Technical University of Cluj-Napoca
Faculty of Computer Science and Automation
Department of Computer Science

Service-oriented Research at Technical University of Cluj Napoca – Distributed Systems Research Lab (DSRL)

Prof. Ioan Salomie

Distributed Systems Research Laboratory
http://dsrl.coned.utcluj.ro

Ro-NeSSI meeting at UVT, April 30, 2010

Agenda

- Research Areas
- Research Team
- Research Projects
- Service Oriented Research at DSRL
- Selected Publications

Research Areas

- Service-Oriented Distributed Systems
- Autonomic Systems
- Pervasive Distributed Systems and Context Awareness
- Bio-inspired computing
- Knowledge Engineering and Intelligent Systems

DSRL Research Team

- Professor Ioan Salomie
- Associate professor Mihaela Dinsoreanu
- Associate professor Anca Rarau
- 5 PhD Students
  - Viorica Chifu, Tudor Cioara, Ionut Anghel, Cristina Pop, Sidor Lazar
- 8 Master Students

Research Projects

- **GAMES** - Green Active Management of Energy in IT Service Centres
  - FP7-ICT-2009-6.3: ICT for Energy efficiency
- **MAESTRO** – Ontology Driven Automatic Web Service Composition
  - Funded by CNCSIS, 2007-2010
- **ArhiNet** – Integrated System for developing semantically-enhanced archive content
  - Funded by CNMP, PNII, Research partnership for priority domains, 2007-2010
- **FOOD-TRACE** - Integrated IT system for assuring traceability and quality control in food industry,
  - Funded by MEC, CEEX project, 2006 - 2008
- **SCANURGENT** – Screening, prophylaxis and correction of children's genital-urinal congenital malformations using minimal invasive techniques
  - Funded by MEC, CEEX project, 2006 – 2008
- **INTELPRO** – Intelligent system for assisting the therapeutically decision at patients with prostate cancer,
  - Funded by MEC CEEX project, 2005 – 2008
- **Automated Verification of Security Protocols**
  - Funded Irish Research Council for Science, Engineering and Technology, 2002-2006.

Service-oriented Research

1. Metrics for DoM
2. Automatic WS Composition Techniques
    1. Graph of Service Cells
    2. Fluent Calculus
    3. Matrix of Semantic Links and Enhanced Planning Graphs
3. Workflow Models for Industrial Processes
4. Product Traceability
5. Green IT for Energy Efficiency in Service Centers

1. Metrics for DoM (1/5)

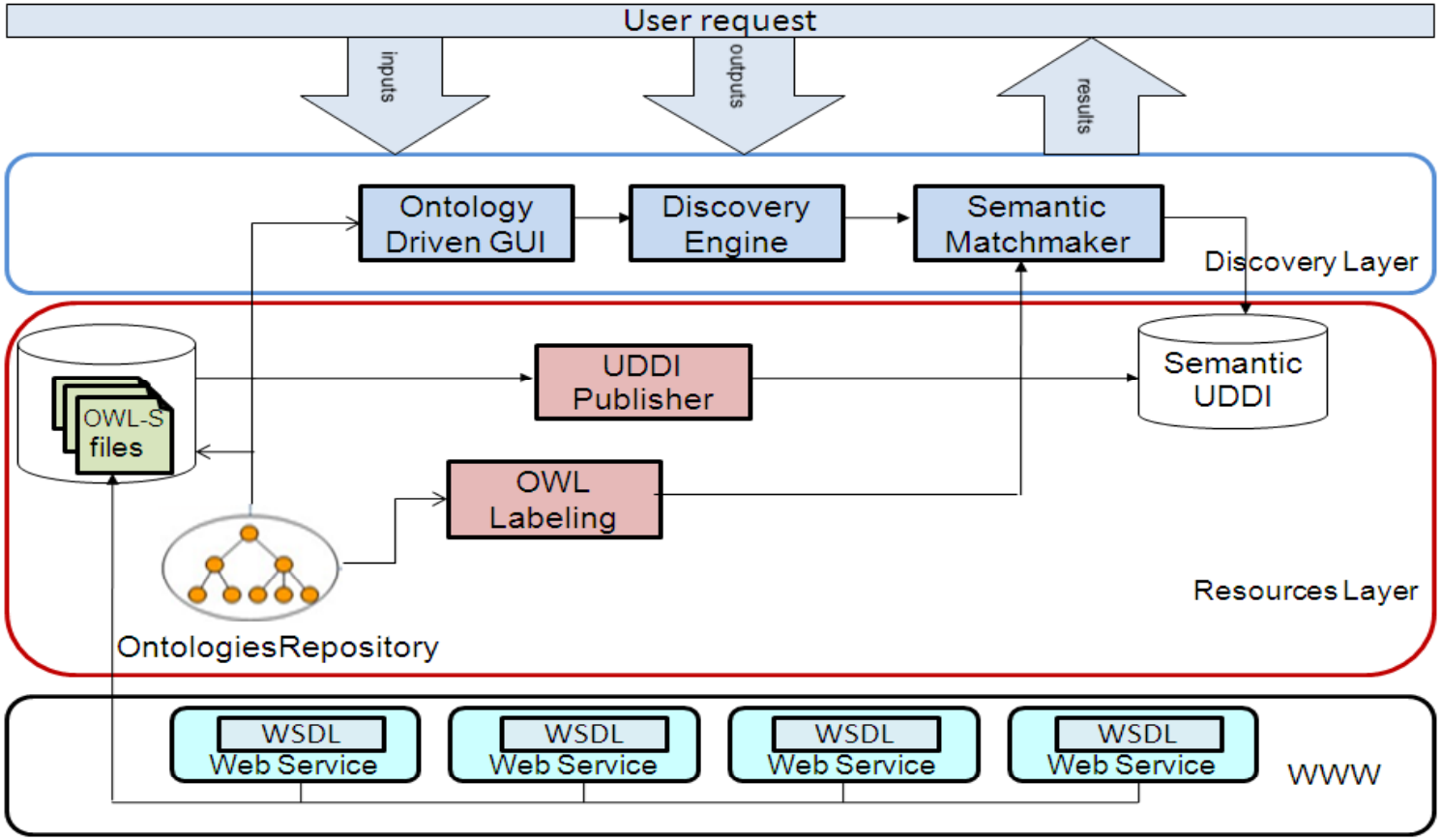
- **Objective**
  - Set up a metrics for the evaluation of the DoM between two services (usually a *request* and a *published* service)
  - Useful for service discovery during service composition process
- **Features**
  - DoM - continuous values in [0,1] interval
    - For large # of services allows a good service discrimination for selection purposes
  - Efficiency
    - Each ontology concept is associated an interval of values based on Agrawal labeling technique
    - Subsume relationships between ontology concepts can be verified in a constant time, independent of the size of the ontology tree

1. Metrics for DoM (2/5)

- **The method**
  - Extends / adapts the *Accuracy Learning* metrics for performance evaluation of methods for learning and automatic population of ontologies
  - Evaluates the semantic similarity between two services by considering
    - Similarity of their inputs and outputs,
    - Similarity of the ontology concepts associated to the inputs and outputs and
    - Similarity of the concepts properties
  - Combines the partial calculated scores into a final DoM value
- **Method evaluation**
  - Extend and adapt for WSs the **Precision** and **Recall** from Information Retrieval
    - Define Precision and Recall for a service request
    - Define mean value of Precision and Recall for a set of service requests

2. Metrics for DoM (3/5)

Experimental prototype



1. Metrics for DoM (4/5)

- **Experiments**
  - OWLS–TCv3 corpus
    - http://www.semwebcentral.org/projects/owls-tc/
    - Set of 7 ontologies (education, medical care, food, travel, communication, economy, weapons)
    - 1007 WS semantically described in OWL-S
    - **28 (corpus proposed) queries** described as an OWL-S atomic process
- **Results**
  - Recall values: [0.69, 1]
  - Precision values: [0.35, 1]
  - Recall mean value: 0.959286
  - Precision mean value: 0.801785714

1. Metrics for DoM (5/5)

- **Quality conclusions**
  - In some cases calculating **DoM(s1, s2)** based on the ontology concepts describing services' inputs and outputs is not enough
  - Improvement – a hybrid approach
    - Consider also the textual service description in the *Service Profile* ontology
    - Example
    - </profile: serviceName><profile: textDescription xml: lang="en"> verify account of person and returns current price of book. </profile: textDescription>).

2.1 WS composition using Graphs of Service Cells (1/10)

- Graph based composition method
- Considers both data and functional semantics

- Service request
  - Set of ontological concepts describing the complex service inputs and outputs (data semantics)
  - Non-functional requirements as preferences / constraints (e.g. minimal cost composed service)
- Composition problem
  - Graph search problem

2.1 WS composition using Graphs of Service Cells (2/10)

- **Main concepts**
  - **ServiceCell**
    - Graph node, wrapper for an atomic service operation
    - *sc* = (*op*, ***in***, ***out***, *QoSscore*, *uScore*, *refSAWSDL*)
  - **Graph of ServiceCells (SCs) GSC**
    - Each WS is associated to a SC
    - GSC statically build and updated in background
  - **StartCell** - composed service inputs (user specified)
  - **EndCell** - composed service outputs (user specified)
  - **SupplierCell** – cell supplying the input of another cell
  - **SaturatedCell** – for each input, a supplier cell is selected

2.1 WS composition using Graphs of Service Cells (3/10)

- **Main concepts (cont.)**
  - **Causal link** – graph edge between a SC out and a SC in
    - Generated as a result of Match Maker evaluation
  - **Filter** – filters the outputs of a cell according to user prefers
  - **CompositionSolution** – a DAG of saturated SCs
  - **Executable composition solution**
  - **Global score** for a composition solution
  - **Good composition solution** (gs)
    - gs satisfies all user constraints
  - **Optimal composition solution** (os)
    - os satisfies all user constraints and preferences
  - **SGDL** – Service Cell Description Language

2.1 WS composition using Graphs of Service Cells (4/10)

- **The method**
  - Graph Construction process
    - DAG representing
      - WS functional semantics
      - Semantic dependency between WSs Inputs and Outputs
  - Resource updating processes
    - Work in background
    - Turns Ontology + SAWSDL files into a GSC
    - GSC further used in composition and execution layer

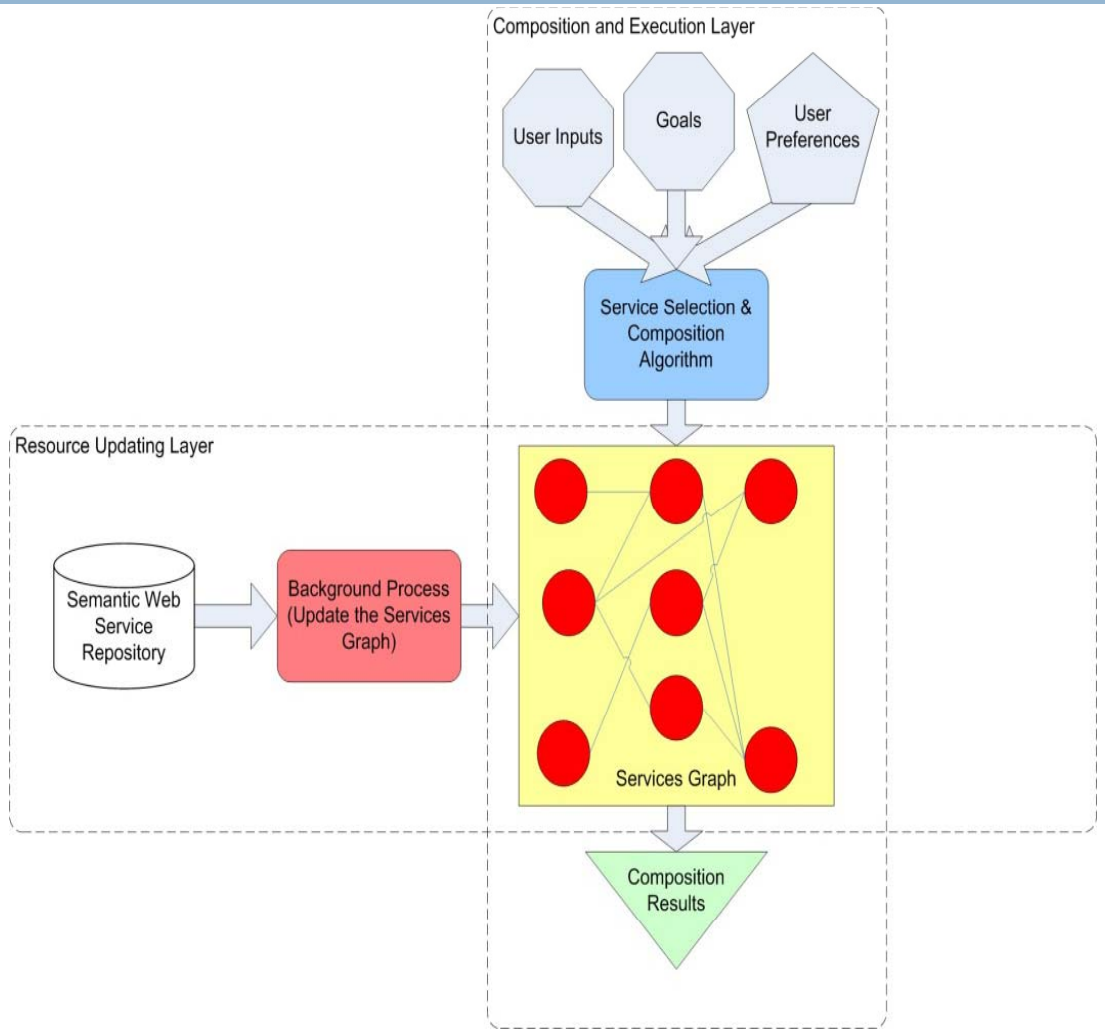
2.1 WS composition using Graphs of Service Cells (5/10)

- **The method (cont.)**
  - Composition processes
    - Search sub-graphs satisfying client requested functionality (generates all possible solutions)
    - Goal-based backwards chaining
    - Rank the solutions (QoS, User constraints / preferences)
    - Select best service composition solution for a given user request

2.1 WS composition using Graphs of Service Cells (6/10)

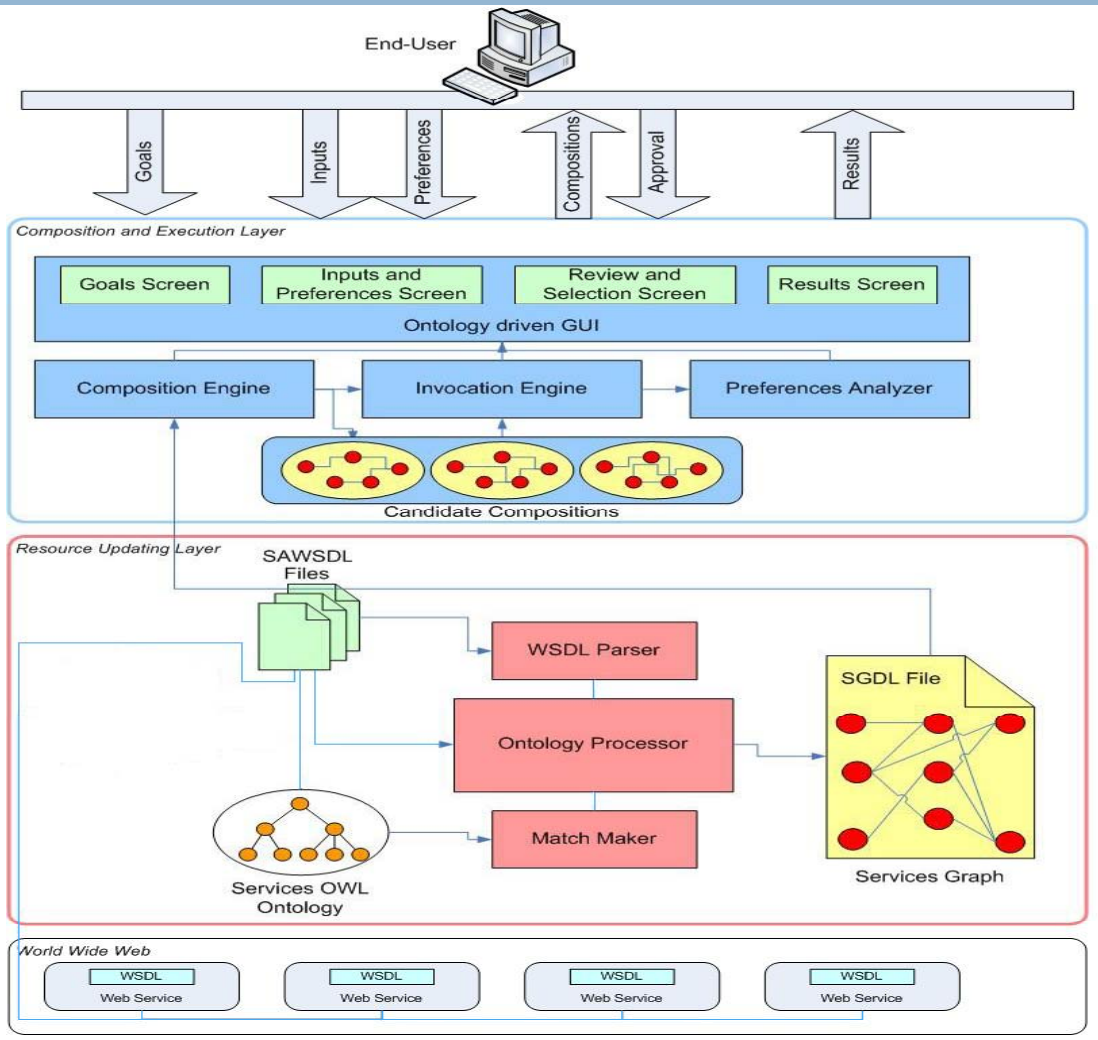
- **The method (cont.)**
  - Solutions Execution
    - All candidate compositions are executed one by one in forward direction from StartCell to EndCell
    - Invoke real-world services in the required order
    - Partial execution (invoke only information-gathering service) for world-altering services
  - Evaluation and Selection
    - Scores are computed for each individual composition
    - Allows user review and approval of the selected composition
    - Updates static ratings (QoS, user rating)

2.1 WS composition using Graphs of Service Cells (7/10)



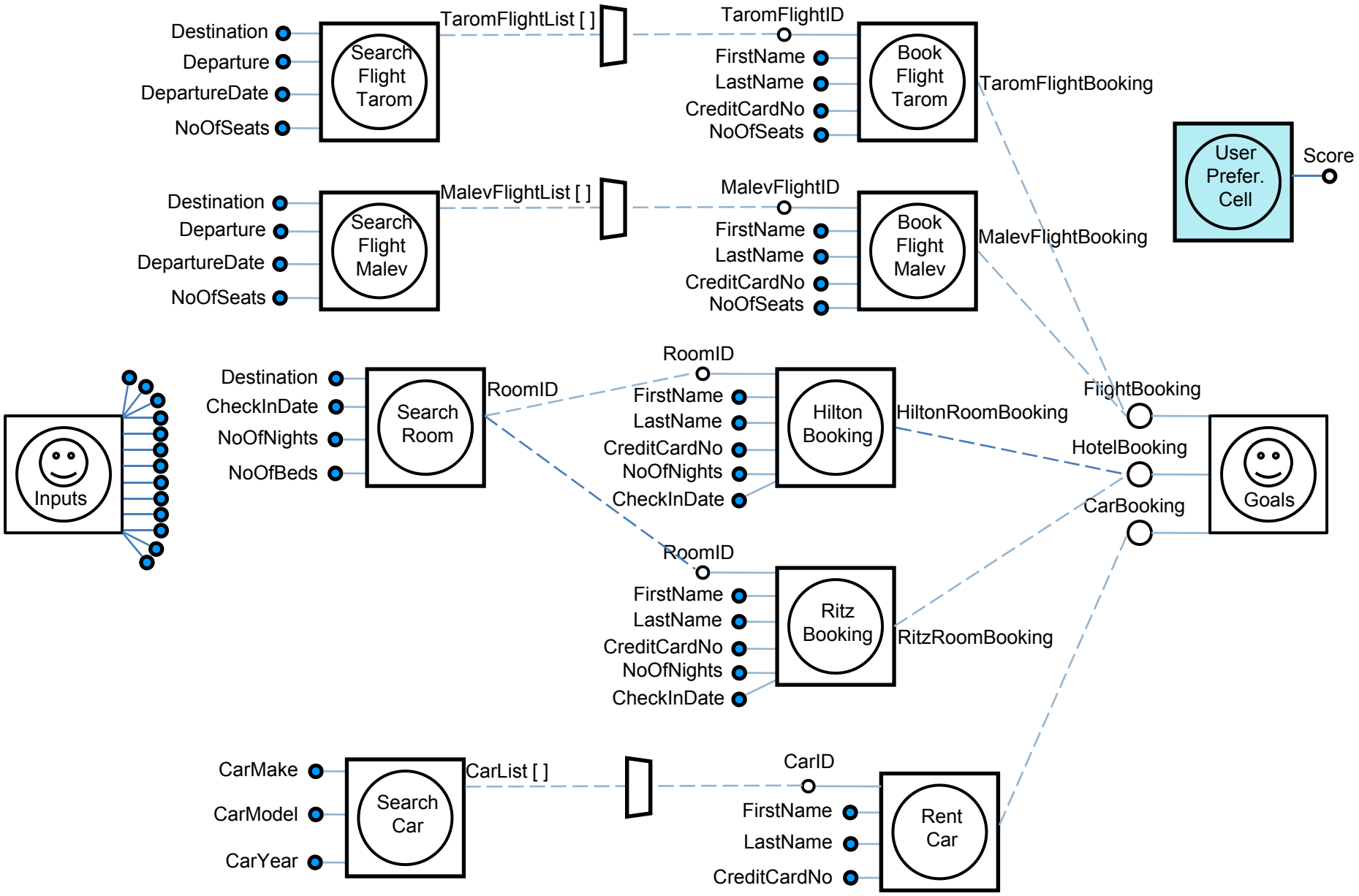
2.1 WS composition using Graphs of Service Cells (8/10)

Experimental prototype



2.1 WS composition using Graphs of Service Cells (9/10)

- **Test Scenario - Trip Planning problem**
  - User goals
    - A flight ticket to the destination
    - A hotel booking
    - A car renting reservation
  - User preferences
    - Low-cost policy



SERVICES GRAPH WITH SPECIAL CELLS – START COMPOSITION BUILDING

2.1 WS composition using Graphs of Service Cells (10/10)

- **Future work**
  - Working with service effects and service pre-conditions, (besides inputs and outputs)
  - Better expressing user preferences, constraints and imposed limitations
  - Other semantic approaches: **OWL-S, WSMO**
  - Better **formalization** of the **SGDL**
  - Improved **matchmaking heuristics**

2.2 WS composition using Fluent Calculus (1/5)

- **Objective**
  - Develop a method for WS composition using Fluent Calculus

2.2 WS composition using Fluent Calculus (2/5)

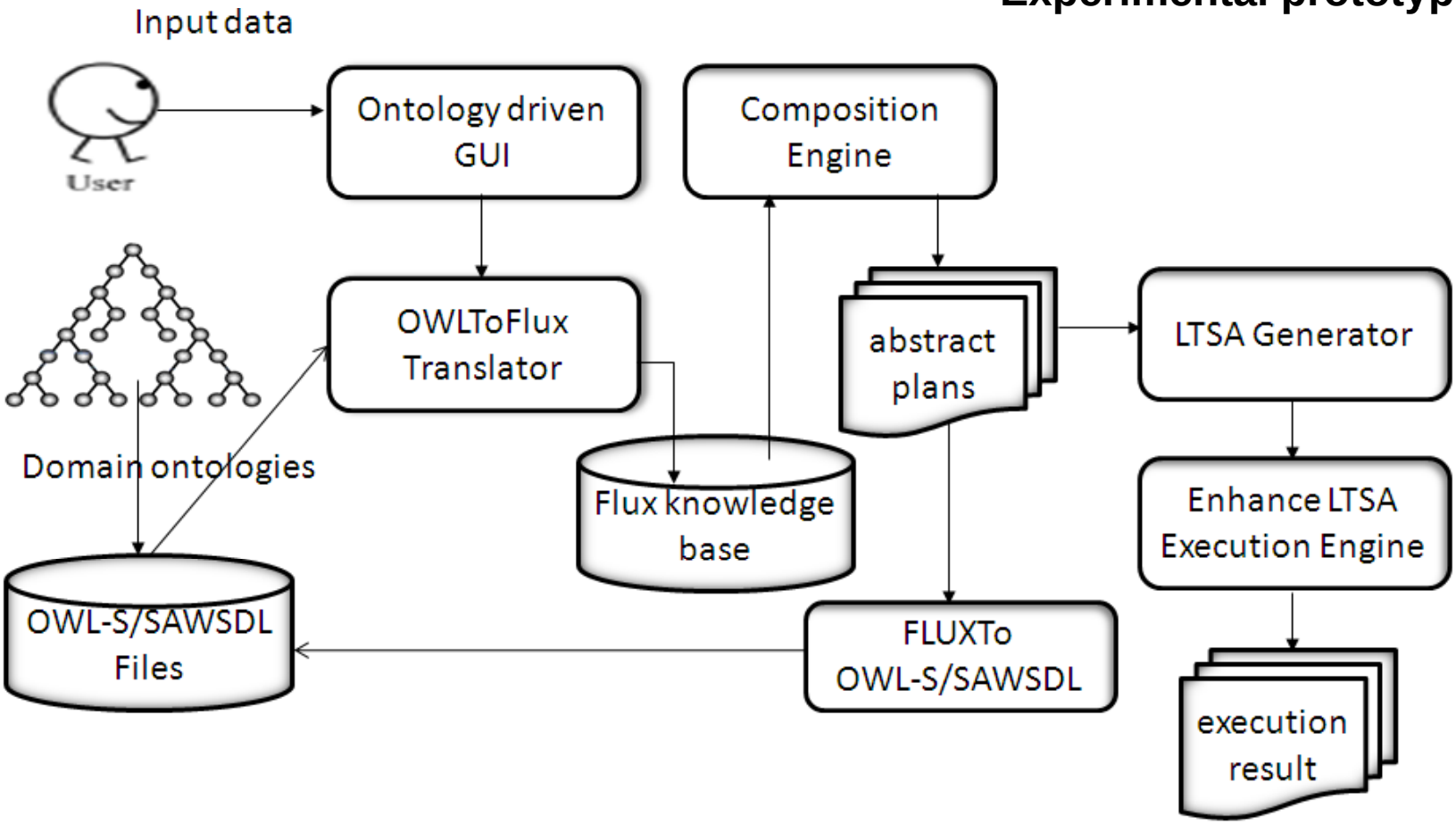
- **Method**
  - Model WS composition problem as a AI planning problem
    - WS composition problem as a Fluent Calculus planning problem
  - Define mapping and translation algorithms between WS external representation (OWL-S) and Fluent Calculus for both atomic and composite processes
    - Atomic OWL-S processes (translate preconditions and inputs, effects and outputs)
    - Composite OWL-S processes (translate 'sequences', 'if-then-else' and 'concurrency')
  - **Translation result**
    - User request (set of concepts describing the requested service) is translated into a set of **fluents**
    - Semantic descriptions of the available services are translated into sets of **actions, fluents, axioms** for action perconditions and state update axioms

2.2 WS composition using Fluent Calculus (3/5)

- **Method (cont.)**
  - Generate an abstract composition plan as a FLUX complex action
  - Execute abstract composition plan instances
    - Use LTSA Generator (Labeled Transaction System Analyzer, Imperial College London) to translate composition plan into a FSM
    - Use LTSA simulator to execute the FSM (the composition plan)
  - Translate a composition plan as a OWL-S complex process

2.2 WS composition using Fluent Calculus (4/5)

Experimental prototype



2.2 WS composition using Fluent Calculus (5/5)

- **Conclusions**
- A new automatic composition method based on Fluent Calculus (not yet reported in the literature)
- Proving that planning capabilities of FC can be used automatically generate a WS service composition
- Situation Calculus (Golog) vs. Fluent Calculus (FLUX)
  - Fluent Calculus (FLUX, inferring through progression) – better computational performance vs. Situation Calculus (Golog, inferring through regression)

2.3 WS composition using a Matrix of Semantic Links and an Enhanced Planning Graph (1/7)

- **Based on AI Planning Graphs**
- **WS composition method**
  - Enhanced Planning Graph (EPG)
  - Matrix of Semantic Links (MSL)
- **Optimal solution selection**
  - Immune-inspired method

2.3 WS composition using a Matrix of Semantic Links and an Enhanced Planning Graph (2/7)

- **Enhancing AI Classical Planning Graph**
  - For better representing WS composition problem
  - Cluster of Services
    - Groups services with similar functionality, similar input parameters
  - Clusters of Literals
    - Ontology concepts semantically describing service I/O
  - Semantic Similarity Link (SSL)

2.3 WS composition using a Matrix of Semantic Links and an Enhanced Planning Graph (3/7)

- **Enhancing AI Classical Planning Graph (cont.)**
  - EPG = {(A_i, L_i)}
    - A_i - Set of clusters of services on i graph level
    - L_i - Set of clusters of literals on i graph level
  - Matrix of Similarity Links (MSL)
    - Iterative constructed during composition process
      - Uses info collected during (i) service discovery and (ii) EPG construction
    - Line and columns: services
    - Each matrix cell represents a tuple with:
      - Semantic similarity link between the two services
      - Semantic similarity score between the two services

2.3 WS composition using a Matrix of Semantic Links and an Enhanced Planning Graph (4/7)

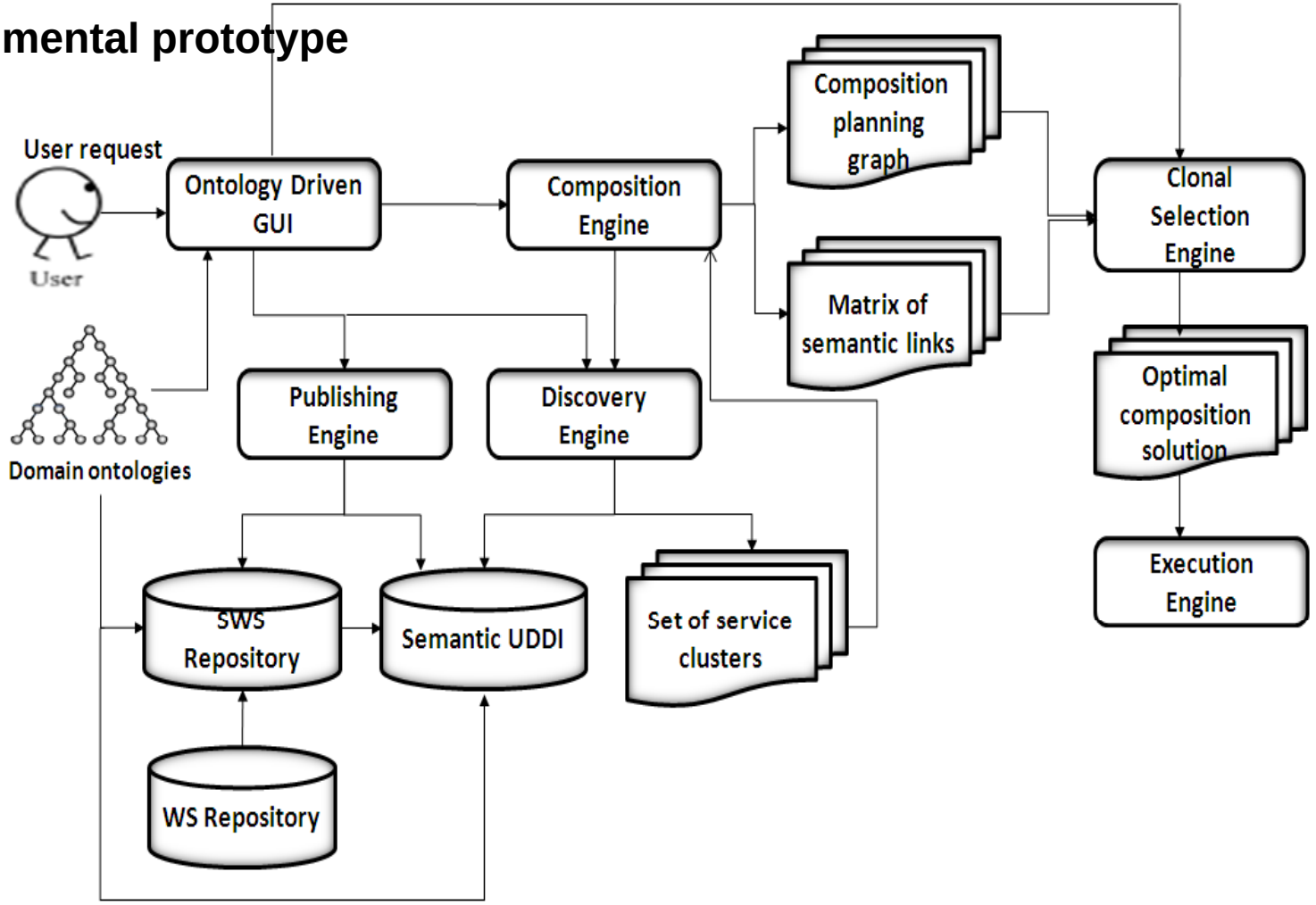
- **Optimal solution selection**
  - Multi-criteria quality function involving
    - QoS criteria (the cost of a composition solution, execution time, availability), a score of semantic similarity, user preferences
  - Immune inspired solution for optimal solution selection
    - Adapts and enhances the CLONALG algorithm [Castro and Zuben]
    - Clonal Selection Engine => **ordered** valid set of solutions

2.3 WS composition using a Matrix of Semantic Links and an Enhanced Planning Graph (5/7)

- **Experimental prototype**
  - Integrates our algorithms for discovery, composition and selection
  - Domain ontologies, semantic annotated (SAWSDL) WSs
  - Semantic UDDI (XML structure: ref to service SAWSDL, info relative to exposed operation, I/O parameters)

2.3 WS composition using a Matrix of Semantic Links and an Enhanced Planning Graph (6/7)

Experimental prototype



2.3 WS composition using a Matrix of Semantic Links and an Enhanced Planning Graph (7/7)

- **Tests**
  - Domain ontologies defining data and functional semantics for
    - Trip planning and
    - Social events planning
  - Tested on 140 in-house developed services, manually annotated

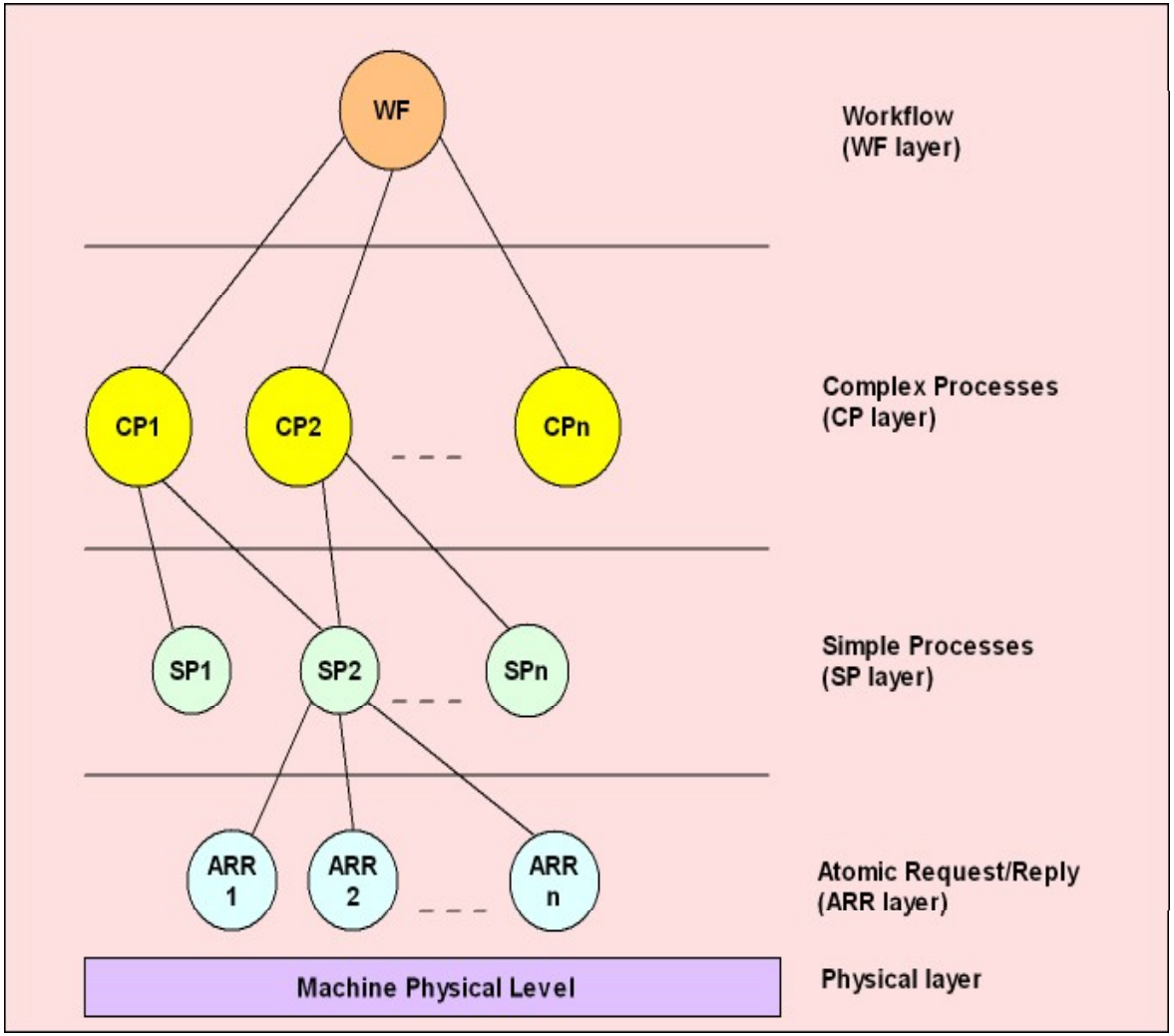
3. Workflow Models for Industrial Processes (1/7)

- **Objective**
  - Capturing and representing business models involving physical machines targeting their workflow integration and simulation
- **How**
  - Define a methodology for the construction of workflow models that comply with specific business rules
  - Verify model consistency using the Process Algebra formalism

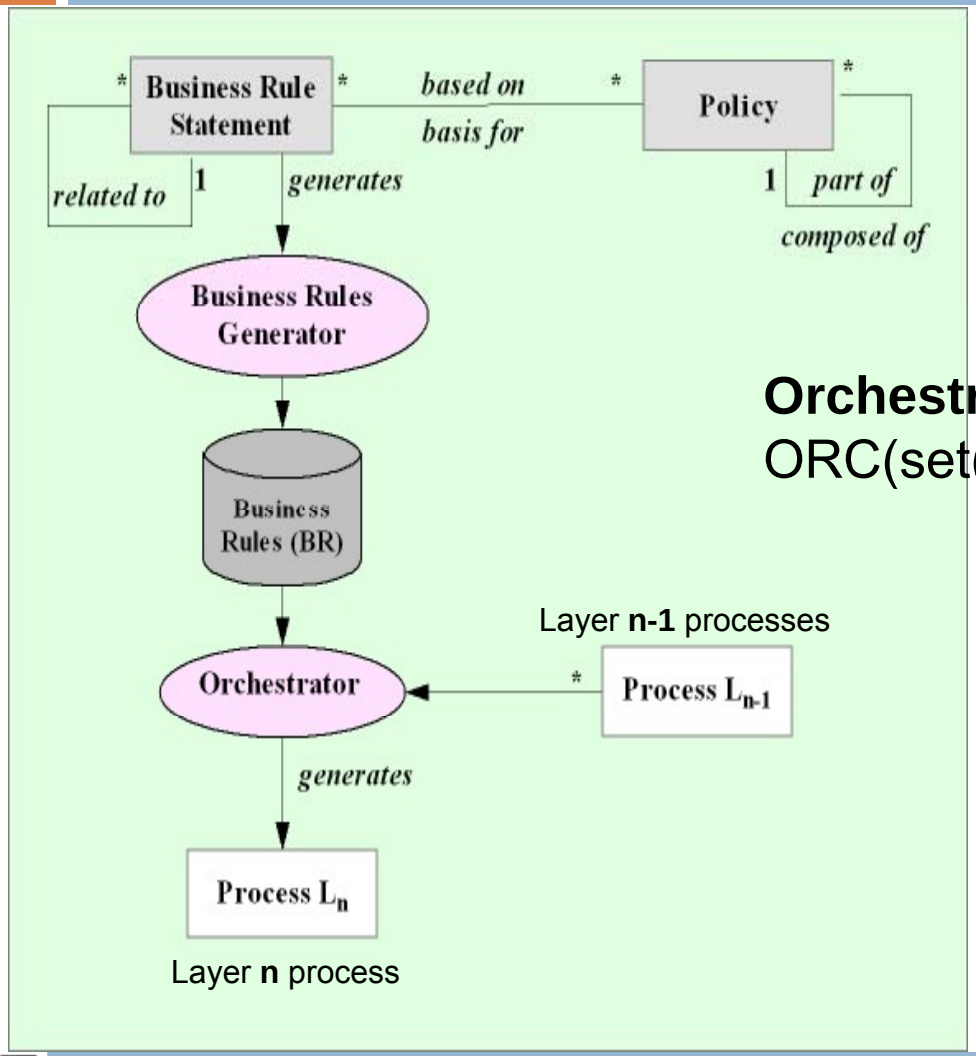
3. Workflow Models for Industrial Processes (2/7)

- **Method**
  - Incremental approach to each layer construction
  - Initial layer – contains physical or simulated machines on the production lines
  - Atomic Request / Reply services layer – directly maps on production line machines
  - A new layer is generated if the following conditions hold
    - At least two processes could be identified on top of the existing layers
    - There is at least one specific business rule that leads to the interaction of the identified processes
  - Topmost level – business workflow

3. Workflow Models for Industrial Processes (3/7)



3. Workflow Models for Industrial Processes (4/7)



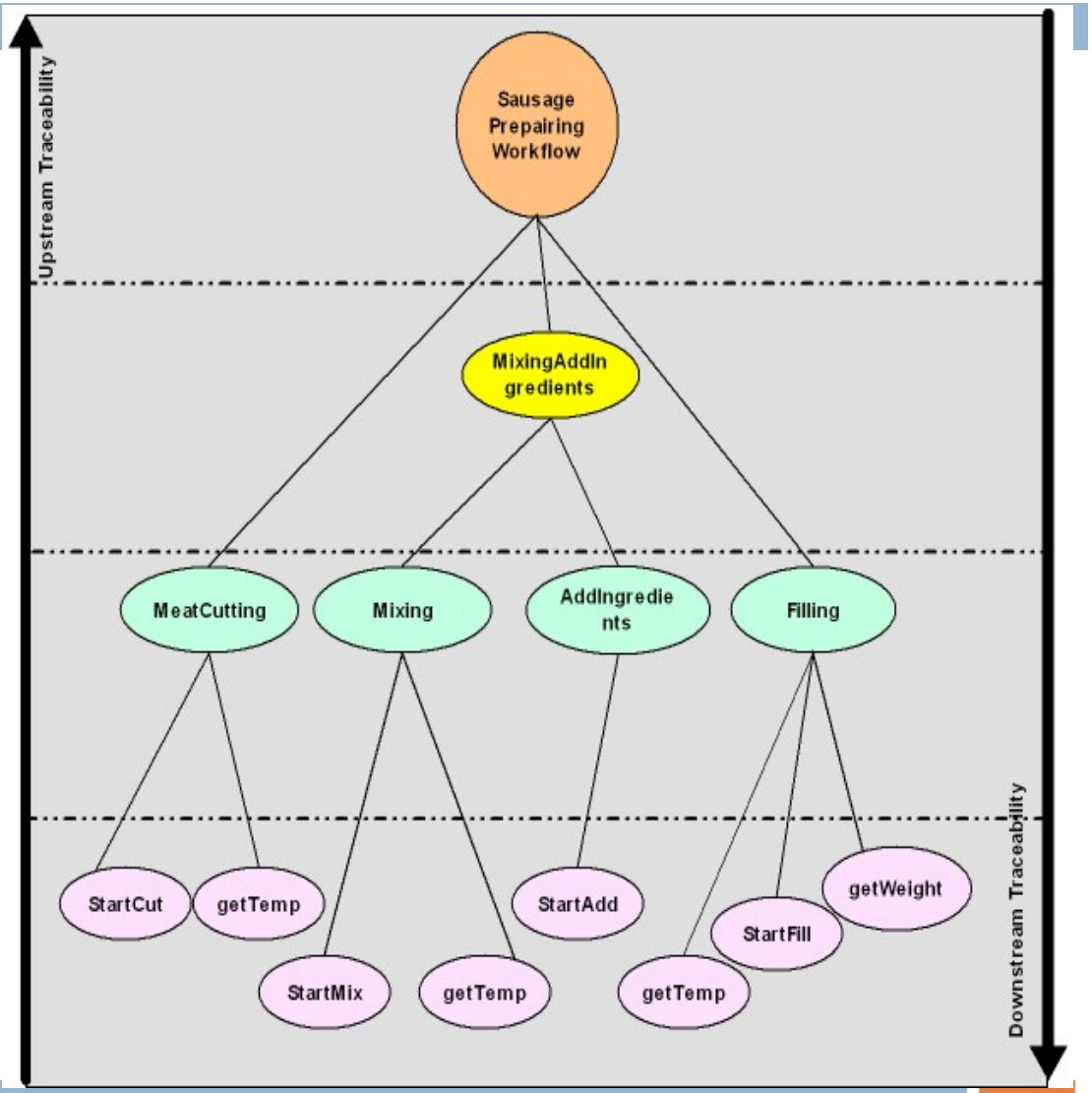
Orchestrator operator:
ORC(set(P), set(BR)) -> CompositeProcess

3. Workflow Models for Industrial Processes (5/7)

- **Case study**
  - FoodTrace research project
  - Sausage preparing workflow
  - The proposed scenario/workflow is represented in Process Algebra CSS and is verified using CWB-NC
    - This permits the logical faults removal from the workflow model before translating it to BPEL.
  - The resulted model, enhanced with traceability elements was translated into BPEL and executed using the Microsoft BizTalk server

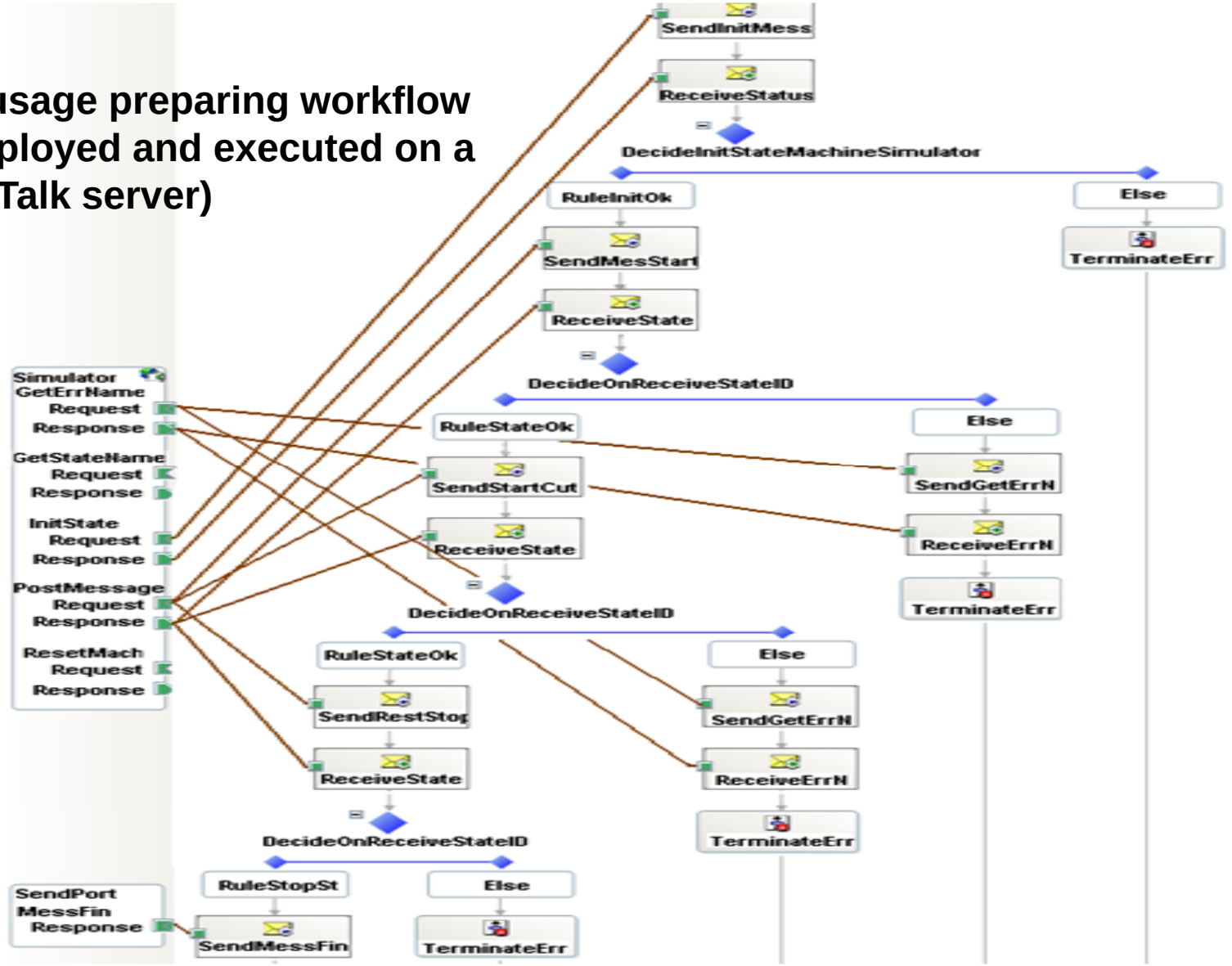
3. Workflow Models for Industrial Processes (6/7)

Case Study – Sausage Preparing Workflow



3. Workflow Models for Industrial Processes (7/7)

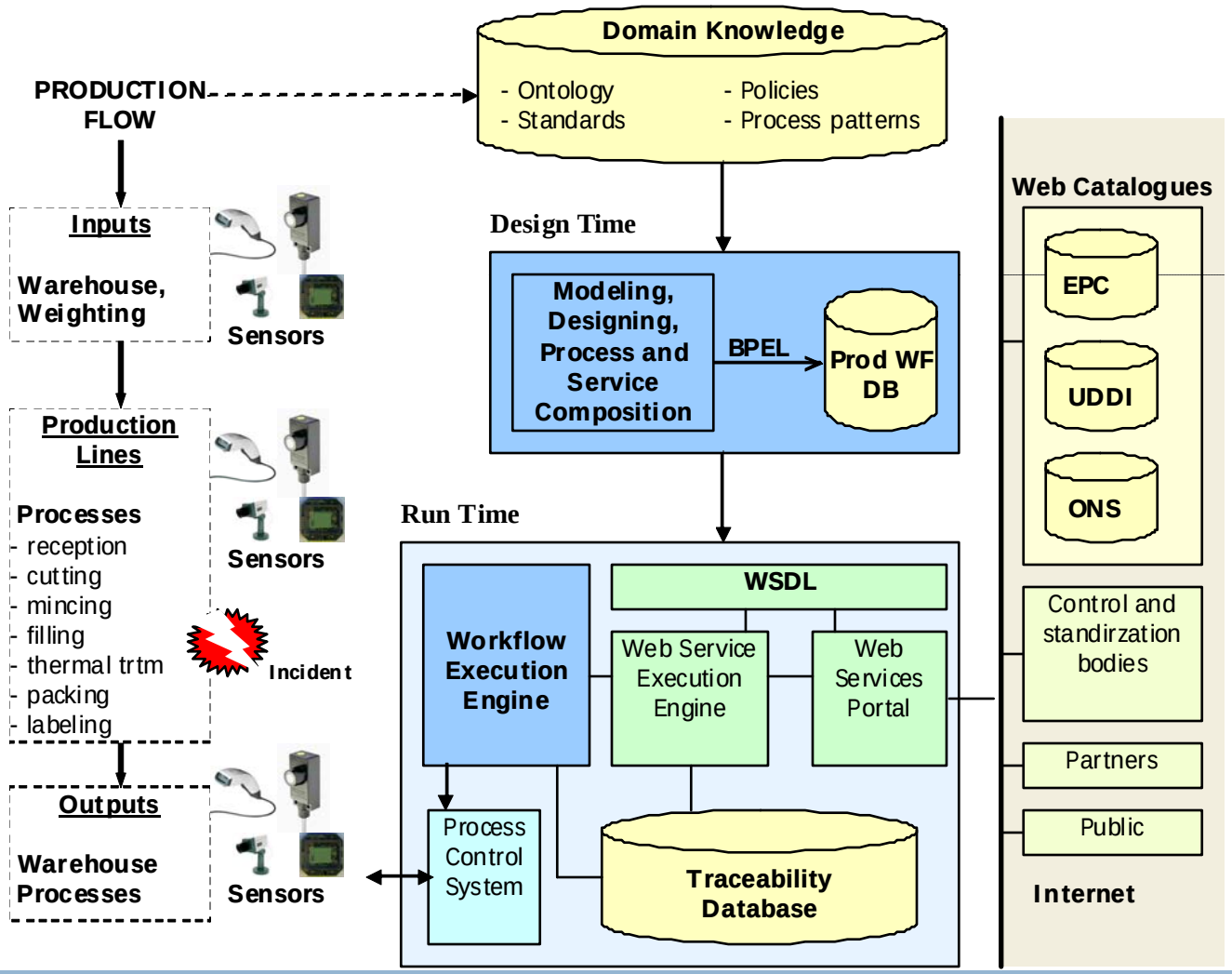
Sausage preparing workflow (deployed and executed on a BizTalk server)



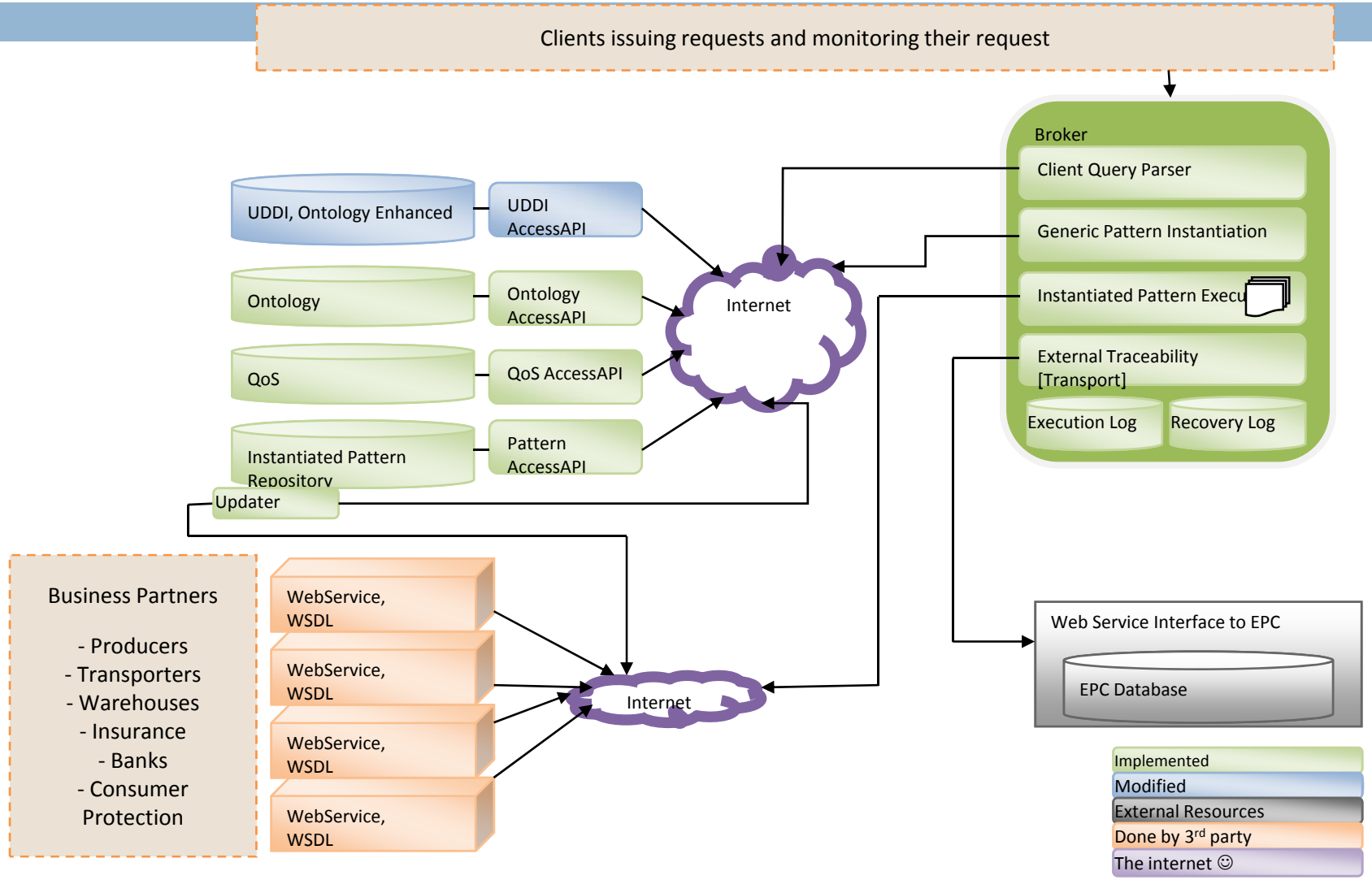
4. Product Traceability (1/3)

- **Objective**
  - Study and design a system for products traceability in the food processing industry
- **Features**
  - Traceability system model
    - The infrastructure for monitoring the processes executed on a food industry production line and
    - The tools and resources to capture, classify, store and access data regarding product quality associated with each manufacturing process
  - WSs for accessing the info rel. to products and processes
    - Business partners, Authorities, Public

4. Product Traceability – Internal (2/3)



3. Product Traceability – External (3/3)



5. Green computing for Energy Efficiency in Service Centers (1/5)

- **Facts**
  - Traditional data centers: 2% of the total energy consumption
  - Data centers CO2 emissions: half of the total airlines' CO2 emissions
  - Business digitization: reduces the demand for paper but increases the need for service centre energy
  - An avatar in Second Life virtual reality world: consumes as much power as an average Brazilian

5. Green computing for Energy Efficiency in Service Centers (2/5)

- **The Solution**

- **Green Computing**
  - A new discipline and practice aiming at designing and using IT resources in an environmentally-aware way
- **Data Centers => Service Centers**
- **Software as a Service Model**
  - The available computing resources are shared by several different users or companies
  - Computation capacity provided on demand
  - Service based approach and service composition - at the providers side or user side (mash-ups) - vs. traditionally application development

5. Green computing for Energy Efficiency in Service Centers (3/5)

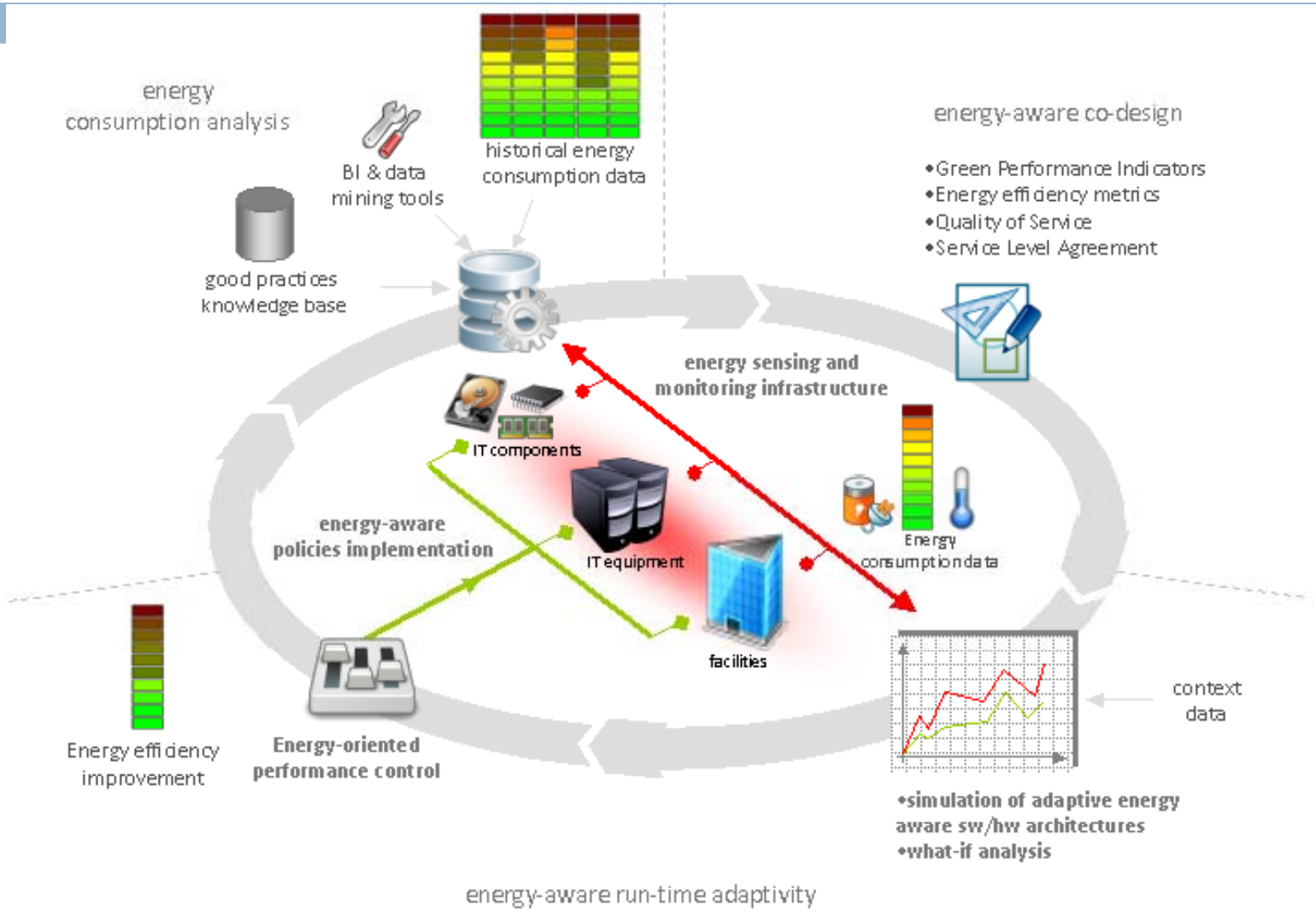
- **Our solution – GAMES: Green Active Management of Energy in IT Service centers**

- **GAMES concept for Green, Real-time and Energy-aware IT Service Centers**
  - Applied from the early design phase of all the business processes and system architecture by using the GAMES methodologies, models, services, and tools
  - Adoption as basis for energy-efficiency
    - Service-based approach to resource management and control,
    - Data mining for inferring knowledge from historical data and
    - Context-awareness and run-time control loops (DPM, long term and short term predictions)

5. Green computing for Energy Efficiency in Service Centers (4/5)

- **Our solution - GAMES: Green Active Management of Energy in IT Service centers (cont.)**
  - **The central innovation** - for the first time, the energy efficiency of the IT Service Centers will be considered simultaneously at three levels, aiming at achieving a set of **Green Performance Indicators**, by trading-off
    - 1) User and functional requirements, Quality of Services and SLA versus energy costs at business/application level
    - 2) Performance, expressed as physical resources workload and Service Level Agreement, against energy costs at IT infrastructure level,
    - 3) HVAC and lighting

5. Green computing for Energy Efficiency in Service Centers (5/5)



Publications (last 3 years) 1/7

- 1. Ionut Anghel, Tudor Cioara, Ioan Salomie, Mihaela Dinsoreanu and Anca Rarau, *Middleware for Smart Environments Management*, International Journal of Computers, Communications & Control, 2010, Volume: V Number: 2 (June 2010), ISSN 1841-9836,
- 2. Ioan Salomie, Mihaela Dinsoreanu, Cristina Bianca Pop, Sorin Liviu Suciu, *ArhiNet-A Knowledge-based System for Creating, Processing and Querying Archival eContent*, Lecture Notes in Business Information Processing, Vol. 45, pp. 99-112, Springer Verlag 2010
- 3. Cioara Tudor, Ionut Anghel, Ioan Salomie, Mihaela Dinsoreanu, Georgiana Copil, Daniel Moldovan, *A Reinforcement Learning based Self-healing Algorithm for Managing Context Adaptation*, Percol 2010 (International Workshop on Communication, Collaboration and Social Networking in Pervasive Computing Environments), accepted for publication

4. Cristina Bianca Pop, Viorica Rozina Chifu,Ioan Salomie, Mihaela Dinsoreanu, Mihaly Fodor, Irina Condor, *A Bee-inspired Approach for Selecting the Optimal Service Composition Solution*,10th International Conference on Development And Application Systems, Suceava, Romania, May 27-29, 2010, accepted for publication.

- 5. Cristina Bianca Pop, Viorica Rozina Chifu, Ioan Salomie, and Mihaela Dînşoreanu, *Optimal Web Service Composition Method based on an Enhanced Planning Graph and Using an Immune-inspired Algorithm*, in the 5th IEEE International Conference on Intelligent Computer Communication and Processing (ICCP2009), Cluj-Napoca (Romania), August 2009, ISBN 978-1-4244-5007-7, pp. 291-298.
- 6.Viorica Rozina Chifu, Ioan Salomie, Riger Agota and, Valentin Radoi, *A Graph Based Backward Chaining Method for Web Service Composition*, in the 5th IEEE International Conference on Intelligent Computer Communication and Processing (ICCP2009), Cluj-Napoca (Romania), August 2009, ISBN 978-1-4244-5007-7, pp. 237-244.

Publications (last 3 years) 2/7

- 7.Viorica Rozina Chifu, Ioan Salomie, Riger Agota and, Valentin Radoi, *A Graph Based Backward Chaining Method for Web Service Composition*, in the 5th IEEE International Conference on Intelligent Computer Communication and Processing (ICCP2009), Cluj-Napoca (Romania), August 2009, ISBN 978-1-4244-5007-7, pp. 237-244.
- 8. Tudor Cioara, Ionut Anghel, Ioan Salomie, Mihaela Dinsoreanu, *A Context-based Semantically Enhanced Information Retrieval Model*, Proceedings of the 5th IEEE International Conference on Intelligent Computer Communication and Processing, 2009, ISBN 978-1-4244-5007-7, pp. 291-298.Indexat ISI, IEEE,
- 9. I.Salomie, M.Dinsoreanu, C.Rat, S. L. Suciu, *Efficient Ontology Processing Using Hierarchical Data Models Representation*, Proceedings of the 5th IEEE International Conference on Intelligent Computer Communication and Processing, 2009, ISBN 978-1-4244-5007-7, pp.211-214, Indexat ISI, IEEE,
- 10. Ionut Anghel, Tudor Cioara, Ioan Salomie, Mihaela Dinsoreanu and Anca Rarau, *A Self-configuring Middleware for Managing Context Awareness*, WINSYS 2009, The International Conference on Wireless Information Networks and Systems, 7-10 July 2009, Milano, Italy, pp. 131-139, ISBN: 978-989-674-008-5, Best Student Paper Award, (ISI Proceeding).

  11. Viorica Rozina Chifu, Cristina Bianca Pop, Ioan Salomie, Mihaela Dinsoreanu, Ioana Avram, Anda Cipariu, *SWSDF – A Semantic Web Service Discovery Framework*, in the 8th Romanian Educational Network International Conference (RoEduNet 2009), ISBN 978-606-8085-15-9, pp. 113-118, Galaţi (Romania), December 2009, (ISI Proceeding).
- 12. Ionut Anghel, Tudor Cioara, Ioan Salomie, Mihaela Dinsoreanu, *An Agent-based Context Awareness Management Framework*, Proceedings of the 8-th International Conference RoEduNet 2009 in Galaţi, România, pp. 107-113, ISBN -978-606-8085-15-9, ISI Proceedings

Publications (last 3 years) 3/7

- 13.Viorica Rozina Chifu, Ioan Salomie, Alpar Köver, and Roland Vachter, *Matching Semantic Web Services Using Learning Accuracy*, in the 11th International Symposium on Symbolic and Numeric Algorithms for Scientific Computing (SYNASC2009), Timisoara (Romania), September 2009, pp.317-324, ISBN: 978-0-7695-3964-5
- 14. T. Cioara, I. Anghel, I. Salomie and M. Dinsoreanu, *A Policy-based Context Aware Self-Management Model*, 11th Int. Symposium on Symbolic and Numeric Alg. for Scientific Comp. (SYNASC 2009), 333-341, ISBN: 978-0-7695-3964-5, 2009,
- 15. Cristina Bianca Pop, Viorica Rozina Chifu, Ioan Salomie, Mihaela Dînşoreanu, Iulia Vartic and Monica Vlad, *Immune-inspired Web Service Composition Framework*, in the 11th International Symposium on Symbolic and Numeric Algorithms for Scientific Computing (SYNASC2009), Timisoara (Romania), September 2009, pp.376-383, ISBN: 978-0-7695-3964-5
- 16. Viorica Rozina Chifu, Ioan Salomie, Ioana Harsa, Marius Gherga, *A Fluent Calculus Approach to Automatic Web Service Composition*, in the Advances in Electrical and Computer Engineering Journal Issue 3/2009, ISI Journal, pp: 75 – 83

17. Ioan Salomie, Mihaela Dinsoreanu, Cristina Bianca Pop, Sorin Liviu Suciu, Tudor Vlad, Ioana Iacob, *ArhiNet- A System for Generating and Processing Semantically-Enhanced Archival eContent*, Proceedings of the 5th International Conference on Web Information Systems and Technologies (WEBIST 2009), March 23-26, Lisbon, Portugal, ISBN 978-989-8111-81-4, pp. 151-158, indexat ISI, DBLP,

Publications (last 3 years) 4/7

- 18. I.Salomie, M.Dinsoreanu, C. B. Pop, S. L. Suciu, *Knowledge Acquisition from Historical Documents for Preserving Transylvanian Cultural Heritage*, Advances in Electrical and Computer Engineering, ISSN 1582-7445, No 2/2009, Indexat ISI
- 19. Tudor Cioara, Ionut Anghel, Ioan Salomie, Mihaela Dinsoreanu and Anca Rarau, *A Self-configuring Middleware for Developing Context Aware Applications* - Extended Paper, in KEPT 2009 Knowledge Engineering: Principles and Techniques Selected Papers, Cluj University Press 2009, pp. 365-373, ISSN 2067-1180
- 20. Tudor Cioara, Ionut Anghel, Ioan Salomie, Mihaela Dinsoreanu, *A Generic Context Model Enhanced with Self-configuring Features*, Journal of Digital Information Management (JDIM), 2009, Volume 7, Number 3, pp.159-165, ISSN 0972-7272

21. Ionut Anghel, Tudor Cioara, Ioan Salomie, Mihaela Dinsoreanu and Anca Rarau, *A Self-configuring Middleware Solution for Context Management*, Lecture Notes, series Communications in Computer and Information Science (CCIS), Springer-Verlag, 2009, accepted for publication.

- 22. Cristina Bianca Pop, Viorica Rozina Chifu, Ioan Salomie, Mihaela Dinşoreanu, *Immune-inspired Method for Selecting the Optimal Solution in Web Service Composition*, in the 35th International Conference on Very Large Databases (VLDB) – the Second International Workshop on Resource Discovery (RED2009), Lyon (France), August 2009, selected for publication in Lacroix: RED 2009, LNCS 6162, pp. 1–17, 2010, Springer-Verlag Berlin Heidelberg 2010

Publications (last 3 years) 5/7

- 23. Viorica Rozina Chifu, Ioan Salomie, Riger Agota and, Valentin Radoi, *Web Service Composition Approach Based On a Graph of Service Cells*, In the proceedings of the 2th Knowledge Engineering: Principles and Techniques Conference (KEPT2009), Cluj-Napoca (Romania), July 2009, in Studia Informatica - Special Issue on Knowledge Engineering: Principles and Techniques, ISSN:1224-869x, pp.: 308-311.
- 24. Emil Ştefan Chifu and Viorica Rozina Chifu, *Evaluating the Hyponym Attachments in an Unsupervised Taxonomy Enrichment Framework*, in the 4th International Conference on Web Information Systems and Technologies (WEBIST), Funchal (Portugal), May 2008, ISBN 978-989-8111-26-5, vol. 1, pp. 240-243, (ISI Proceeding).
- 25. Viorica Rozina Chifu, Ioan Salomie, Emil Ştefan Chifu and Constantin Pârţac, *Harmony - A Framework for Automatic Web Service Composition*, in the 4th International Conference on Web Information Systems and Technologies (WEBIST), Funchal (Portugal), May 2008, ISBN 978-989-8111-26-5, vol. 2, pp. 247-252, (ISI Proceeding).
- 26. Viorica Rozina Chifu, Ioan Salomie and Emil Ştefan Chifu, *Taxonomy Learning for the Romanian Language using SOTA and Wordnet*, in the 4th International Conference on Web Information Systems and Technologies (WEBIST), Funchal (Portugal), May 2008, ISBN 978-989-8111-26-5, vol. 2, pp. 169-174, (ISI Proceeding).
- 27. Ioan Salomie, Viorica Rozina Chifu, Ioana Giurgiu, and Mihai Cuibus, *SAWS: A Tool for Semantic Annotation of Web Services*, in the 16th IEEE International Conference on Automation, Quality and Testing, Robotics (AQTR 2008), Cluj-Napoca (Romania), May 2008, ISBN: 978-4224-2576-1, pp. 387-391, (ISI Proceeding).

Publications (last 3 years) 6/7

- 28. Viorica Rozina Chifu, and Ioan Salomie, *Fluent calculus-Based Web service composition – From OWL-S to Fluent Calculus*, in 4th IEEE International Conference on Intelligent Computer Communication and Processing, Cluj-Napoca, Romania, Aug. 2008, ISBN:978-1-4244-2673-7, pp.161-168, (ISI Proceeding).
- 29. Ioan Salomie, Ionut Anghel, Tudor Cioara, Mihaela Dinsoreanu - *A Context Awareness Model Enhanced with Autonomic Features*, Proceedings of 4th IEEE International Conference on Intelligent Computer Communication and Processing (ICCP 2008), Cluj-Napoca, Romania, Aug. 2008, pp. 239-246, ISBN: 978-1-4244-2673-7, (ISI Proceeding).
- 30. Ioan Salomie, Tudor Cioara, Ionut Anghel, Mihaela Dinsoreanu - *RAP - A Basic Context Awareness Model* in Proceedings of 4th IEEE International Conference on Intelligent Computer Communication and Processing (ICCP 2008), Cluj-Napoca, Romania, ISBN: 978-1-4244-2673-7, pp. 315-318, , (ISI Proceeding).
- 31. Emil Ştefan Chifu and Viorica Rozina Chifu, *A Neural Model for Unsupervised Named Entity Classification*, in the IEEE International Conference on Intelligent Agents, Web Technologies and Internet Commerce - IAWTIC08, Vienn (Austria), December 2008, ISBN 9781740882989, pp.1073-1078, IEEE Computer Society Press Proceeding, indexed ISI, EI, CSD.
- 32. Viorica Rozina Chifu, Ioan Salomie and Emil Ştefan Chifu, *Automatic Web Service Composition Using OWL-S and Fluent Calculus,* in the IEEE International Conference on Intelligent Agents, Web Technologies and Internet Commerce (IAWTIC08), Vienn (Austria), December 2008, ISBN 9781740882989, pp.271-276, IEEE Computer Society Press Proceeding, indexed ISI, EI, CSDL.

Publications (last 3 years) 7/7

- 33. Ioan Salomie, Viorica Rozina Chifu, Ioana Harşa and Marius Gherga, *Towards Automated Web service Composition with Fluent Calculus and Domain Ontologies*, in the ACM Proceedings of the 10th International Conference on Information Integration and Web-based Applications & Services (iiWAS2008), Linz (Austria), November 2008, ISBN: 978-1-60558-349-5, pp.: 201-207.
- 34. Tudor Cioara, Ionut Anghel, Ioan Salomie, Mihaela Dinsoreanu - *A Generic Context Model with Autonomic Features*, IEEE 2nd International workshop on Context Modeling and Management for Smart Environments (CMMSE '08) London, 13-16 Nov. 2008, (ISI Proceeding).

  35. Viorica Rozina Chifu, Ioan Salomie, and Simona Manole, *Fluent calculus Based Web service composition*, the Second International Conference on Web Reasoning and Rule Systems (RR2008), Karlsruhe (Germany), October 2008, LNCS Springer Berlin / Heidelberg, ISBN: 978-3-540-88736-2, pp. 230-231.
-