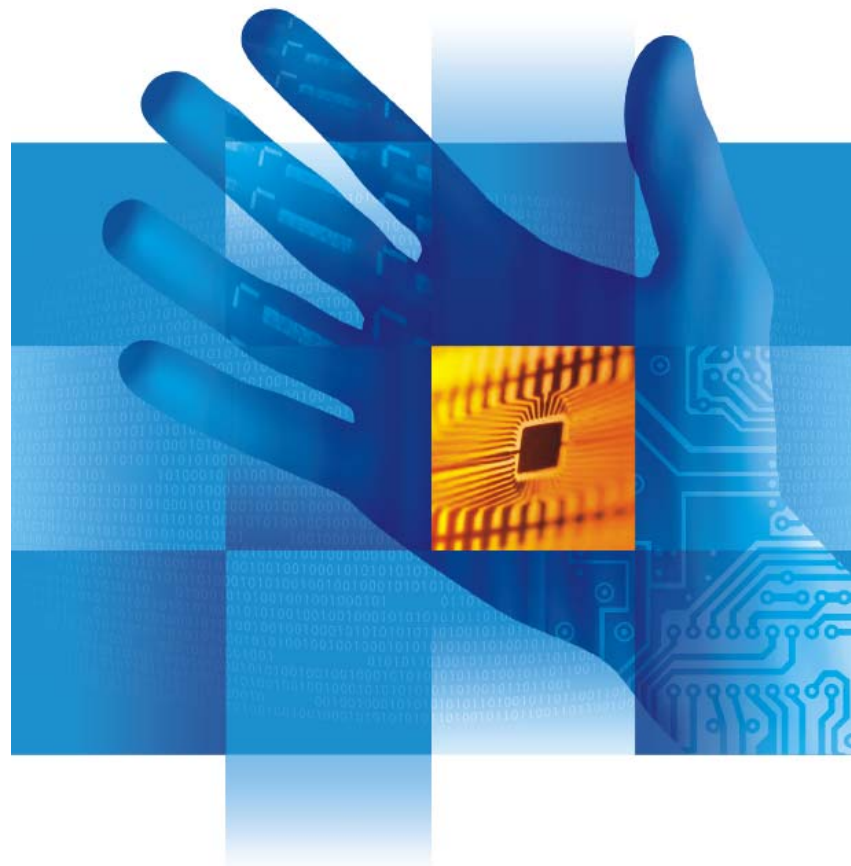


Multi-Agent System and Traffic Simulation

(ADS2008)

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The size does not matter 😊





Outline

- Project introduction
- Modeling
 - Agent Behavior Diagrams
- Simulation
 - ... traffic
- Conclusion



Project description

- **LabIS** (Research **L**aboratory of **I**ntelligent **S**ystem)
 - it started 3 years ago
 - 3 studied areas
 - Logic
 - Logical analysis of natural language, knowledge representation, inference machines, TIL-Script development
 - **Processes**
 - Process management, control and coordination, process simulation and prediction
 - MAS & GIS
 - Communication, infrastructure, real data processing
- **Design and implementation** of MAS based on the process modeling, behavior modeling
- **JADE** (Java, .NET) as the framework for ***AgentStudio*** software.



Modeling & Simulation

- Modeling
 - extended UML
 - Agent Behavior Diagram (ABD)
 - Behavior reconfiguration
 - Semi-code generation
- Simulation
 - The way how to prove the theoretical background
 - Connection to “logic components”
 - Traffic simulation





Agent Behavior Modeling

- The **Agent Behavior** refers to the actions or reactions of an Agent in relation to the environment and some situations. It depends on skills, knowledge and capabilities of particular Agent during its life.
- The **Agent Behavior Modeling** is a process where the particular Behavior is captured as algorithm. The model makes the basis for next phases of software process.





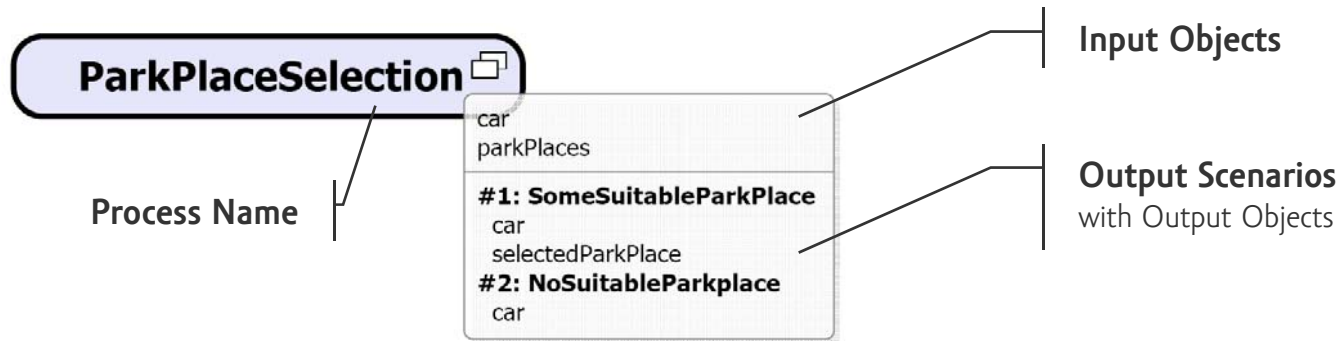
What is the Agent Behavior Diagram?

- It is a tool that helps us to model and specify the behaviors of agents.
- It is based on standard “UML Activity Diagram” technique.
- Why a new diagram?
 - additional process specification
 - ensure the modification of MAS
 - conjunction of graphical and textual data which helps the programmers to imagine final behavior
 - it represents a background for further behavior reconfiguration

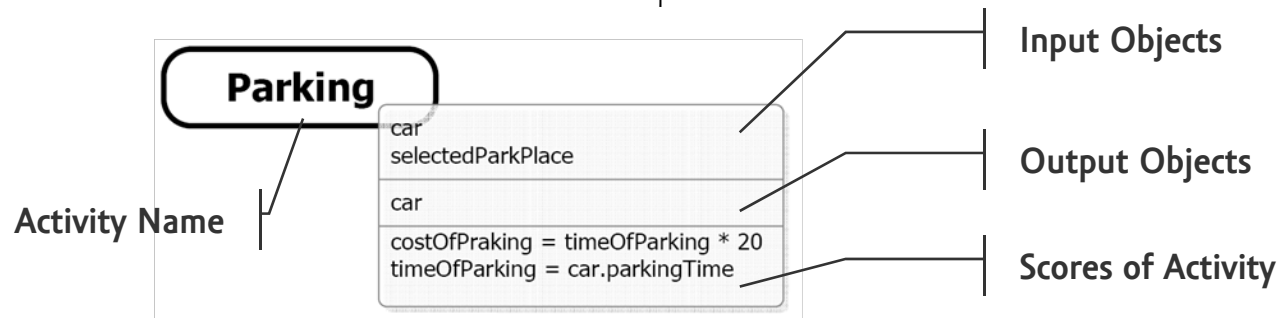


Agent Behavior Diagram elements

Extended Process Node
with additional information shape



Extended Activity Node
with additional information shape



Agent Behavior Diagram elements

Send Activity Node

one-to-one Agent communication
with additional information shape

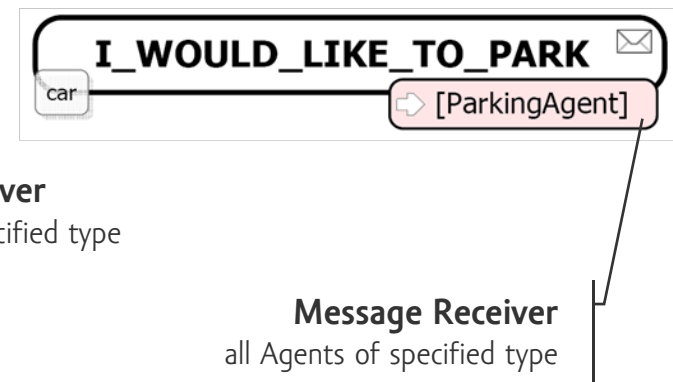


Objects related to the Message
Input Objects in case of Send Activity

Message Receiver
one Agent of specified type

Send Activity Node

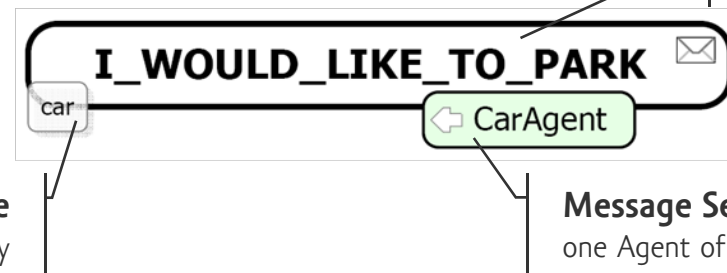
one-to-more Agent communication
with additional information shape



Message Receiver
all Agents of specified type

Receive Activity Node

one-to-one Agent communication
with additional information shape



Message Identification

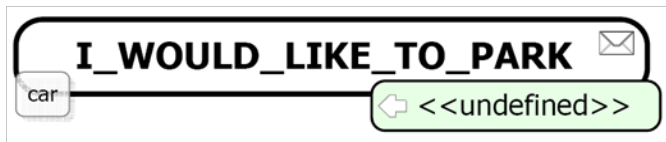
Objects related to the Message
Output Objects in case of Receive Activity

Message Sender
one Agent of specified type



Agent Behavior Diagram elements

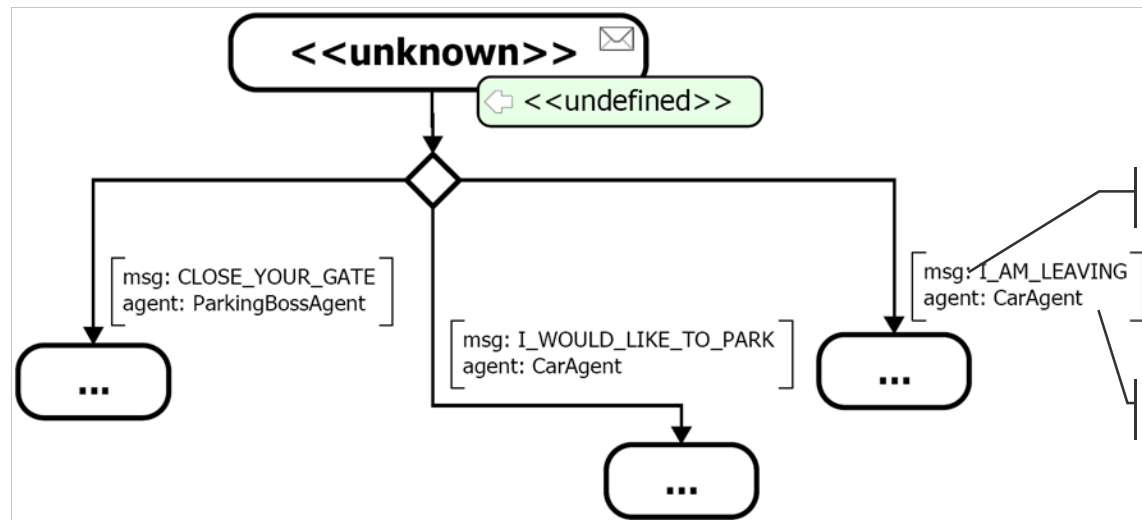
Receive Activity Node
defined Message from unknown Sender
with additional information shape



Receive Activity Node
undefined Message from one defined Sender



Receive Activity Node
undefined Message from unknown Sender



Received Message

Message Sender Agent



Process and Realization

- The **Process** is a naturally designed sequence of operations or events, possibly taking up time, space, expertise or other resource, which produces some outcome. The Processes form the behavior of an Agent.
- The **Realization** is a model element that provides an description for implementation of an process element. By other words, the realization is one of possible algorithms for process firing; this algorithm is specified by one “Agent Behaviour Diagram”.



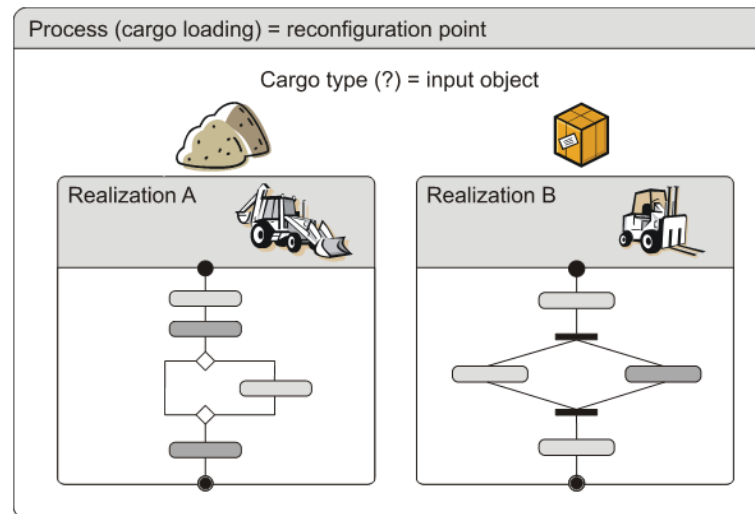
Behaviour Reconfiguration

1. **The Specification Phase**
2. **The Selection Phase** - checking of the applicable Realizations of a given Process and finding the most suitable one.
 1. the selection of applicable Realizations – based on Input Objects occurrence
 2. the finding the most suitable Realizations - based on Input Objects values and properties, Scores, etc.
3. **The Execution Phase**

loose material



use excavator



solid material



use lift truck



AgentStudio Designer

AgentStudio 1.0

File Model Drawing tools Application

Model

- Metropolitan Parking System
 - Agents
 - ParkingAgent
 - PrimaryProcess
 - UpdateParking
 - CarAgent
 - Parking
 - FindingAnotherParkingRange
 - PrimaryProcess
 - Initialization
 - Processes
 - MoveToCity

Tools

- Activities Management
- Objects Management
- Messages Management
- Score Types Management
- Dictionary of Model

Elements

- Process Node
- Activity Node
- Send/Receive Activity Node
- Decision Node
- Thread Split Node
- Thread Join Node
- Initial Node
- Final Node
- Note

PrimaryProcess

CarAgent

Initialization

MoveToCity

SetDestinationAsPosition

I WOULD LIKE TO PARK

I AM READY FOR YOU

UpdateParkingTable

FindingAnotherParkingRange

I AM LEAVING

I AM HERE

Send/Receive Activity Node ...

Current Activity Messages

- SEND: a Message to one Agent
- SEND: a Message to the set of Agents (all instances of a given types)
- RECEIVE: a Message from one Agent
- RECEIVE: unknown Message from one Agent type
- RECEIVE: a Message from undefined Agent type or multiple Agent types
- RECEIVE: unknown Message from undefined Agent type or multiple Agent types

Send Activity

Message I_WANT_TO_PARK

Agent Type ParkingAgent

Receive Activity

Message I_AM_READY_FOR_YOU

Agent Type ParkingAgent

Dictionary ...

Activity Id	Description	Usage in ...	Input Objects	Output Objects
CalculateParkingElement		PrimaryProcess (ParkingAgent)	car destination parking	car parkingElement
CalculateParkplace		PrimaryProcess (ParkingAgent)	car parking reservation	car parking
CarInitialization		Initialization (CarAgent)		car parkingTable
ConnectionToNavigation		Initialization (CarAgent)	car	car navigation
DeleteFromParking		PrimaryProcess (ParkingAgent)	car parking	parking
DrivingWithNavigation		MoveToCity ([Processes]) MoveToDestination	destination navigation	navigation

Petr Gajdoš, Michal Radecký

AgentStudio designer

1.2.3007.23951
2008-03-26 01:18 odp.

Details OK

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research supported by the Czech Academy of Sciences (project No. 1ET101940420)

Modeling & Simulation

- Modeling
 - extended UML
 - Agent Behavior Diagram (ABD)
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 - The way how to prove the theoretical background
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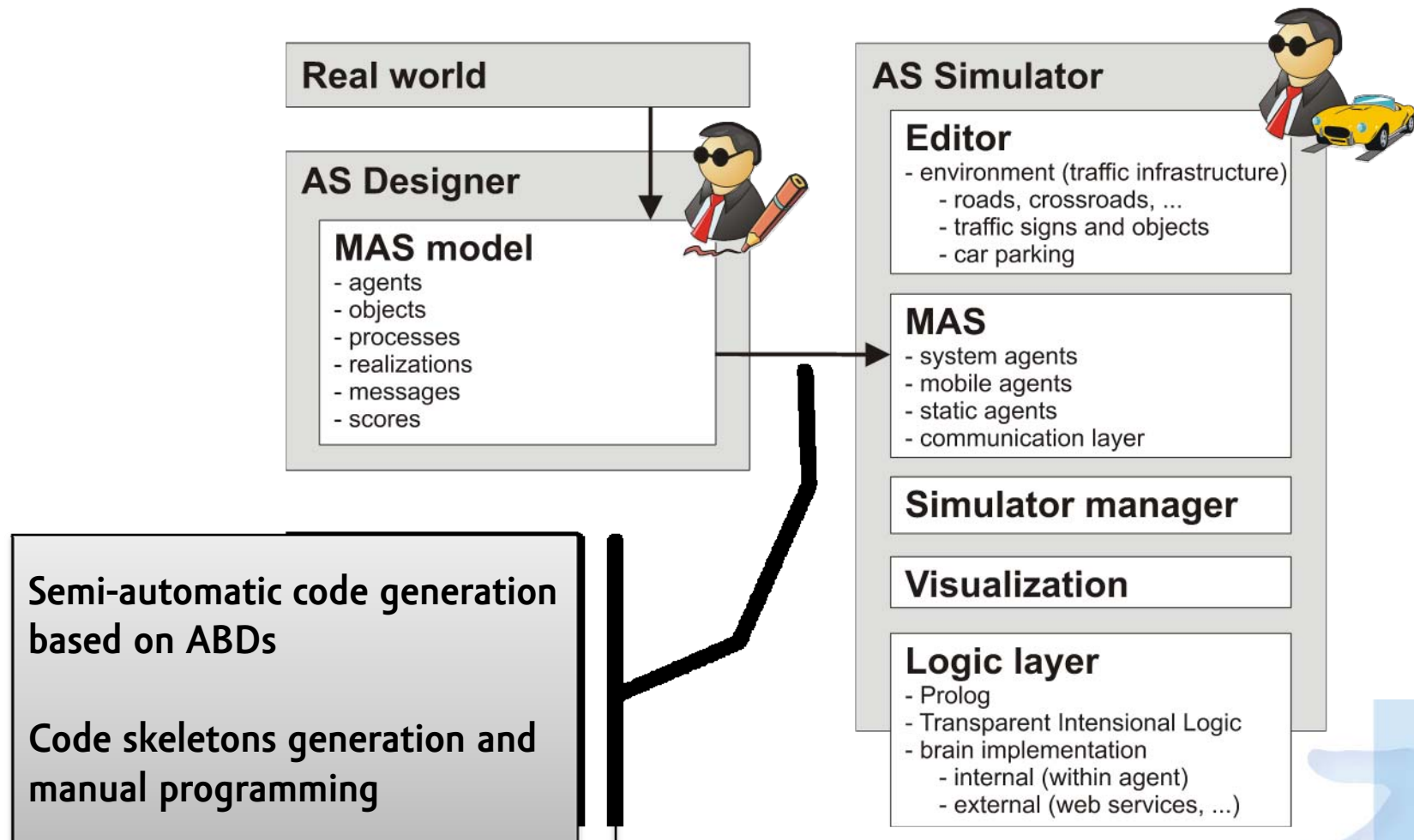


Simulations

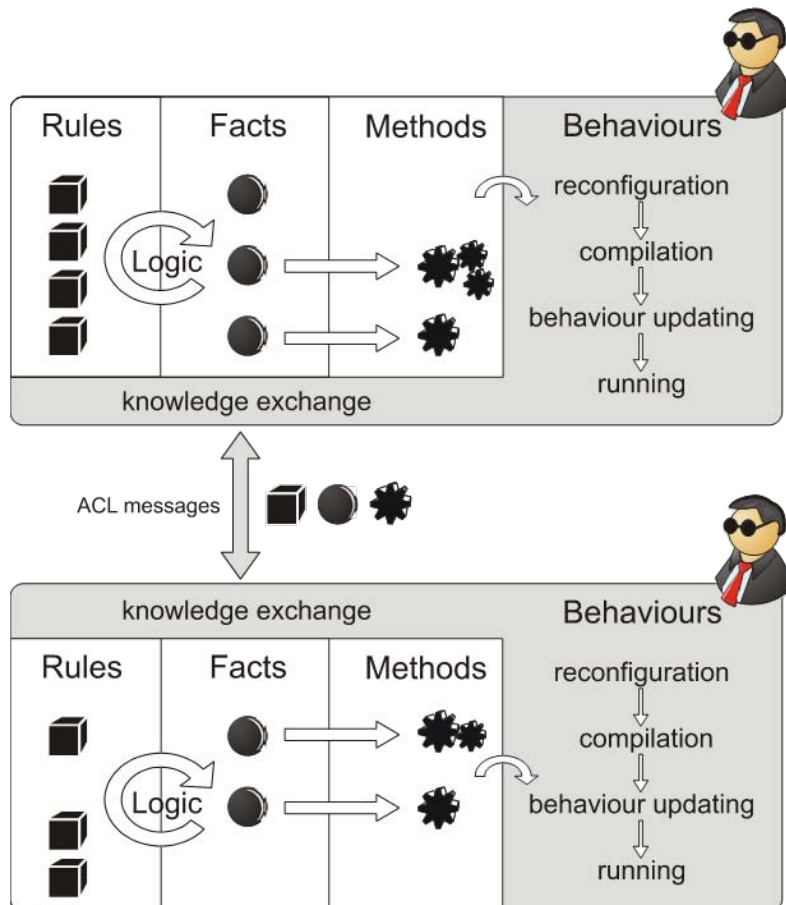
- What we want to simulate?
 - behaviors of agents based on given laws
 - e.g. highway code, business rules, etc.
 - process reconfiguration and objective achieving
 - decision making based on first order logic and/or TIL
 - the comparison of different inference machines
 - knowledge exchange and distribution
- Why the traffic simulations?
 - “clear” rules
 - it is easy to model different situations
 - real data



AgentStudio



Agent architecture



- knowledge base
 - rules
 - first order logic
 - TIL
 - facts
 - world data
 - ontology
 - Methods
 - elementary program codes which do not depend on MAS architecture
- Behaviors
 - process-reconfiguration
 - dynamic dll codes
- ACL messages



AgentStudio Simulator

The screenshot displays the AgentStudio Simulator interface, which includes a central map area showing a road network with several cars (agents) moving. The interface is divided into several panels:

- Main Menu:** Contains buttons for List View, Tree View, and Traffic shapes (CrossRoad Shape Y, CrossRoad Shape X, CrossRoad Shape C).
- Zooming:** Includes zoom in and zoom out buttons.
- Toggle info:** Contains checkboxes for Show Agents Labels, Show Agents Visibility, Show infrastructure details, Send/receive Eagle Eye, and Generate Visibility XML for non-brain Agents. Below these are buttons for Show MapData, Generate MapData, and Set Map Properties.
- AgentGUI (Agent 1@MainMap):** Displays the agent's location (16.2, crossroad:5.4), path (7,5,5,6,9,END), and current state (Lights, Left Indicator, Right Indicator, Break Lights, Back Lights). It also shows a speed indicator at 95.
- AgentGUI (proxy_Agent_6_MainMap@M):** Displays time statistics (Start time: 3/18/2008 2:38:05 PM, Time up: 0:0:5.46), Agent System Status (Agent State: Idle(3)), Communication (Queue Size: 0, Incoming Messages: 2885, 0.38 MB, Outgoing Messages: 2886, 2.14 MB), and Info.
- JADE platform manager:** Shows the MainMap(jicp://localhost:1099) and lists mobile agents (Agent_1@MainMap, Agent_2@MainMap, Agent_3@MainMap, Agent_4@MainMap, Agent_5@MainMap, Agent_6@MainMap) and static agents (WorldRegister1@MainMap, MapDispatcher1@MainMap).
- AgentStudio simulator logo:** A small window at the bottom center shows the AgentStudio simulator logo and version information (1.5.2599.25981, 2008-03-18 02:26 PM).

Future Work

- Specification of correct and complete meta-model of MAS Model
- Formalization of this meta-model, its components and “Agent Behavior Diagram” (Petri Nets, π -calculus, etc.)
- Map the MAS Model onto the other forms (XML, analytic tools, etc.) and semi-automatic MAS code generation
- Integration of the reconfiguration approach to the complex approaches of Agents` intelligence



Thank you for your attention ...

