

Project: Logic-MAS “Logic of a Global Knowledge Space in a Multi-Agent World”

Work plan and deliverables as stated in the Proposal:

Deliverables and/or milestones

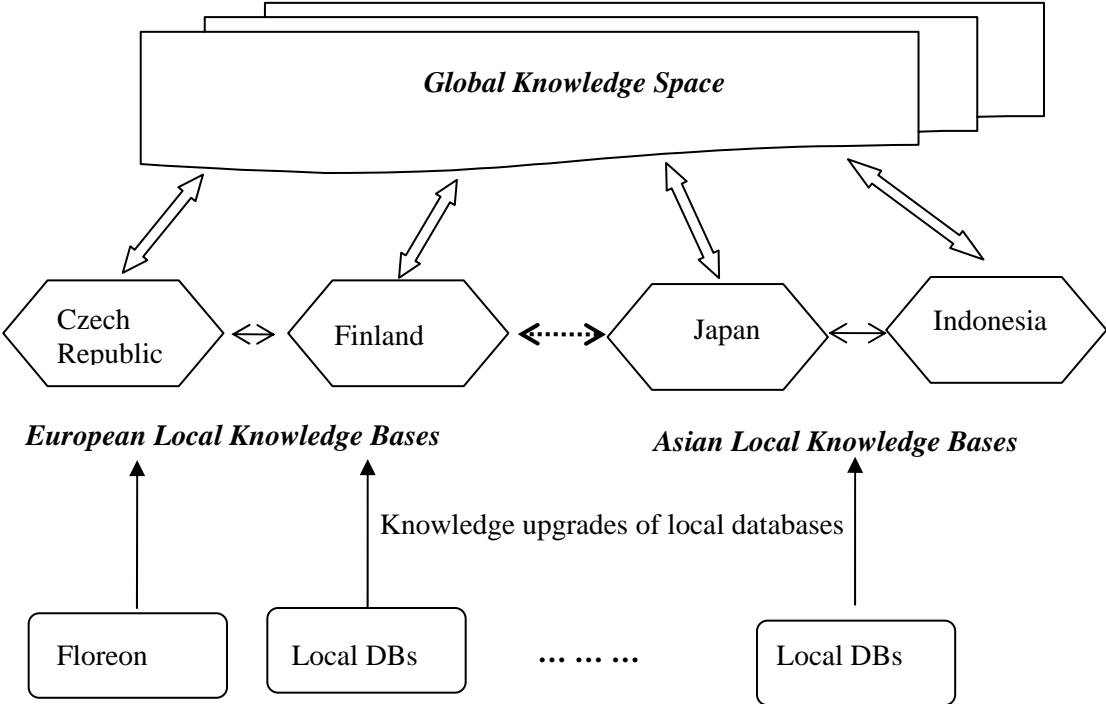
The scientific added value consists in:

- Development of a new declarative TIL-Script programming language that makes a fine-grained natural-language analysis and communication possible
- Complex information retrieval and search based on natural-language formulation of questions, and data mining *via* multilingual dictionaries
- Emergency and critical situations prediction, modelling and handling, which is made possible by a robust, fully distributed system of collaborative autonomous agents
- Spatial and temporal local knowledge clusters
- Modelling techniques and tools supporting multi-cultural communication and management of disaster knowledge (to be used in the handling of situational information)
- Reference model for distributed service oriented system connecting heterogeneous service nodes; interfaces for interoperability, formal specification and connectivity based on intelligent agents
- Methodology for the development of safe software based systems in a distributed architecture
- Integration of the local European knowledge bases with the Japanese and Indonesian Knowledge Bases into a Global Euro-Asian risk management knowledge space: *Common Operation Picture*

The **phase-space** of the system characterises risk management in time:

- *Monitoring, prediction and detection* of potential emergency situations and crises. This is one of the *project goals*. By evaluating current data we will compare the situation with those that are available in the system knowledge base. If the situation falls under a critical similarity class, the warning system is alerted. For instance, the situation in Bohemia in summer 2002 was similar to that of 1890. Hence the system might have classified the situation as a 500-year flood much earlier than it actually happened.
- Emergency help and *first-aid* during the crisis. This is dealt with by particular Emergency Services (see <http://www.sos112.info/>).
Using fuzzy similarity classes, our system will provide *knowledge support* for the local Integrated Emergency System (see <http://sova.vzsjp.cz/prvnipomoc/system.html>).
 - In the case of *big catastrophes* the emergency operations are handled by international co-operative bodies; knowledge described by predefined model structures (situational knowledge model) is of high importance, and it provides a support to common understanding and high quality knowledge exchange
- *Post-event* minimization of economic, property and ecological damages. In this phase particular humanitarian (non-) governmental organisations are involved.
The Logic-MAS resulting system will provide *knowledge support* for them.
- *Evaluation* of the causes, course and consequences of the crisis. In this phase we obtain new knowledge and verify current rules in order to obtain a *feedback* for the prediction and detection.

The following figure illustrates the collaborative architecture of the resulting system. Architectural details and collaboration mechanisms of the system are in the focus of this research project.¹



Local data on disasters like floods, mud flow, tsunami, chemical attacks, etc.

¹ The idea of collaborative architecture was presented by Koji Zettsu and Yasushi Kiyoki in the NICT workshop, Kyoto, March 2007. See also Jaakkola (2007).

In details:

a) Tools and Theoretical Deliverables:

- * TIL-Script FIPA compliant communication declarative language
- * Conceptual systems of agents grouped by their inferable skills
- * The ‘logic of events’
- * Methodology of building up an emergency event-driven multi-agent system; specification of the role of agents in the recognition of service demands
- * The architecture and communication standards for emergency risk messaging in a multi-agent system
- * The architecture (generic reference model) of a distributive knowledge risk management system
- * Methodology for developing safe distributed software systems

Stage 1 (June 2008-May 2009)

IP01 – Ostrava (Duzi et al)

- Implementation of the 1st version of the TIL-Script language (July 2008);
 - in this version the fundamental TIL functions will be realised, i.e., it will not handle partiality (non-denoting terms) in full.
 - However, in order to let the agents learn and enrich their internal knowledge base, the exchange of unrecognised concepts and their refinement by mentioning the respective constructions, i.e., the hyper-intensional features of TIL will be analysed and partly dealt with.
- Behaviour Scenario for a multi-agent system driven by crises (July 2008);
- Testing agents’ dynamic behaviour using the Agent Studio² and the current model and ontology of traffic system (continuously, first results in August 2008):
 - Testing agents messaging in the TIL-Script
 - Testing agents’ learning mechanism: see <http://www.cs.vsb.cz/til/>
- Design of the internal knowledge base and its interconnection with the other units as well as the Brain Interface (December 2008)
- Using ontology of floods: TIL-Script typing of the basic notions using Word Net (continuously, in cooperation with the NLP centre in Masaryk University Brno);
- Architecture of the agents’ Brain: design (December 2008) and implementation (May 2009)
- Upgrade of the Prolog Brain Unit into the ontology of crises (January 2009);
- Communication scenario: event-driven system (January 2009);
- Study on the applicability of the theory of chaos for prediction and evaluation of crises (May 2009);

IP03 – Jespersen, Delft + IP05 – Materna, Prague–Brno

- Proposal of the ‘logic of events’ (May 2009, in cooperation with NLP Centre in Masaryk University Brno), in particular:
 - TIL analysis of the type of an event;
 - TIL analysis of the kinds of relations between events;
 - TIL analysis of the dynamic aspects and temporality of events;

² The Agent Studio software tool for MAS development and simulation that has been developed in the Laboratory of Intelligent System (LabIS) within the project “Logic and AI for Multi-Agent Systems”.

- Stating attributes of events.
 - Stating general rules for handling events.
- Working out the notion of inferable knowledge as set out in the pioneering paper Duží, Jespersen, Müller (2005); in particular,
 - TIL analysis of the classification of agents' inference abilities into skill-level classes (December 2008);
 - Proposal of Conceptual systems based on agents' grouping into classes (May 2009)

Stage 2 (June 2009-May 2010)

IP01 – Ostrava (Duzi et al)

- Implementation of the 2nd version of the TIL-Script language (December 2009);
 - in this version the prototype of “full TIL” will be realised, i.e., including partiality and hyper-intensionality.
- Prototype of the multi-agent system driven by flood crises: testing of the prototype (December 2009)
- Testing agents' dynamic behaviour using the Agent Studio and the ontology of floods. In particular:
 - Testing agents messaging in the TIL-Script (continuously)
 - Testing agents' learning mechanism (continuously, first version in August 2009)
- Testing the TIL-Script internal knowledge base on floods and its interconnection with the other units as well as the Brain Interface (June 2009)
- Further development of the ontology on floods: cooperation with the NLP centre in Masaryk University Brno (continuously)
- Architecture of the agents' Brain: testing the prototype communication (continuously)
- Design of the fuzzy version of the TIL-Script (May 2010, in cooperation with the Institute of Computer Science AVCR in Prague and with NLP centre in Masaryk University Brno)
- Scenario of crises evaluation and prediction using the theory of chaos (May 2010)

IP03 – Jespersen, Delft + IP05 – Materna, Prague–Brno

- The ‘logic of events’ specification and testing general rules in the real-data environment; data supplied by IP04 (Split)
 - Checking the consistency of the logic
- The analysis of computing inferable knowledge based on crisp explicit knowledge rules
 - Specification of Conceptual systems based on agents' grouping into fuzzy classes

Stage 3 (June 2010-May 2011)

IP01 – Ostrava

- Design and Implementation of the full functionality of agents' brain,
 - in particular the perception of environment, its space and temporal aspects and events.
- The analysis of computing inferable knowledge based on fuzzy explicit knowledge rules
 - Specification of Conceptual systems based on agents' grouping into fuzzy classes
- Tuning agents' dynamic behaviour using the Agent Studio and the ontology of floods. In particular:
 - Agents messaging in the TIL-Script
 - Agents' learning mechanism

- Tuning the TIL Brain and communication using real data on floods obtained from Floreon (Ostrava) and from Split
- Testing the fuzzy version of the TIL-Script (in cooperation with the Institute of Computer Science AVCR in Prague and with NLP centre in Masaryk University Brno)

IP03 – Jespersen, Delft + IP05 – Materna, Prague–Brno

- The ‘logic of events’ specification and testing general rules in the real-data environment (data obtained from the Local knowledge grids: Floreon, Split and Pori)
 - Checking the consistency of the logic
- The analysis of computing inferable knowledge based on fuzzy explicit knowledge rules
 - Specification of Conceptual systems based on agents’ grouping into fuzzy classes
- Logic of ‘space and time’ specification

IP03 – Jespersen, Delft + IP01 – Duzi

Application of mathematical methods of geodata evaluation in terms of space and time attributes; using methods of reasoning under incomplete or vague information (in cooperation with the LoMoReVi 2007 project).

b) Practical applications – case study on floods. Outputs:

- * Knowledge grid nodes for testing the interoperability of the co-operative knowledge nodes in practice; the nodes are operating in
 - Ostrava (Floreon knowledge-base upgrade),
 - Pori
 - Split
 - NICT: Kyoto and Tokyo
- * Knowledge architecture and communication protocol
 - Concept design: Conceptual systems of disaster fuzzy classes
 - Software design: Jade software packages for warning messaging
 - Prototyping: information technology support for preventing and handling floods
- * Warning system support
- * Studies in the area of safe software solutions

Stage 1 (June 2008-May 2009)

(IP02 Pori – Hannu Jaakkola)

- Methodology for building up a distributed knowledge base system (December 2008):
 - summary of the existing ones;
 - new features of the open Service Oriented Architecture (SOA) technology
 - state-of-the-art review on knowledge pattern languages
 - state-of-the-art review on process modelling techniques
 - analysing the role of intelligent agents as a part of the network of services
 - binding proposal of the architecture and communication protocol
- Implementation of the development environment (December 2008);
- Implementation of the local Grid node (May 2008)
- Introductory studies in the development of safe software
- Analysis of the knowledge modelling techniques and supporting tools (knowledge packages in communication between humans, human and computer, computer and computer)

(IP01 Ostrava – Marie Duzi et al)

- Conceptual analysis of emergency / critical situations including their *spatial* and *temporal* aspects (December 2008);
 - Building ontology of floods in cooperation with the Water Research Institute and the Czech Hydro-Meteorological Institute
- Analysis of the spatial and temporal aspects (May 2008):
 - Application of mathematical methods of geodata evaluation in terms of space and time attributes;
 - Analysis of using methods of reasoning under incomplete or vague information (in cooperation with the LoMoReVi 2007 project).
- Proposal of partition criteria, proposal of fuzzy classes of similarity
 - incl. knowledge patterns for floods
- Local Grid on floods: Floreon system knowledge upgrade proposal

(IP04 Split – Ivan Slapnicar)

- Purchasing and installing hardware (6 Blade servers, network equipment, server cabinet);
- Installing cluster and grid software, and the respective search engine;
- Setting up search of Croatian scientific and government data;
- Developing and implementing matrix based data-mining algorithms;
- Developing and implementing algorithm for generating hierarchical categories (ontologies);
- Provision of real data on floods (continuously, first results in September 2008);
- Implementation of the local Grid node (May 2009)

(AP03 Jyväskylä – Anneli Heimbürger, AP01 – Tokyo, Yasushi Kyioki)

- Design of the cross-cultural ontology

Stage 2 (June 2009 – May 2010)

(IP02 Pori – Hannu Jaakkola)

- design and implementation of the SOA architecture components; testing the components; interoperability issues (agent technologies); (December 2009)
- specification of the knowledge pattern language; business process modelling principles;
 - prototype tool evaluation and utilization (May 2010)
- evaluation of the technical solutions supporting safe software solutions

(IP01 Ostrava – Duzi et al)

- Testing the prototype of the multi-agent system driven by flood crises on real data obtained in Split and Pori (May 2010)

(IP04 Split – Slapnicar et al) + Japonci role naplnovani daty

- Purchasing and installing additional Blade servers; setting up search of entire Croatian web with all algorithms developed so far; setting up search of crisis related international data with all necessary modifications to the software and algorithms developed so far (August 2009)
- Provision of real data (continuously);
 - analysing and reporting the usage of the search environments;
- Setting up natural language formulation searches in all the search environments (May 2010, in cooperation with AP01 – Tokyo, AP02 – Kyoto))
- In cooperation with AP01 and AP02:

- Evaluation of the search data
- Provision of data on floods (grouped by criteria specified by IP01)
- Real-data prototype Grid node base (May 2010).

IP01 + IP02 + IP04 + AP03, AP01, AP02

- Building interface to Japanese and Indonesian local knowledge grids using TIL-Script ACL messages (Ostrava), knowledge patterns (Pori) and search mechanisms (Split)
- Testing the communication with Japanese and Indonesian local knowledge grids using TIL-Script ACL messages;
- Testing of the cross-cultural ontology

Stage 3 (June 2010-May 2011)

(IP02 Pori – Hannu Jaakkola)

- Tuning the system, performing reliability and performance tests;
 - testing the development environment in practical applications ;
 - testing the SOA solution in real network environment (using real data from Kyoto and Split, as well as Floreon system – Ostrava);
 - generalization of the results – context and domain independent technologies;
- Knowledge representation - application of the knowledge pattern language
- Testing the SOA solution in real network environment (using real data from Kyoto and Split, as

(IP04 Split – Ivan Slapnicar)

- Provision of real data on floods (grouped by criteria specified by IP01) using natural language formulation searches to all the sites.
- Setting up multi-agent based searches in all the search environments.
- Performance test and optimisation of the search environments.

IP01 + IP02 + IP04

- Full integration of particular local knowledge clusters into a virtual global knowledge space *via* the TIL-Script message-exchange system.
- Testing evaluation and integration methods in the real time environment.
- Generalisation of the flood model ontology into other risky situations.
- Testing the *Common Operation Protocol* on real Asian data.

IP01 + IP02 + IP04 + AP03, AP01, AP02

- Evaluation of the cross-cultural ontology: Common Operation Protocol tested on real data from particular knowledge grids should behave “in the same pattern”