Analysis and Comparison of Systems for Heterogeneous Information Resources Integration

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Talk outline

- **Information Integration Problem**
- Heterogeneous Information Resources Integration
- Analyzed Integration Systems
- Important Integration Principles and Comparison Criteria
- Results

Information Integration Problem

- The current period of IT development is characterized by an explosive process of information models creation.
- **Distributed infrastructures**: OMG, semanticWeb, SOA, digital library, information grid, …
- **Information models**: data models, workflow models, process service composition models, semantic models
- **Accumulation** of based on such models information resources, the **number** of which **grows exponentially**

- Dr. Patrick Ziegler
- http://www.ifi.uzh.ch/~pziegler/IntegrationProjects.html
- 183 Integration Projects

Types of Information Integration Systems

- Data warehousing
- Virtual Data Integration
- Message Mapping
- Object Relational Mapping
- Document Management
- Portal Management

Data warehousing

- Data warehouse – database that consolidates data from multiple sources
- Each resource may have a **DB schema** that **differs** from the **warehouse schema**. So **data has to be reshaped** into common warehouse schema
- Extract-Transform-Load (ETL) tools
  - cleansing operations
  - reshaping operations

Virtual Data Integration

- Gives the illusion that data sources have been integrated **without materializing** data
- Offers a **mediated schema** against which users can pose queries
- The **implementation**, often called a **query mediator system**, translates the **user's query** into **queries over the data sources** and integrates the result of those queries so that it appears to have come from a single integrated database
- Resources are **heterogeneous** in that they may use **different database** systems and structure the data using **different schemas**

Message Mapping

- **Message-oriented middleware** helps integrate independently developed applications by **moving messages** between them
- If a broker is avoided through all applications' use of the same protocol, then the product is called an **enterprise service bus**.
- If the focus is on defining and controlling the order in which each application is invoked, then the product is called a **workflow system**.

Object Relational Mapping

- Application **programs** today are typically written in an **object-oriented** language, but the **data** they access is usually stored in a **relational** database.
- Mapping applications to databases requires **integration** of the **relational and application schemas**
- **Differences** in **schema constructs** can make the mapping rather **complicated**
- Object-to-relational **mapper** offers a high-level **language** in which to **define mappings**
- **Resulting mappings** are then **compiled** into **programs** that **translate queries and updates** over the object-oriented interface into queries and updates on the relational database

Document Management

- Much of the **information** is contained **in documents**
- To promote **collaboration** and avoid **duplicated work** in a large organization, this information needs to be integrated and published
- **Integration** may simply involve **making the documents available** or integration may mean **combining** information from these documents **into a new document**
- In some applications, it is useful to extract structured information from documents. The ability to **extract structured information** of this kind may also allow businesses to **integrate unstructured documents**

Portal Management

- One way to **integrate** related information is simply to **present** it all, side-by-side, **on the same screen**
- A **portal** is an type of **integration in mind**
- Portal design requires a mixture of content management (to deal with documents and databases) and user interaction technology (to present the information in useful and attractive ways)

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Heterogeneous Information Resources Integration

- Information **Resource driven** approach
  - moving from sources to problems (an integrated schema of multiple sources is created independently of a definition of specific application)
- is not scalable with respect to the number of sources
- does not make semantic integration of sources in a context of specific application possible
- does not lead to justifiable identification of sources relevant to specific problem,
- does not provide the required information system stability w.r.t. evolution of the observation sources (e.g., appearance of a new information source relevant to the problem lead to reconsideration of the integrated schema)

Heterogeneous Information Resources Integration (2)

- **Problem driven** approach
  - moving from a problem to the sources (a description of an application subject domain (in terms of concepts, data structures, functions, processes) is created, into which sources relevant to the application are mapped)
- assumes creation of subject mediator that supports an interaction between an application and sources on the basis of the application subject domain definition
- removes the disadvantages mentioned for the approach driven by information sources

Integration using Views

- Global As View (GAV)
  - According to GAV a global schema is defined in terms of the pre-selected sources
- Local As View (LAV)
  - Sources are defined as views over the mediator schema
- Both As View (BAV)
  - Based on the use of reversible schema transformation sequences. LAV and GAV view definitions can be fully driven from BAV
- GLAV
  - Later a variation of LAV allowing the head of the LAV view definition rules to contain any source schemas query and hence is able to express the case where a source schemas are used to define the global schema constructs (GAV)

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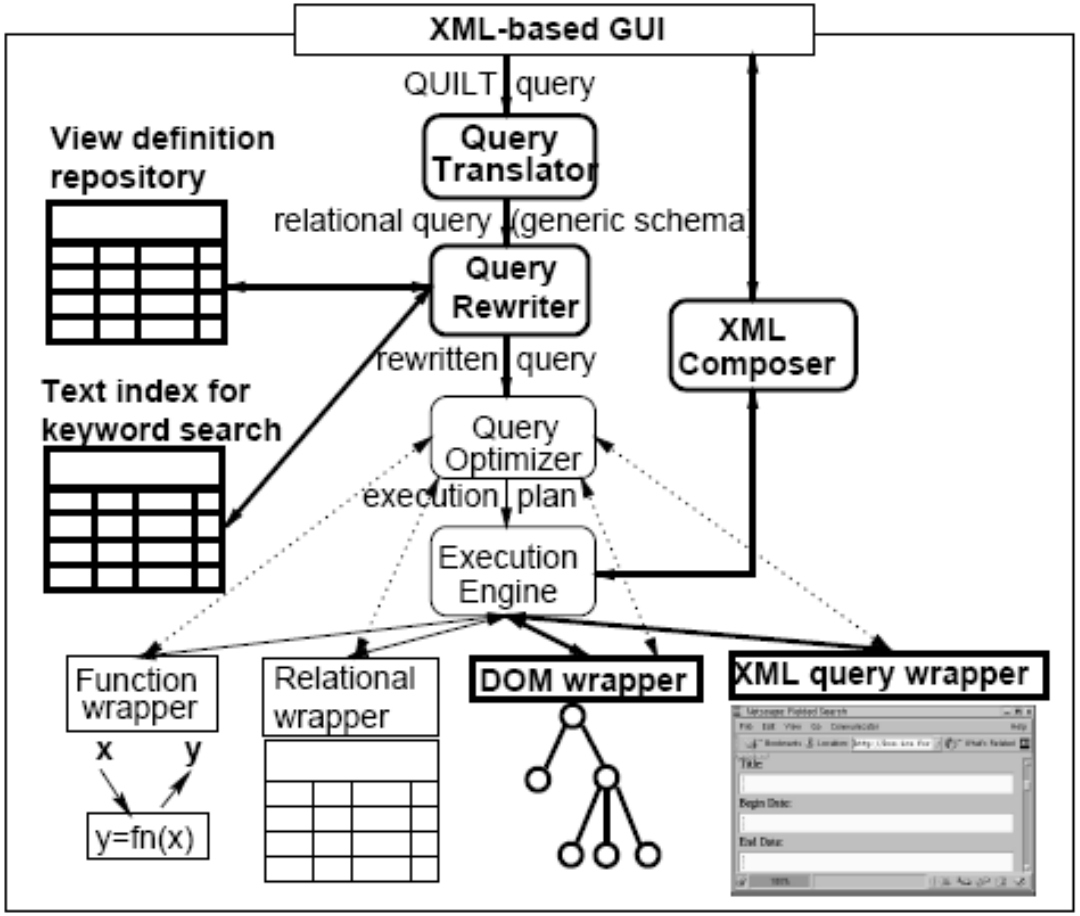
Information Integration Systems

- Agora
- AutoMed
- Infomaster
- PICSEL
- SIRUP
- Information Manifold
- MedMaker
- SYNTHESIS

AGORA

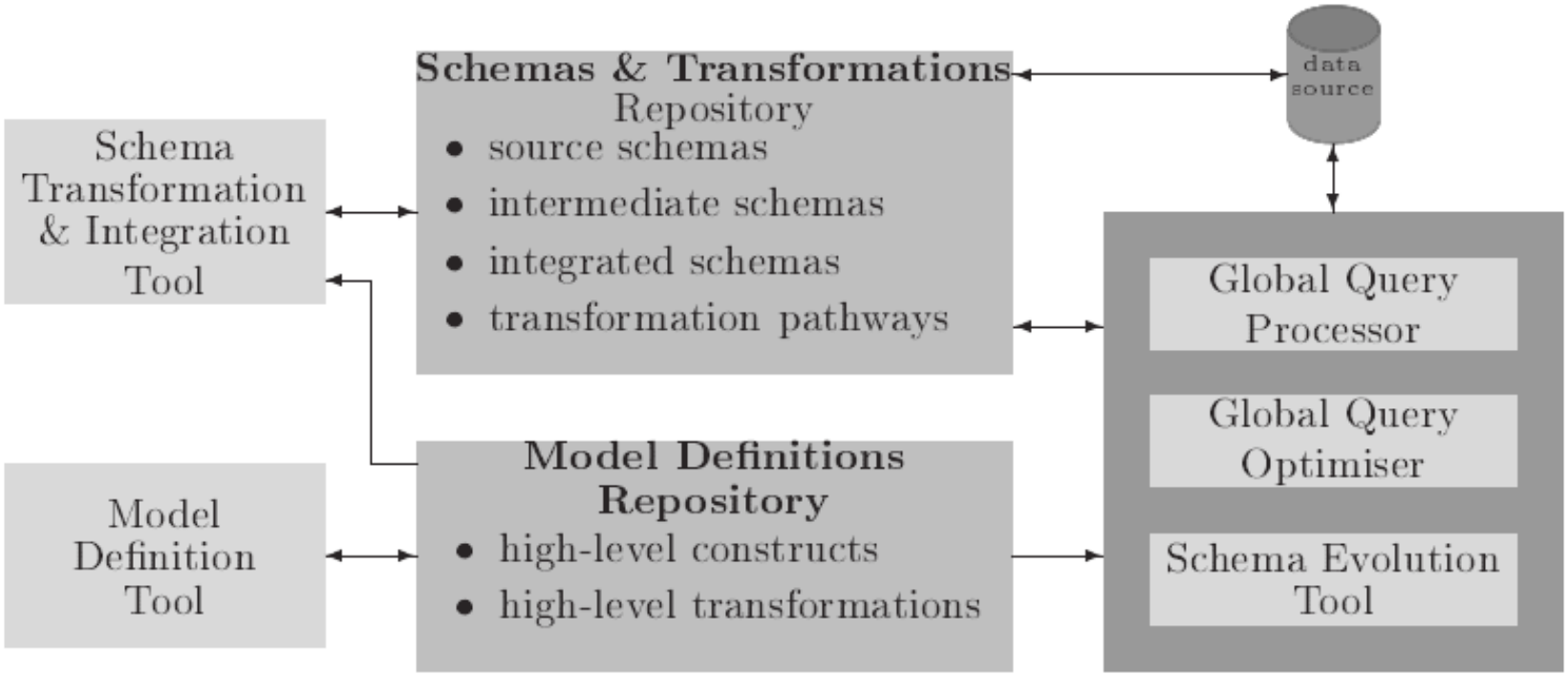
- **Approach**: LAV
- **Canonical model**: XML
- **Query language**: Xquery
- **Resources**: XML, Relational



Implemented in LaSelect

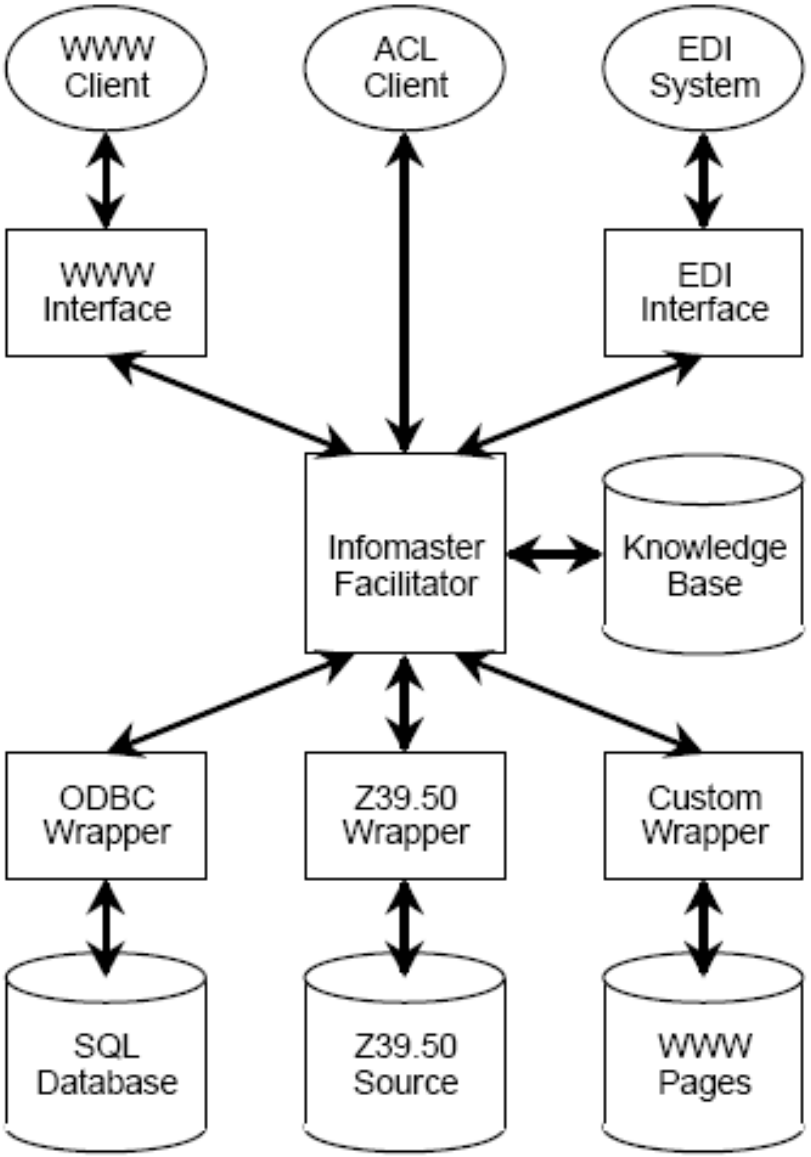
AUTOMED

- **Approach**: BAV
- **Canonical model**: HDM
- **Query language**: AIQL
- **Resources**: Relational, XML, flat files



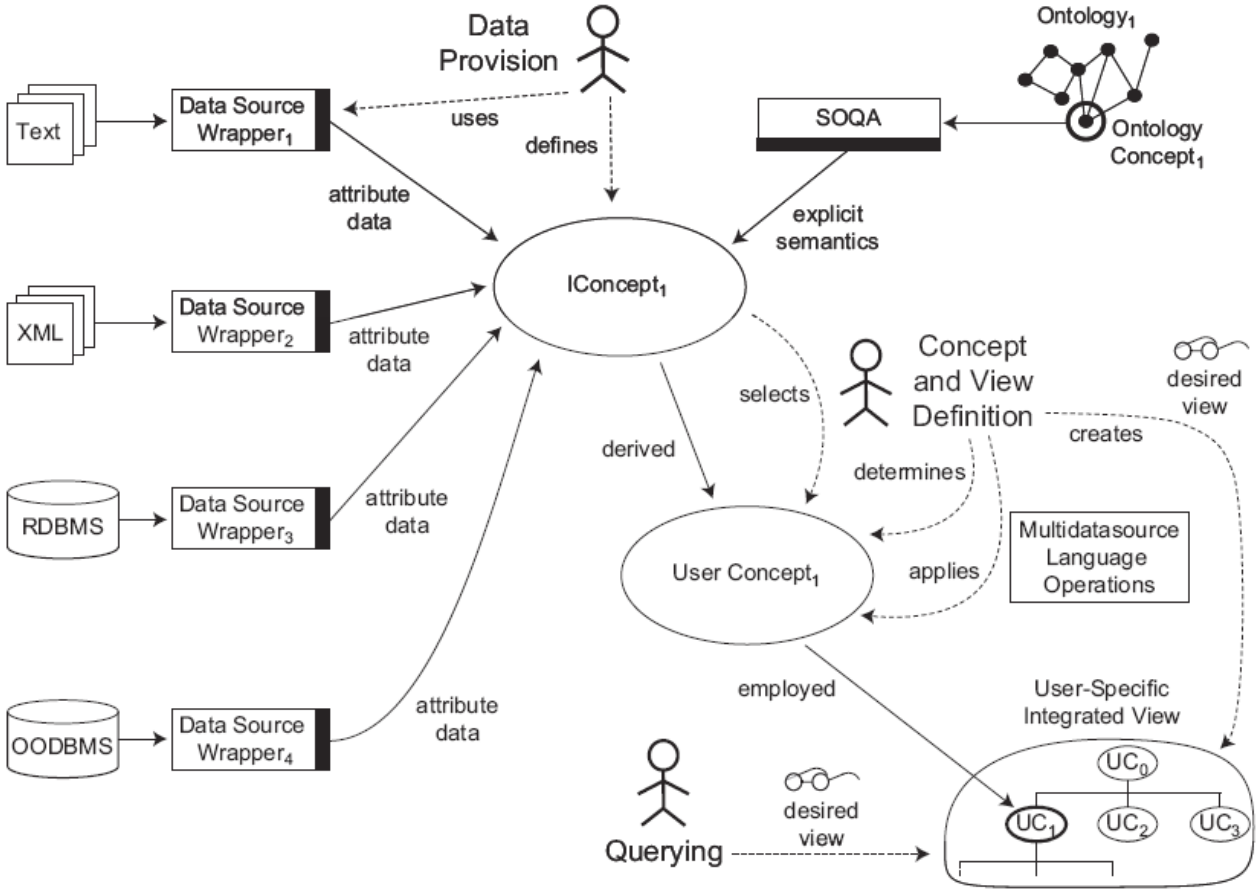
INFOMASTER

- **Approach**: LAV
- **Canonical model**: KIF
- **Query language**: KQML
- **Resources**: Relational, Z39.50, custom pages



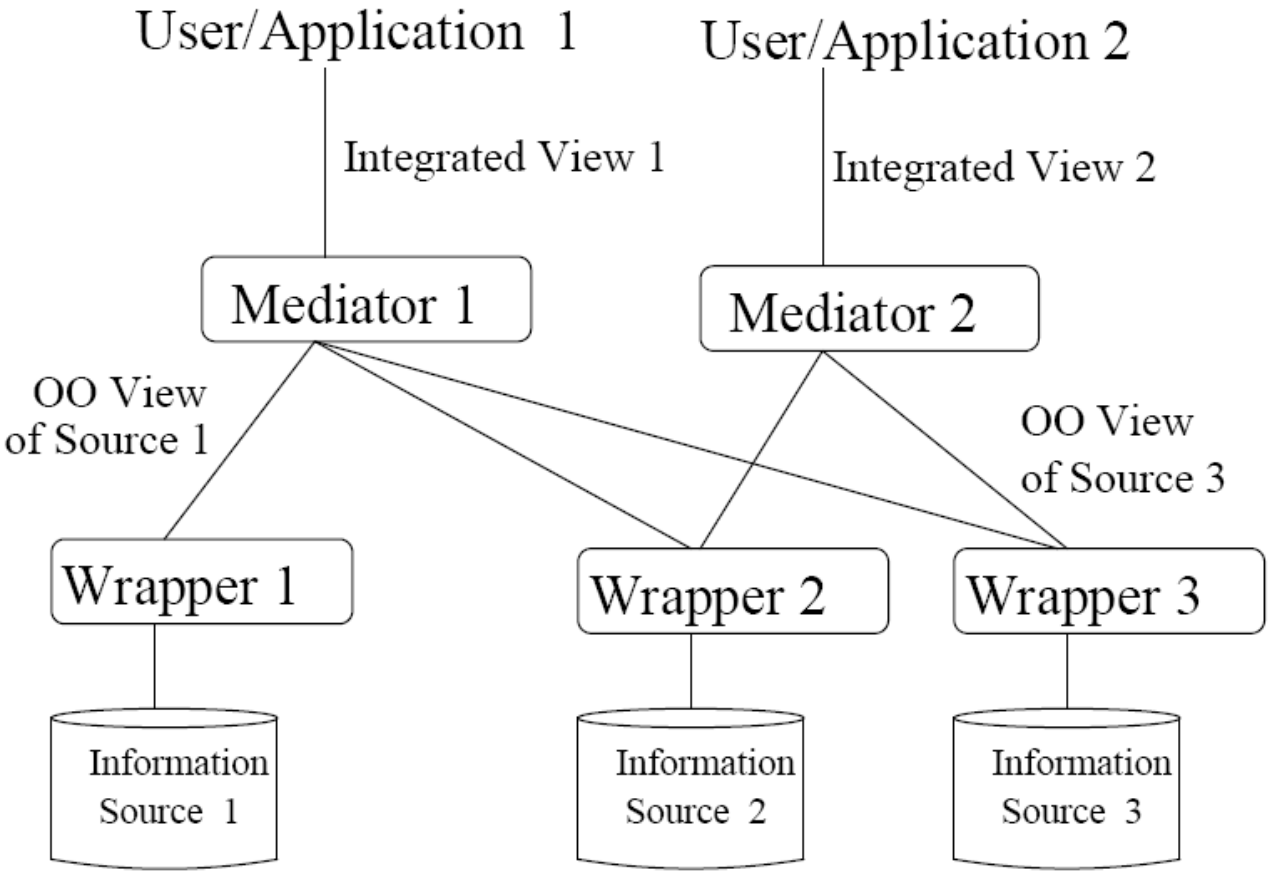
SIRUP

- **Approach**: LAV
- **Canonical model**: ICONCEPT
- **Query language**: SQL-like
- **Resources**: Relational, XML, ontology



MEDMAKER

- **Approach**: GAV
- **Canonical model**: OEM
- **Query language**: MSL
- **Resources**: Relational, Semi-Structured

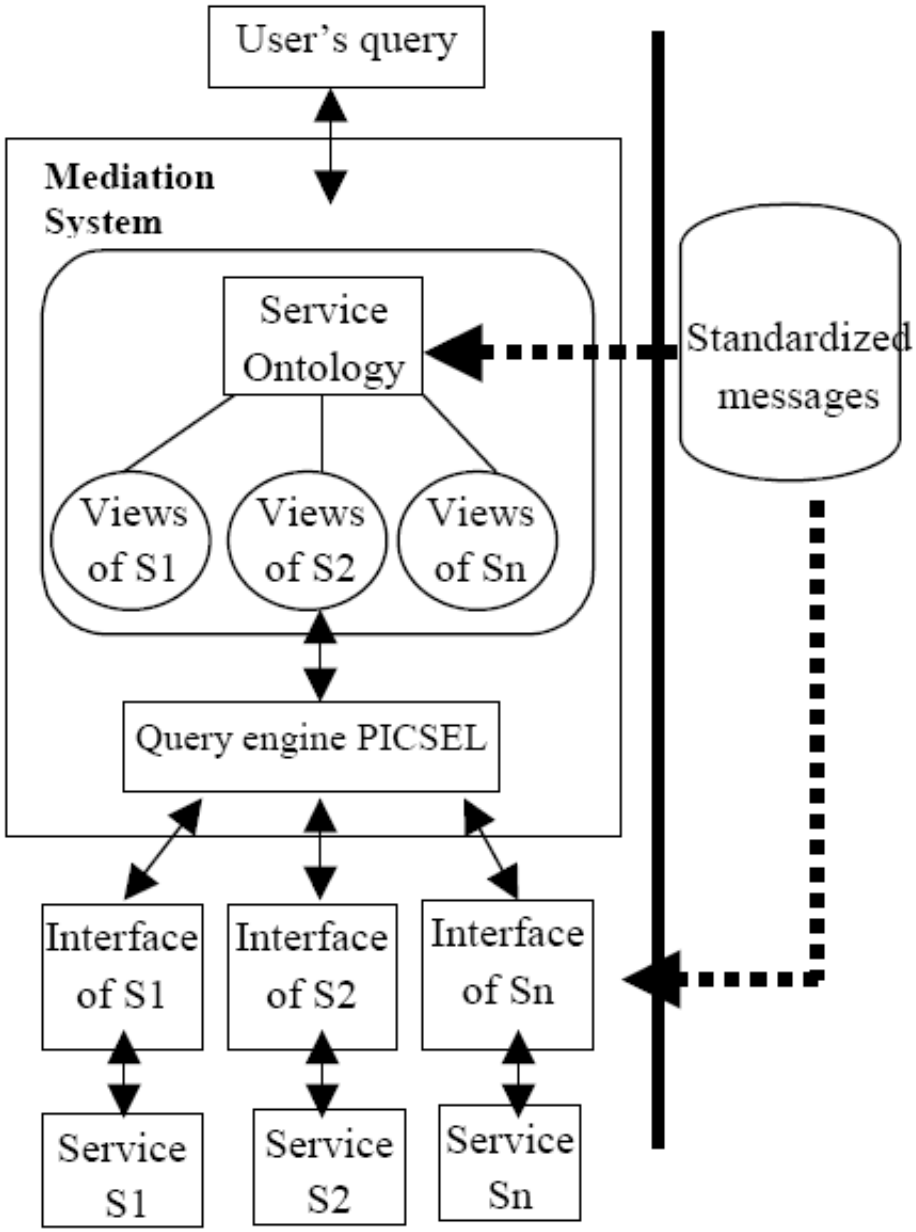


Information Manifold

- **Approach**: LAV
- **Canonical model**: CARIN-Classic
- **Query language**: Datalog-like
- **Resources**: XML, Relational, semi-structured, …

PICSEL2

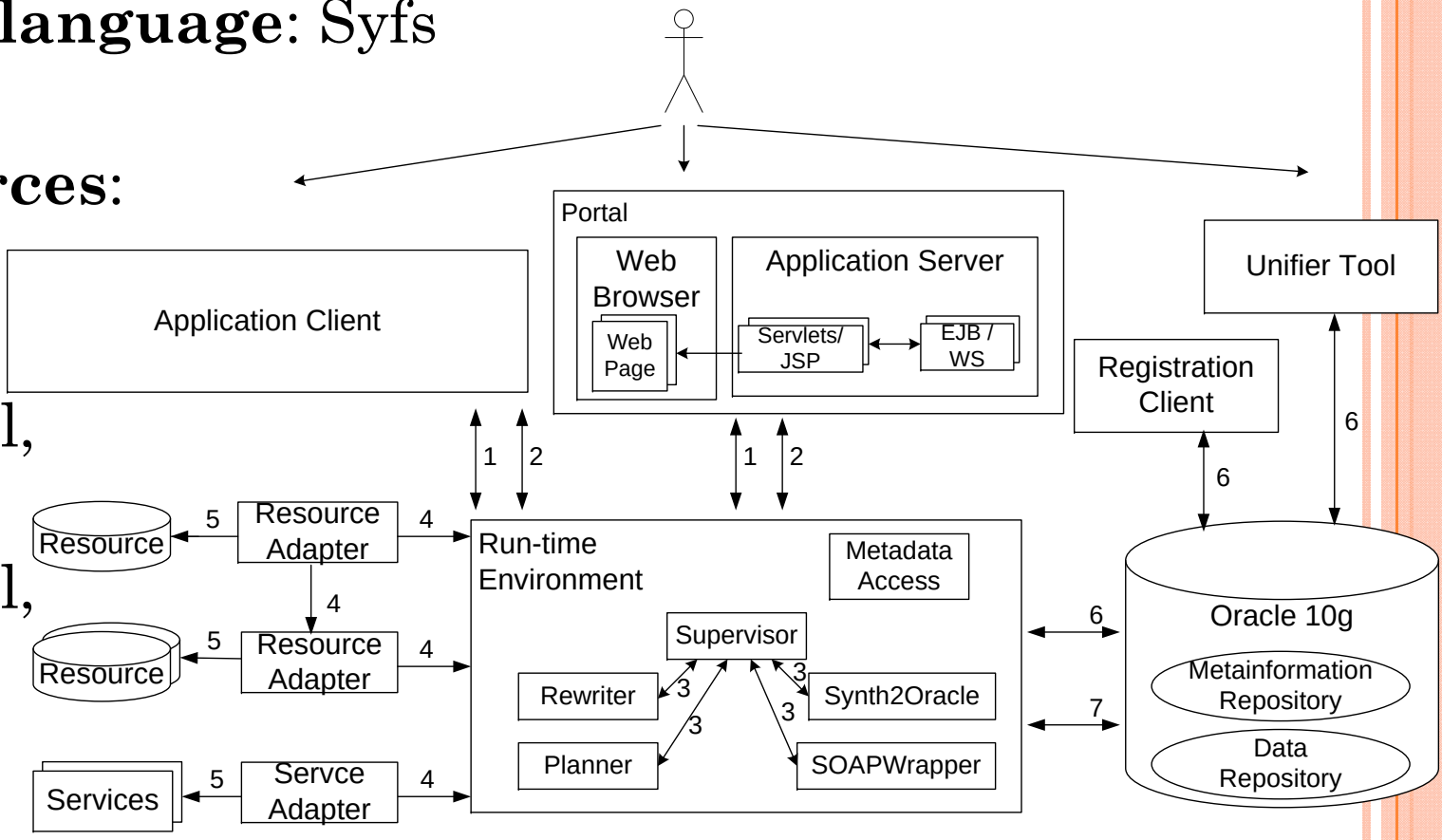
- **Approach**: LAV
- **Canonical model**: CARIN KB
- **Query language**: CARIN (Datalog like)
- **Resources**: Services



SYNTHESIS

- **Approach**: LAV
- **Canonical model**: SYNTHESIS
- **Query language**: Syfs

- **Resources**: XML, services, Relational, Objec-Relational, e.t.c.



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Important Integration Principles

- ASME Criteria
  - Abstraction
  - Selection
  - Modeling
  - Explicit Semantic
- Principles
  - Integration **Approach**
  - **Extensible** Canonical Informational Model
  - Semantic Schema Matching
  - Problem solving specification

ASME Criteria

- **Abstraction** refers to shielding users from low-level heterogeneities and underlying data sources
- **Selection** means the possibility of user-specific selection of data and data sources for individual integration
- **Modeling** corresponds to the availability of means to incorporate user-specific ways to perceive a domain of interest for which integrated data is desired in the process of data integration
- **Explicit semantics** refers to means for explicitly representing the real-world semantics of data.

Integration Principles

- **Integration Approach**
  - LAV removes the disadvantages of GAV
  - Abstraction + Modeling = Approach (LAV, GAV, …)
  - Criteria – **Approach** (“A”)
- **Extensible Canonical Informational Model**
  - Resources are **heterogeneous**, so the **unification** of **resources models** in the frame of some **unifying information model** called ***canonical*** is required
  - **Unification requires** a technique of **matching the specifications** of various resources
  - **Refinement relation**: It is said that specification A refines specification D, if it is possible to use A instead of D so that the user of D does not notice this substitution
  - Criteria – **Unification** (“U”)
  - Criteria – **Selection** (“S”)

Integration Principles (2)

- **Semantic Schema Matching**
  - Resource Registration require metadata (ontology)
  - Criteria – **Explicit Semantic** (“E”)
- **Problem solving specification**
  - Application domain specification includes: concepts, data structures, **functions**, processes
  - Criteria – **Functionality** (“F”)
  - Architecture Extensibility
  - Criteria – **Hybrid** (“H”)
  - User Friendly Integration Tools Availability
  - Criteria – **Tools** (“T”)

Comparison Criteria

- **AUSEFHT**
  - **A**pproach
  - **U**nification
  - **S**election
  - **E**xplicit Semantic
  - **F**unctionality
  - **H**ybrid
  - **T**ools

Results

System	A	U	S	E	F	H	T
Agora	LAV	No	No	No	No	No	Yes
AutoMed	BAV	Yes	No	Partially	No	Yes	Yes
Infomaster	LAV	No	No	No	No	No	No
SYNTHESIS	GLAV	Yes	Yes	Yes	Yes	Yes	Yes
PICSEL	LAV	No	Yes	Yes	Yes	No	Yes
SIRUP	LAV	No	Yes	Yes	No	Yes	Yes
Information Manifold	LAV	No	No	No	No	No	Yes
MedMaker	GAV	No	Yes	Partially	No	No	Yes

Conclusion

- **SYNTHESIS** – ex facte Excellent Project
- **MedMaker** – is interesting, cause automatic mediator generation
- **AutoMed** – is interesting, cause BAV views, and their transformation into LAV or GAV views. HDM, model mappings (Relational, XML, ER, UML, ORM), inter model transformation.
- **SIRUP** – ontology oriented approach. AIQL query.
- **PICSEL** – service integration oriented approach.

- Criteria must be wider
- More projects must be analyzed