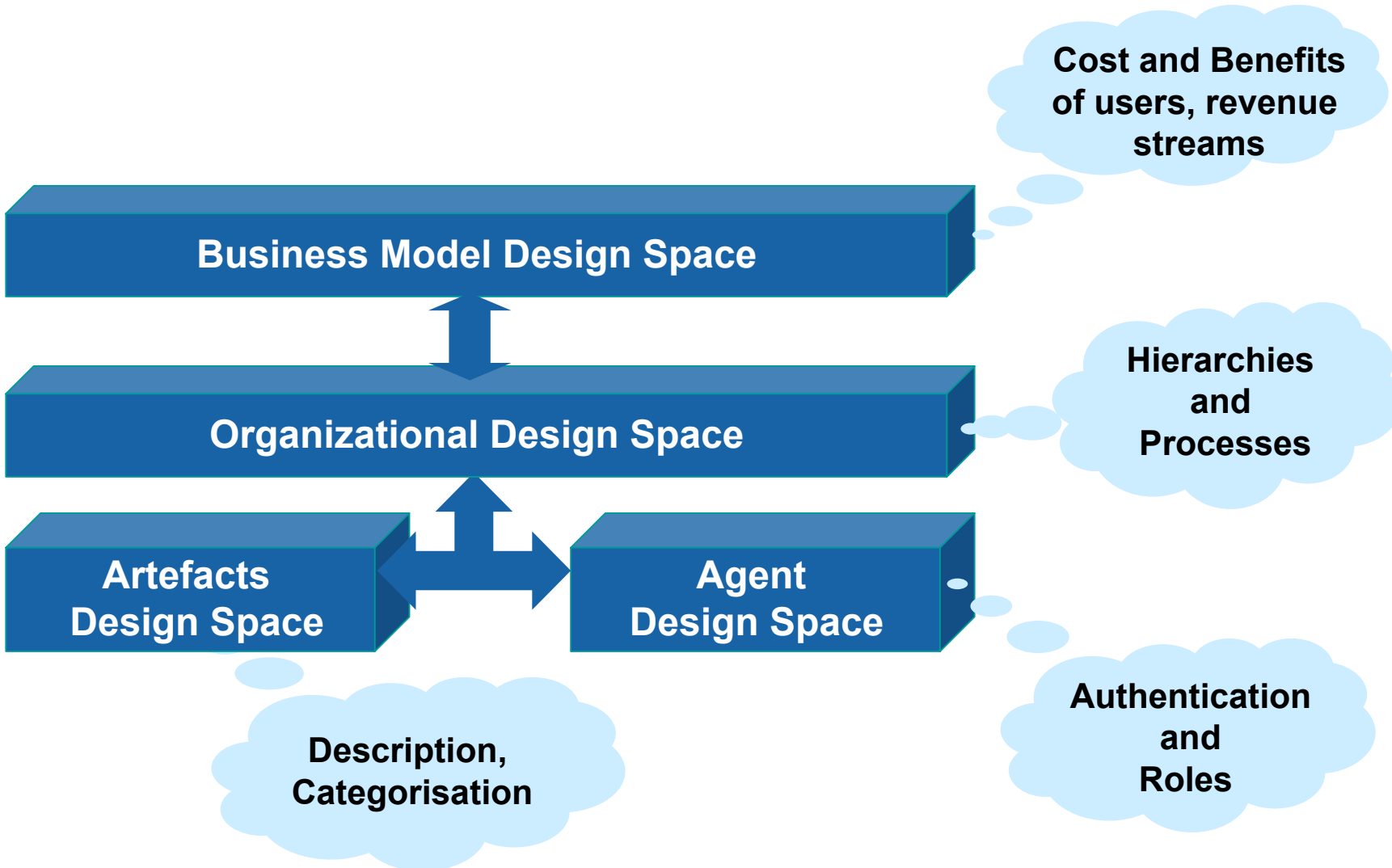
In the past users have been reluctant to use smart spaces:



- 1998: STRIKE at York University;
- 2000: At the Virtual University of Wirtschaftsuniversität Wien only 48 References to Learning Resources were found (given that Wirtschaftsuniversität Wien offers 1.900 courses per semester);
- 2001: UNIVERSITAS 21 faculty and students boycott a smart space project among American and Australian Universities

Socio-economic Research Question: What are success factors of smart spaces for teaching?

Design Spaces



Methodology

Interview technique

- Telephone Interviews based on questionnaire

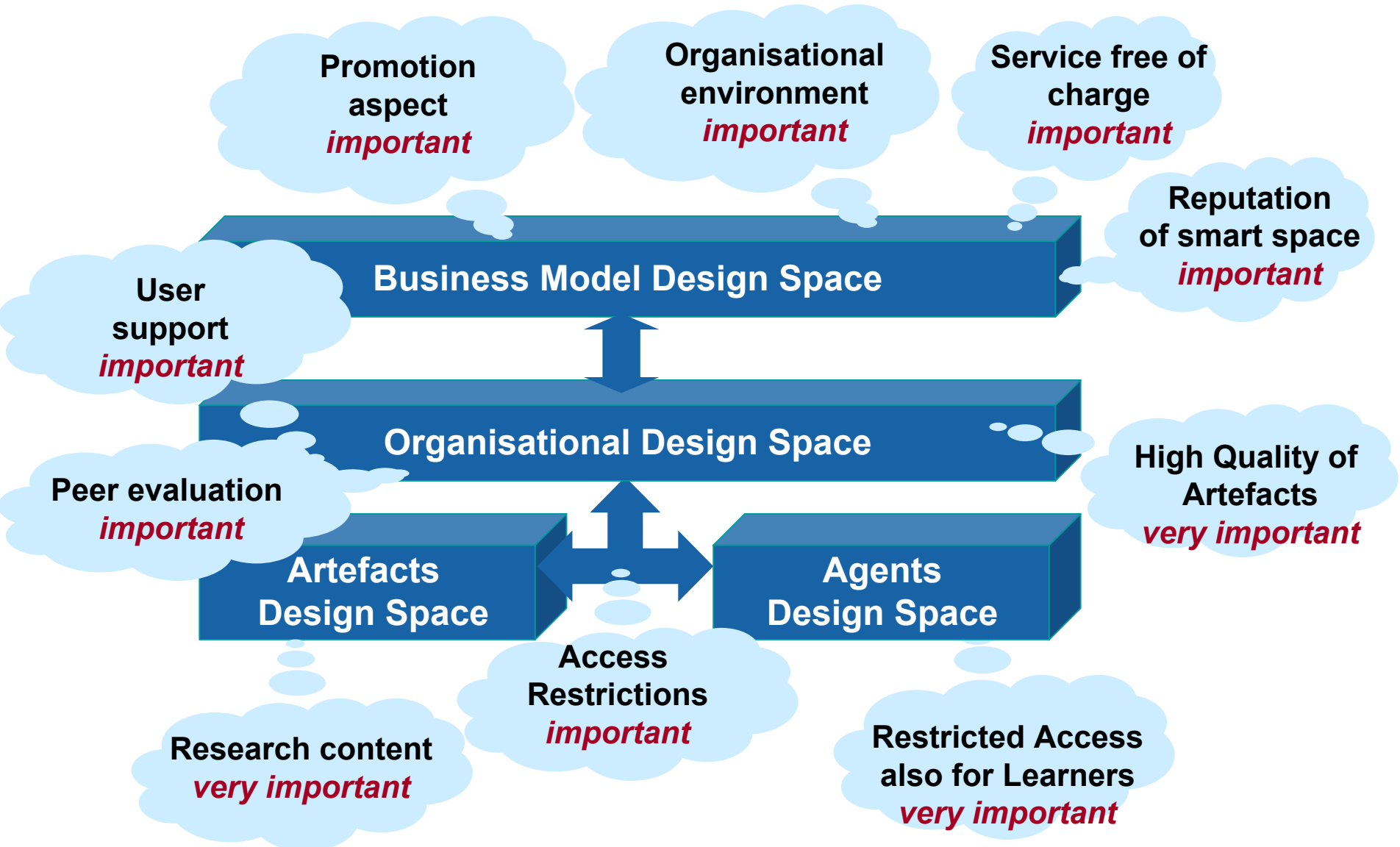
Survey population

- Faculty of four European Business Schools: Wirtschaftsuniversität Wien, Universität St. Gallen, Universität zu Köln, HEC Paris
- Weighted Random Sample of 127 faculty members

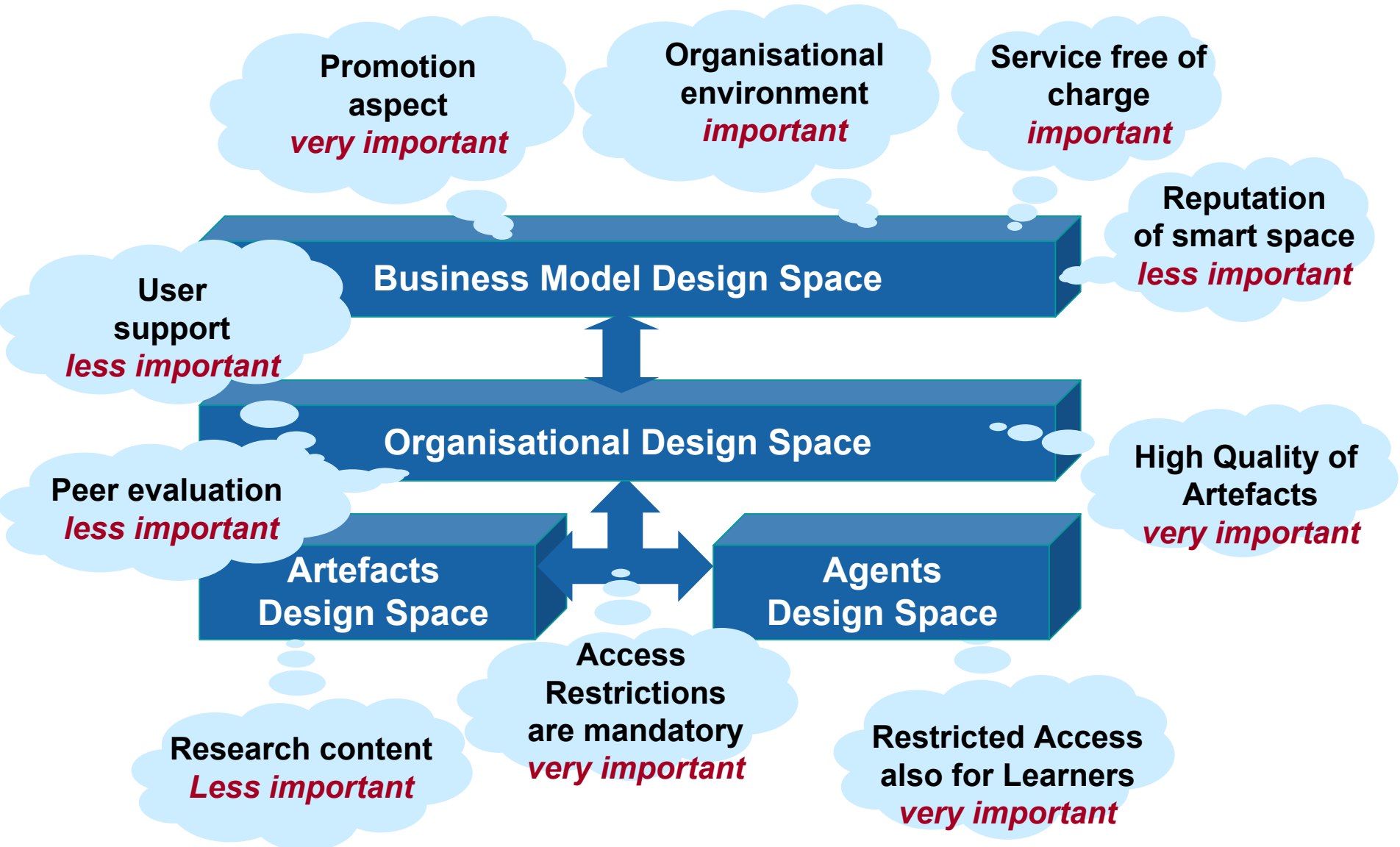
Fundamental Decision in Business Model Design Space

Community Model	**Transaction Model**
Collaborative Design and Delivery of Learning Resources „Co-operate“	External Acquisition and Distribution of Learning Resources „Buy“

Design of a Community Scenario



Design of a Commercial Scenario



Success Factors Relating to User Type

Supporter of Community Model
(General interest: 70,9 %)

- Higher interest on exchanging research content
- Early adaptor
- Most likely not in a leading position
- Access restriction less important
- No willingness to pay for the service

Supporter of Transaction Model
(General interest: 37,8 %)

- Less interested in exchanging research content
- Not an early adaptor
- Being represented in the smart space is important
- Access restriction very important
- Higher willingness to pay for the service

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