

# Report on NATO ASI Summer School

## Software Agents, Agent Systems, and their Applications

*Tangiers, Morocco  
September 13-23, 2010*

Ing. Masterand  
Octavian Voicu  
octavian.voicu@gmail.com

**AI-MAS Group**  
*"AIM AS high as you can"*

*October 22, 2010*

# Contents

- Overview of NATO ASI
- State of the Art in MAS for WSN
- Semi-formal Modelling of MAS
- Resources
- Q / A

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# Overview

- In depth coverage of:
  - software agents
  - agent systems
  - methodologies & technologies used in their development and implementation
- The school is funded under the NATO Science for Peace and Security Program

# Scenarios

- Emergency situation
  - caused by “natural accident / human error”
  - caused by malicious action
- Damages / victims
  - of a single person
  - of a team of attackers
  - humans
  - infrastructure
  - environment
- Response team with one or more members

# Topics (1)

- **Marcin Paprzycki** – Introduction, Scenarios
- **Radovan Cervenka** – Semi-formal modelling of multi-agent systems
- **Giovanni Caire** – JADE: a Java based framework to develop distributed multi-agent applications
- **Lars Braubach** – BDI Agent systems
- **Mohammad Essaidi** – State-of-the-Art of WSN

# Topics (2)

- **Amal El Fallah Seghrouchni** – MAS: An innovative technology for collective planning
- **Mike Hinchey** – Software agents in NASA
- **Giancarlo Fortino** – Agents and sensor networks
- **Costin Badica, Gregor Pavlin, Michiel Kamermans** – Agents in (chemical) disaster management
- **Katia Sycara** – Ontologies and agent systems

# Topics (3)

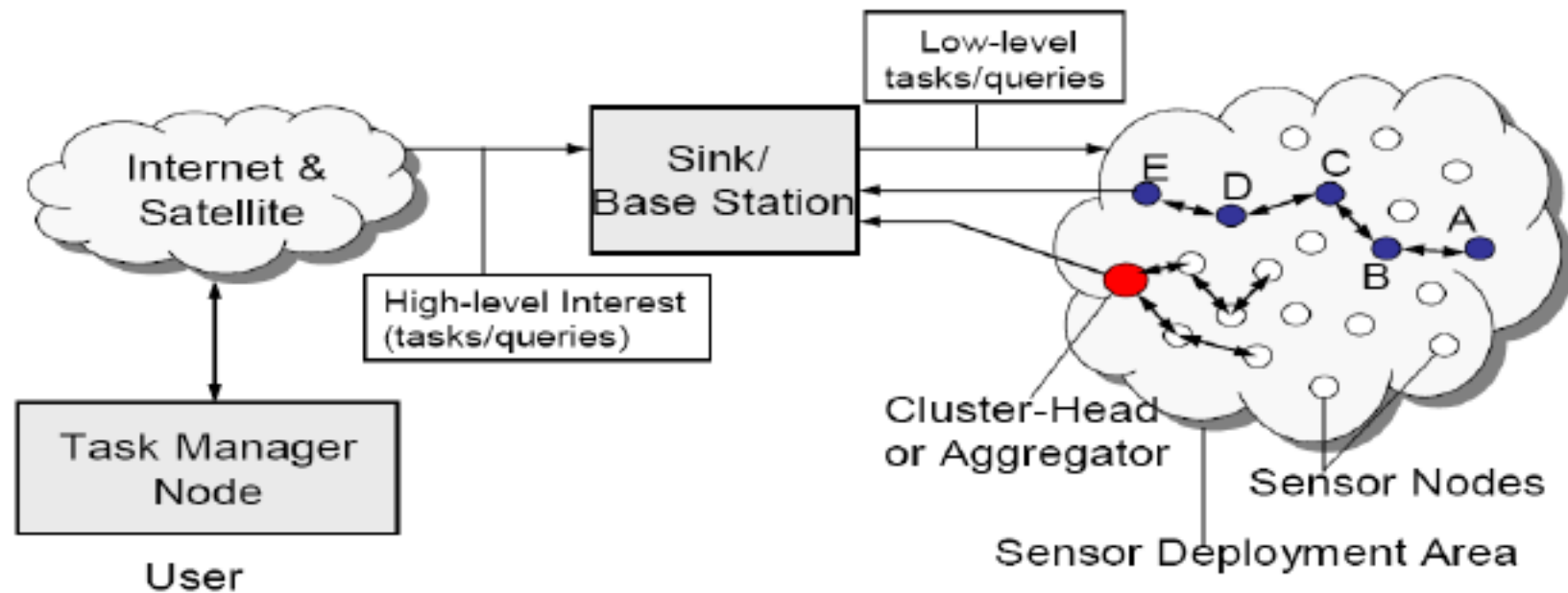
- **Premysl Volf** – Management of UAV's
- **Giacomo Cabri** – Agents in medical emergencies
- **Igor Kotenko** – Software agents for network security
- **Maria Ganzha** – Agents as resource brokers and managers in Grids
- **Rafal Leszczyna** – Security of agent platforms; Anonymity architecture; Agents simulating malware



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# Wireless Sensor Networks



# Programming WSNs

- Complex task because nodes:
  - Have limited capabilities
  - Have low processing power
  - Need to conserve energy
  - Use unreliable communication
- Usually application/domain specific
  - Need a middleware to facilitate reusability
- Solution: **mobile agent-based paradigm**

# Mobile Agents in WSNs

- Network load reduction
- Network latency overcoming
- Protocol encapsulation
- Asynchronous and autonomous execution
- Dynamic adaptation
- Orientation to heterogeneity
- Robustness and fault-tolerance

*Lange and Oshima (1999)*

# WSN Sensors



**MICAZ**



**SunSpot**



**TelosB**

# Multi-Agent Systems for WSNs (1)

- MAS for conventional platforms:
  - Java-based: Aglets, Ajanta, Voyager, Jade, etc...
  - Non-Java-based: D'Agents, ARA, etc...
- MAS for WSN:
  - Agilla (very lightweight, tuple-space, TinyOS)
  - SensorWare (TCL, only for iPAQ)
  - Variants/Extensions of Agilla
  - actorNet (actor model of computation, functional prog language, TinyOS)

# Multi-Agent Systems for WSNs (2)

- Only 2 Java-based MAS available for WSNs:
  - MAPS (Mobile Agent Platform for Sun Spots)
  - AFME (Agent Factory Micro Edition)

# Comparison

	<b>Agilla</b>	<b>actorNet</b>	<b>MAPS</b>	<b>AFME</b>
<b>Migration</b>	Y	Y	Y	Y
<b>Multitasking</b>	Y	Y	Y	Y
<b>Communication Model</b>	tuple space	messages	messages	messages
<b>Programming Language</b>	proprietary ISA	Scheme-like	Java	Java
<b>Agent Model</b>	Assembler-like	Functional	Finite State Machine	BDI
<b>Intentional Agents</b>	N	N	N	Y
<b>Sensor Platforms</b>	Mica2, MicaZ, TelosB	Mica2	Sun SPOT	Sun SPOT



# MAPS framework

- Runs on Sun SPOT sensors
  - Sun SPOT is based on Squawk VM
  - Programming is done in Java
  - NetBeans IDE
  - Communication
    - Single-hop & multi-hop
    - Reliable & unreliable
- Multi-plane State Machine
- Java is used for programming events, conditions and actions of the agents' behavior

# Limitations

- Static class loading (mobility only in state)
- Flash memory (4MB) + RAM (< 512 KB)
- Migration – really slow (4.5s serialization time)
- Simulator provided, but doesn't support mobility

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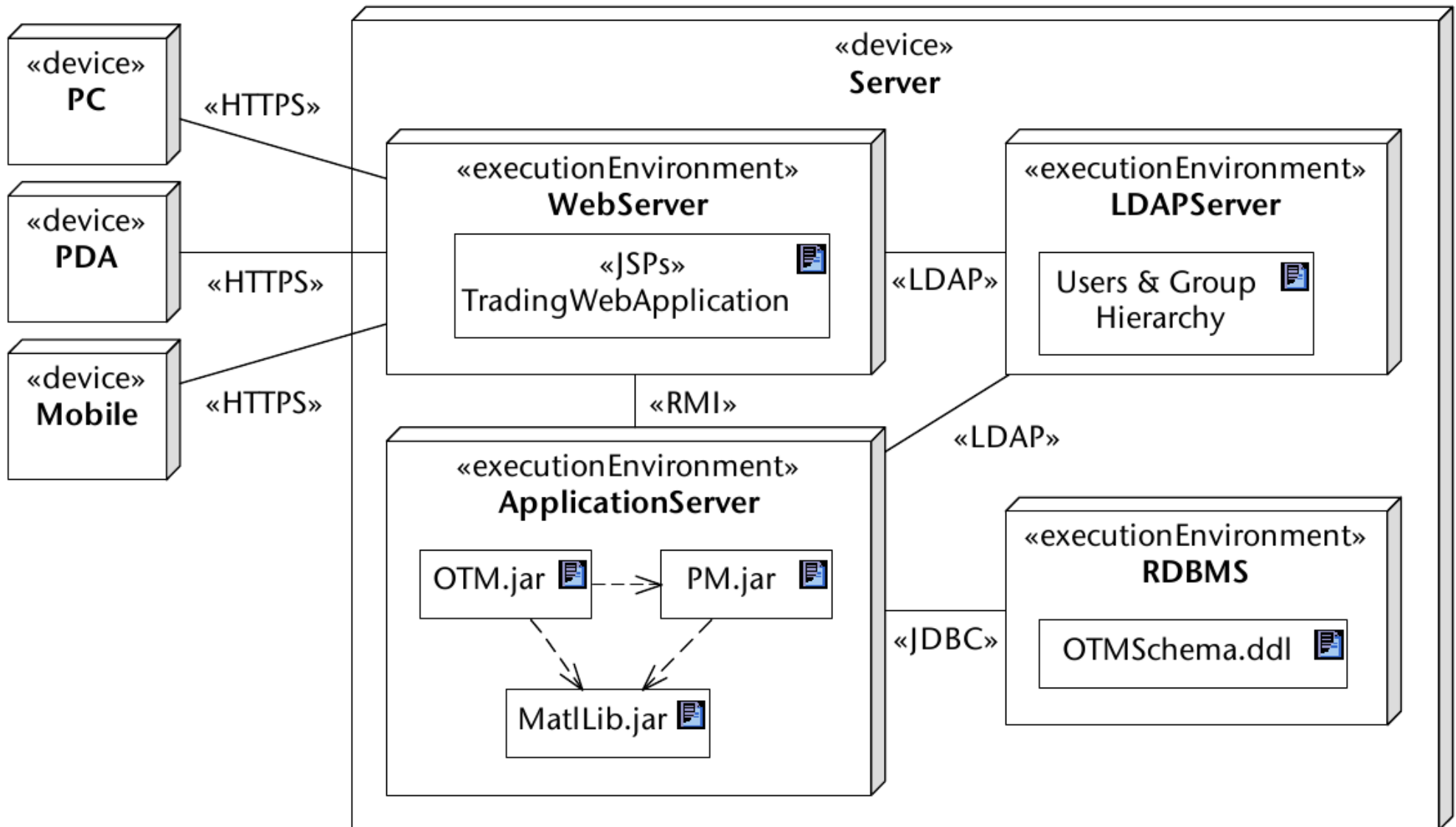
# Agent Modelling Language

- The Agent Modeling Language (AML) is a **semi-formal visual modeling language** for specifying, modeling and documenting systems in terms of concepts drawn from MAS theory.
- Integrates best practices from OOSE and AOSE
- Well specified and documented
- Versatile and easy to extend
- Supported by CASE tools

# Scope of AML

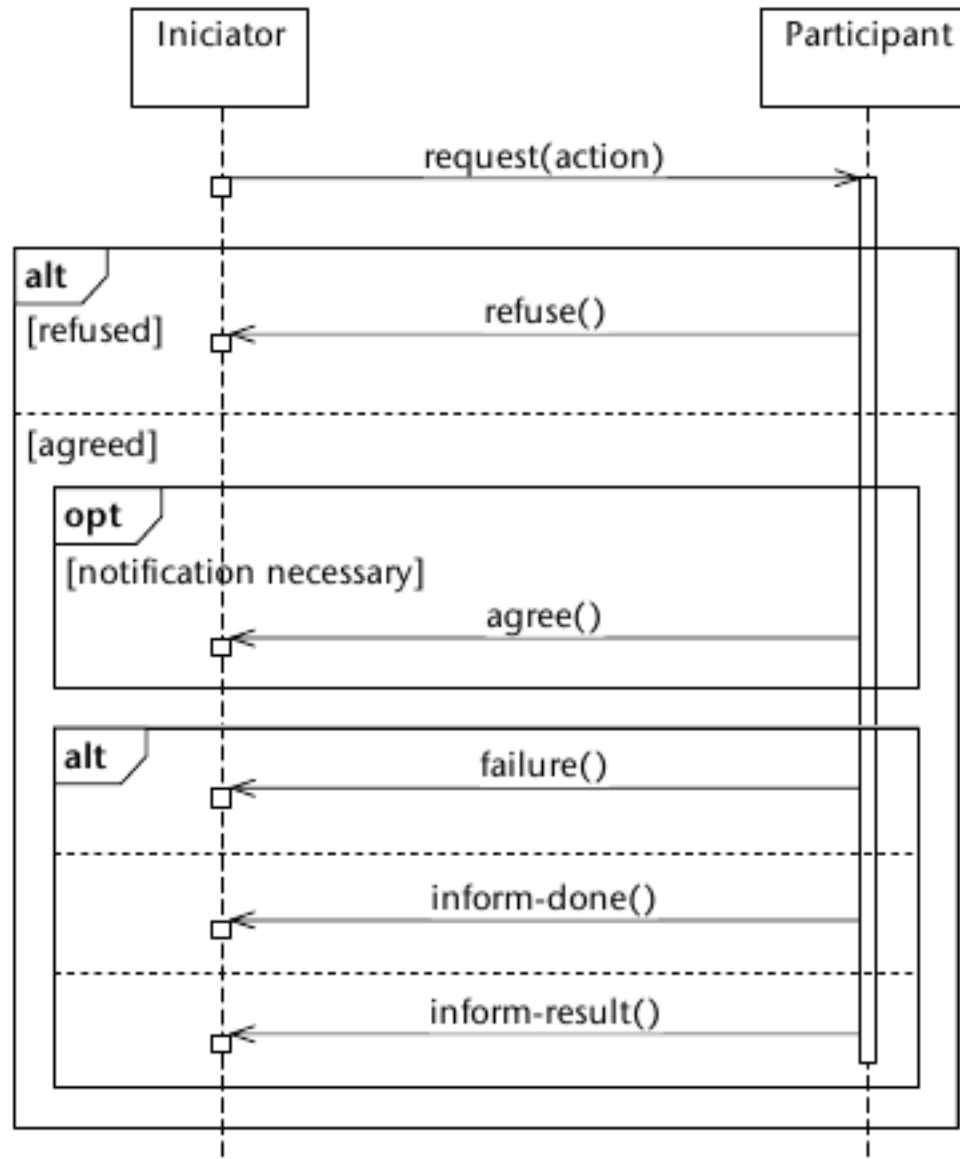
- Support for human mental process of requirements specification and analysis of complex problems / systems
- Support for the abstraction of architectural and behavioral concepts associated with MAS:
  - MAS entities
  - social aspects
  - ontologies
  - deployment
  - agent mobility
  - behavior abstraction and decomposition
  - observations and effecting interactions
  - communicative interactions
  - services
  - mental aspects

# Deployment

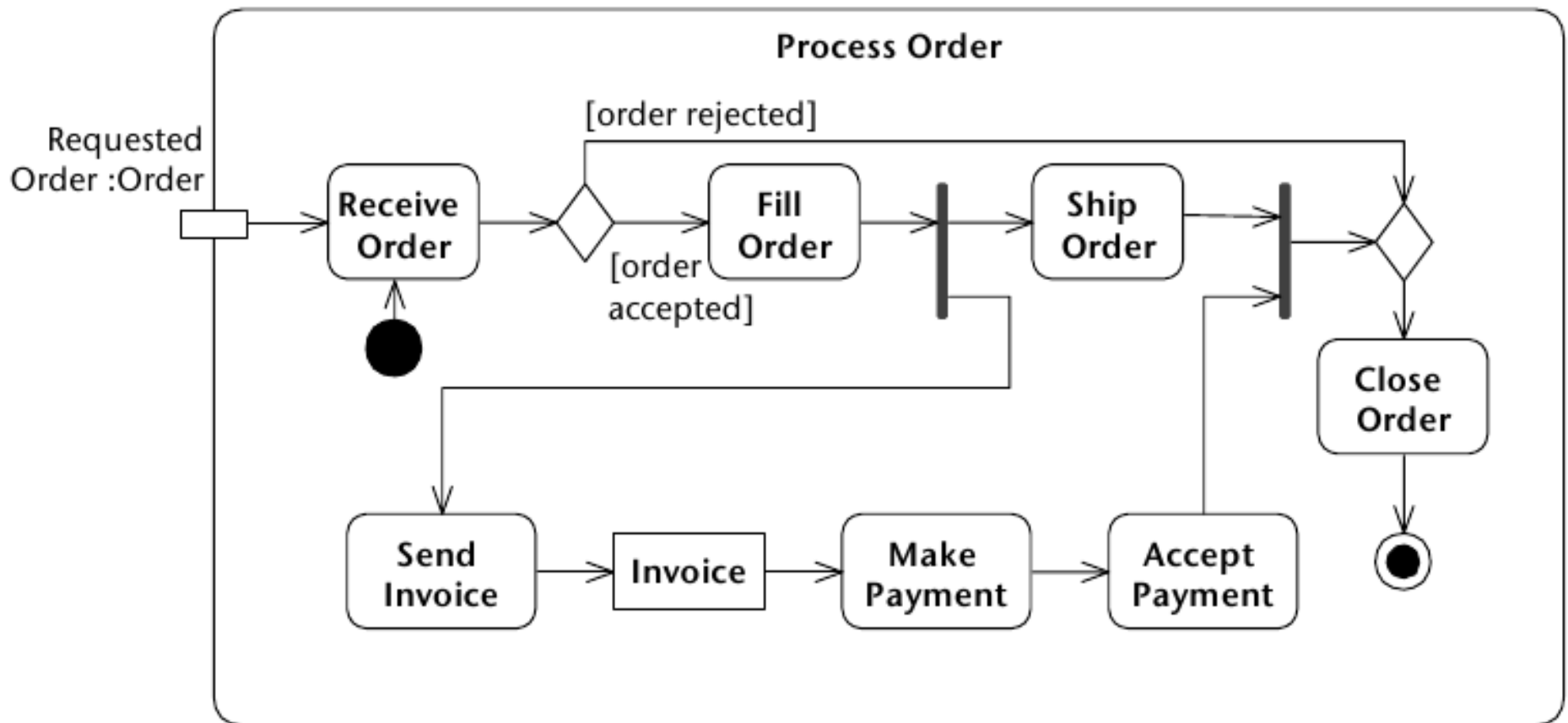


# Interactions

*FIPA Request Protocol*

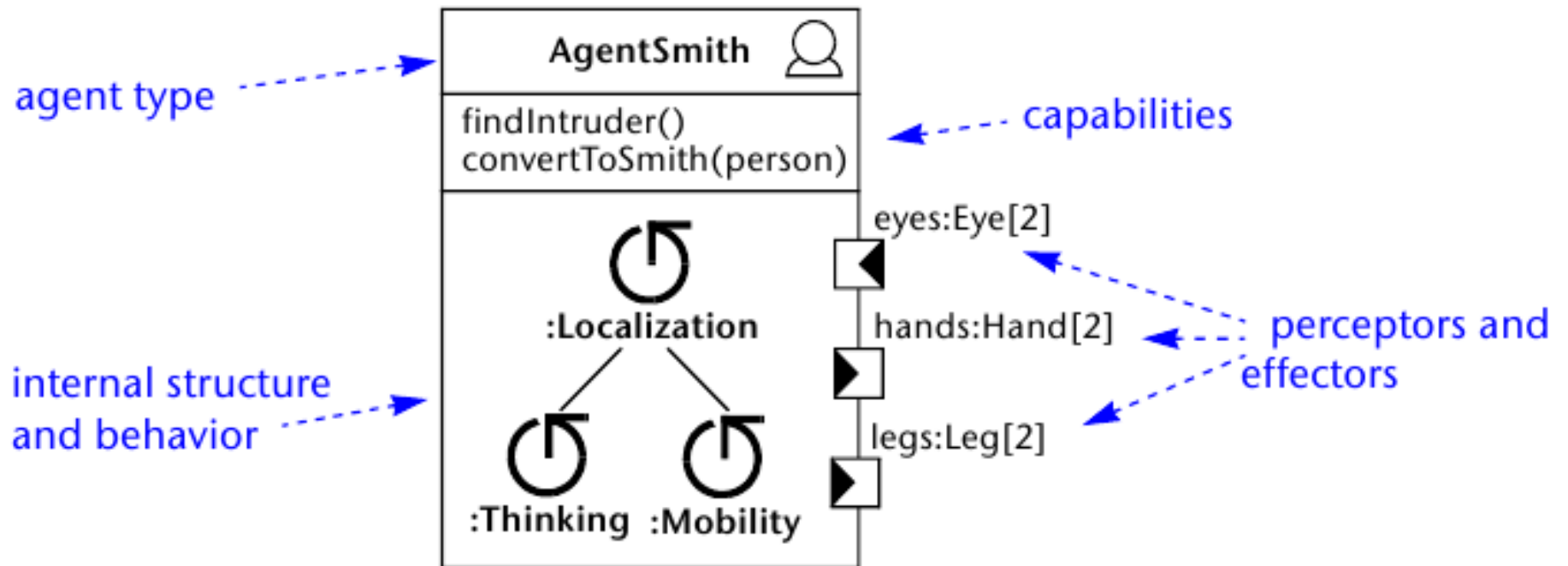


# Activities

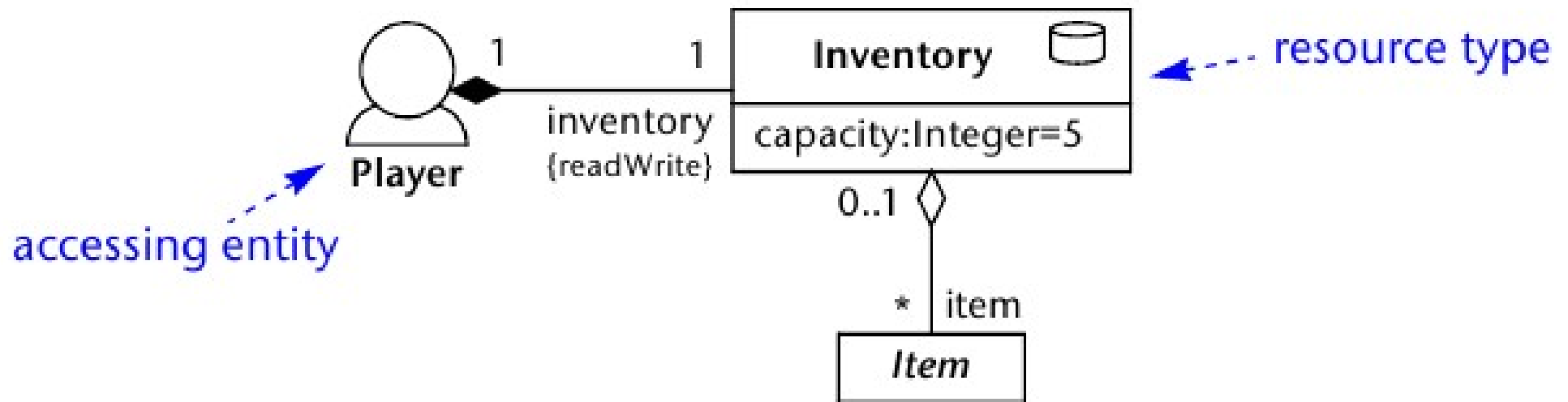




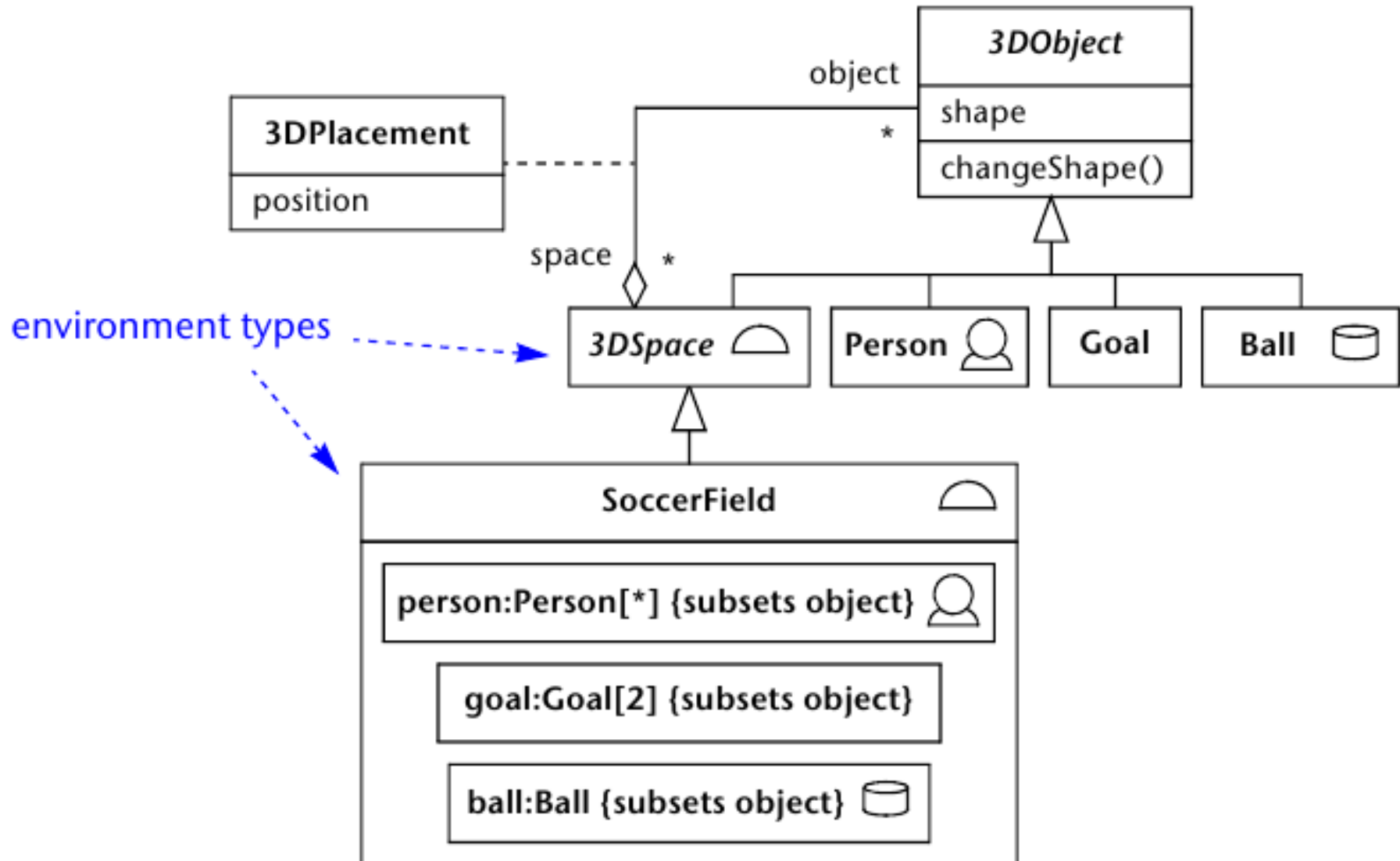
# Agent Types



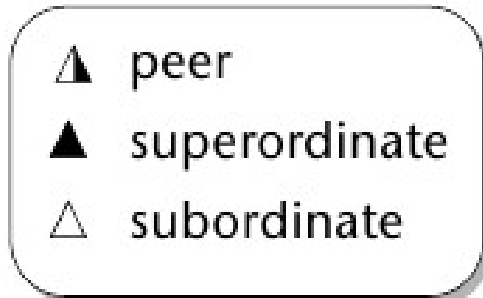
# Resource Types



# Environment Type

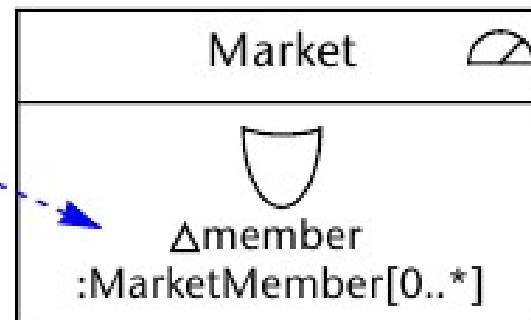


# Social Relationships

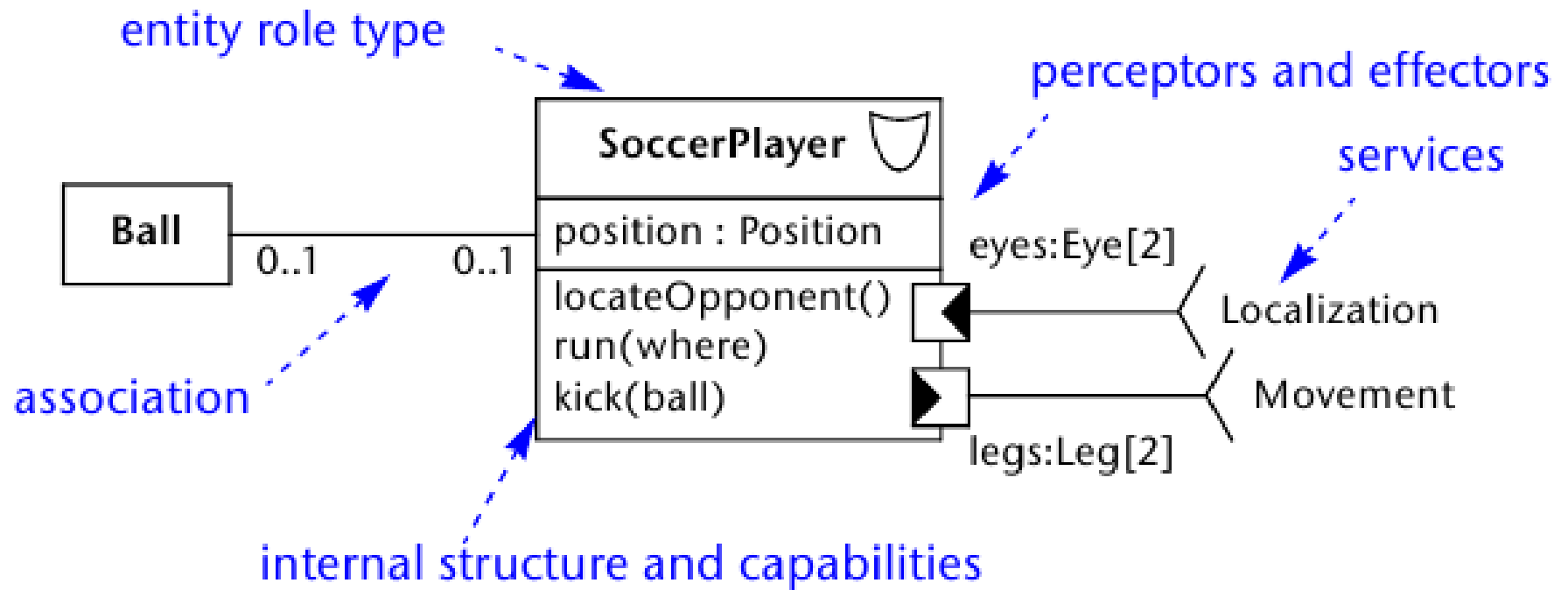


social associations

social part/attribute

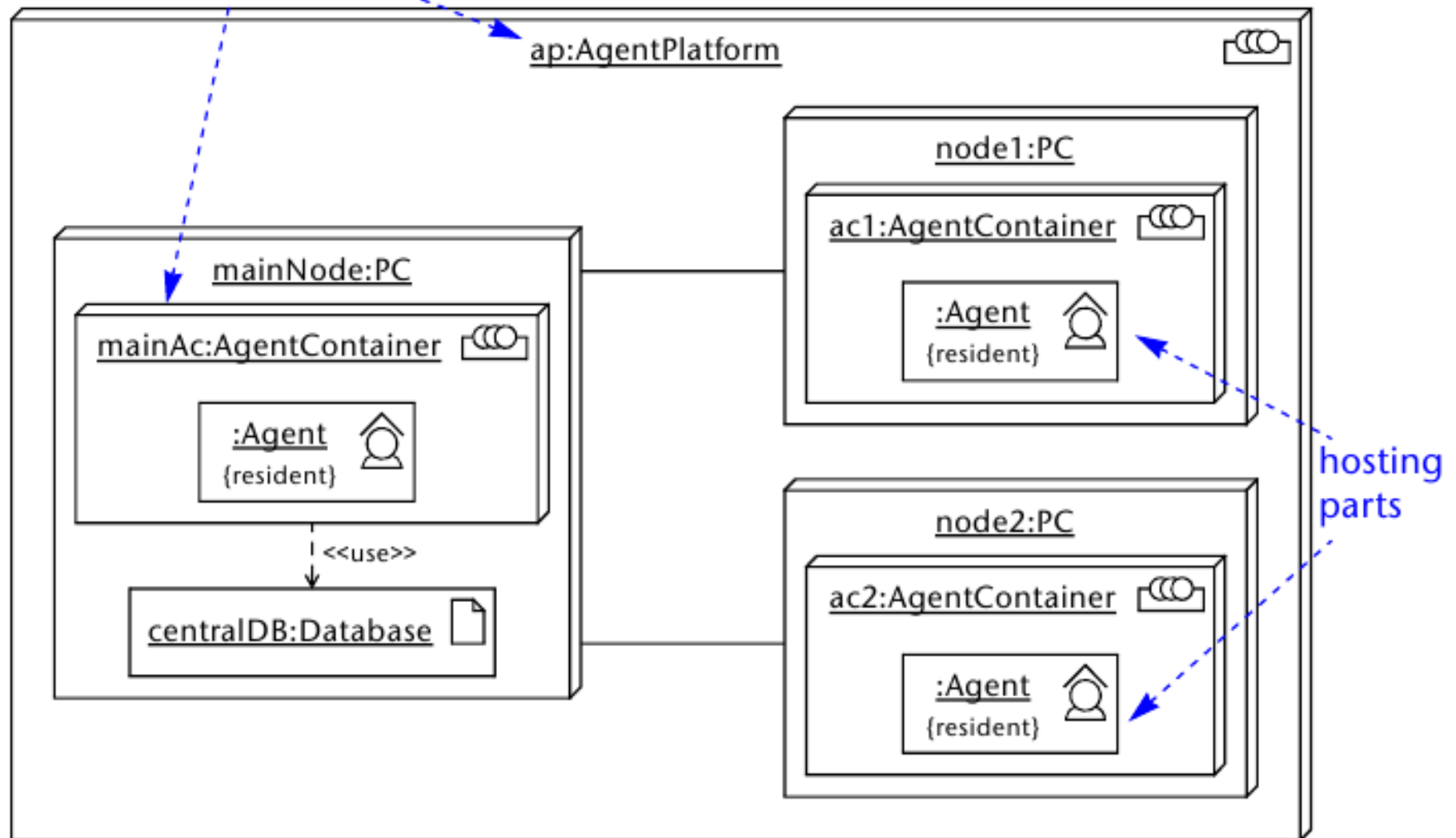


# Entity Role Types

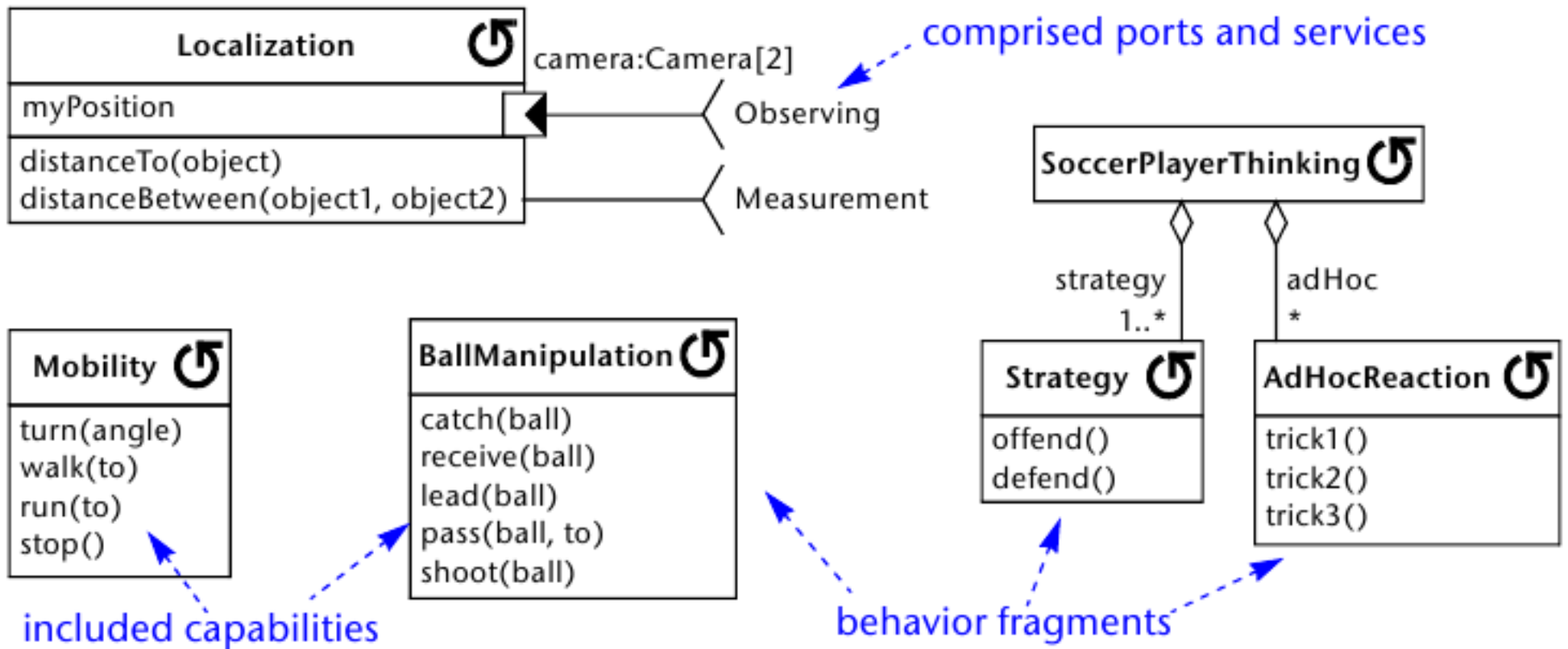


# Agent Execution Environment

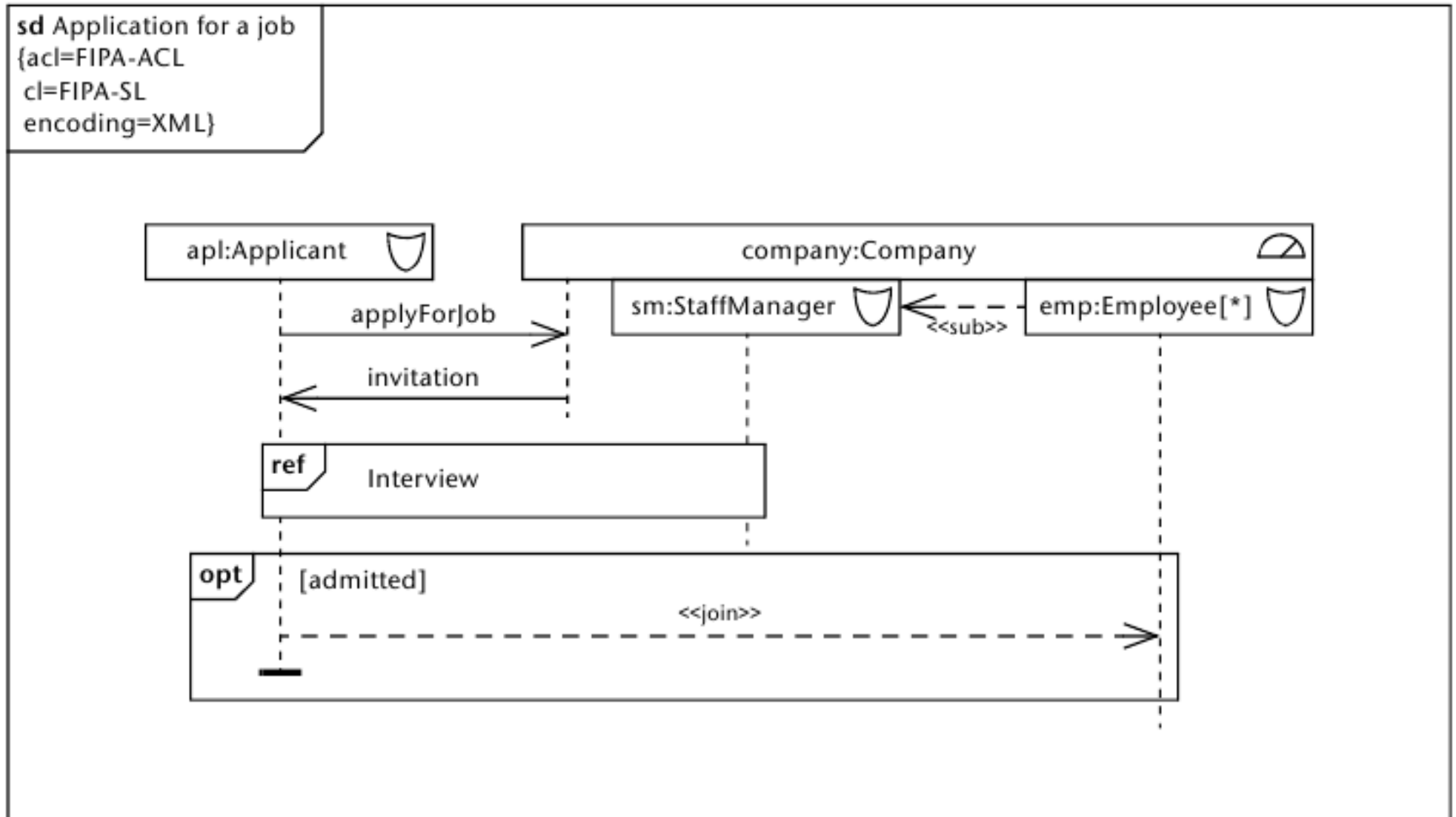
agent execution environments



# Behavior Fragment

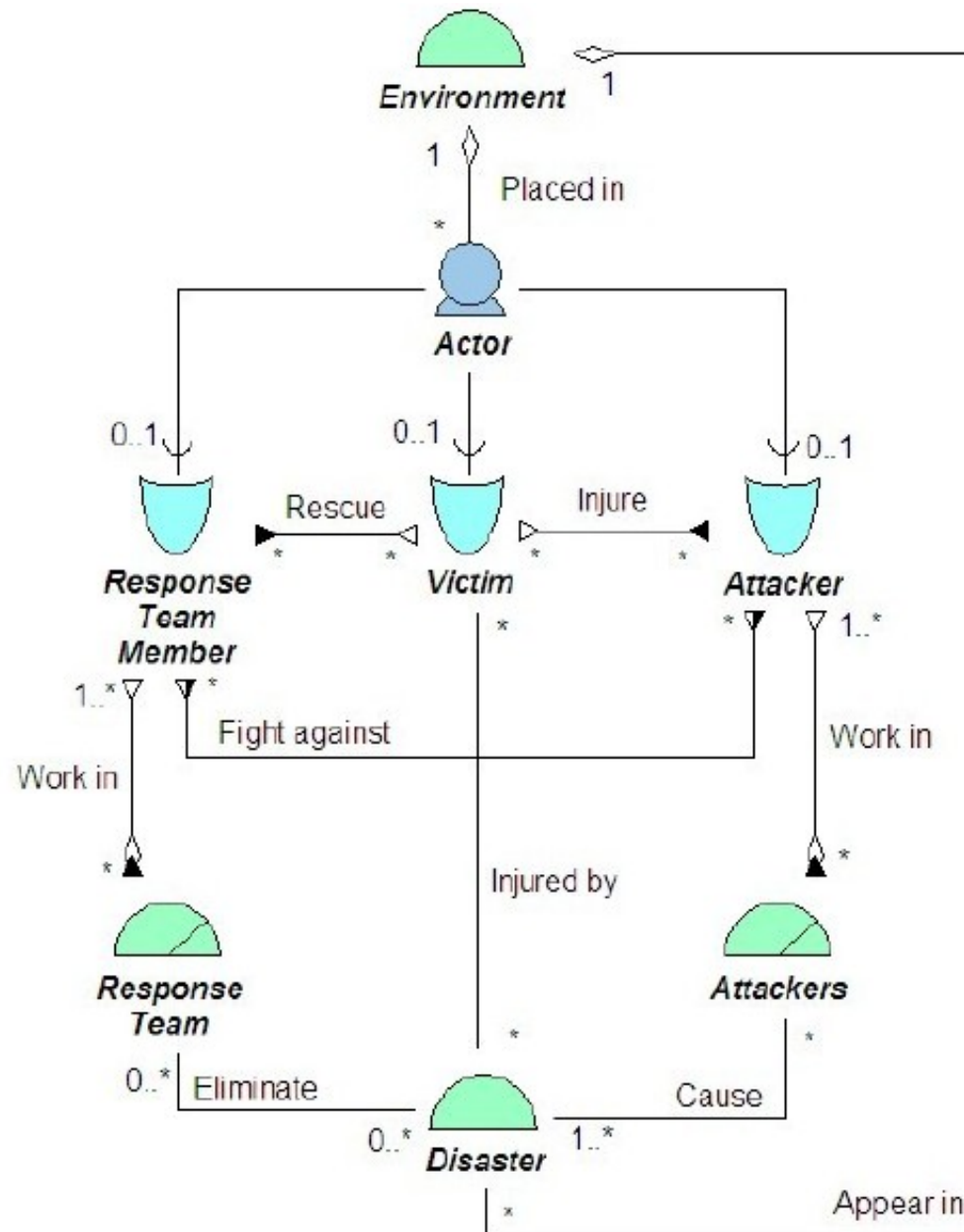


# Communicative Interactions

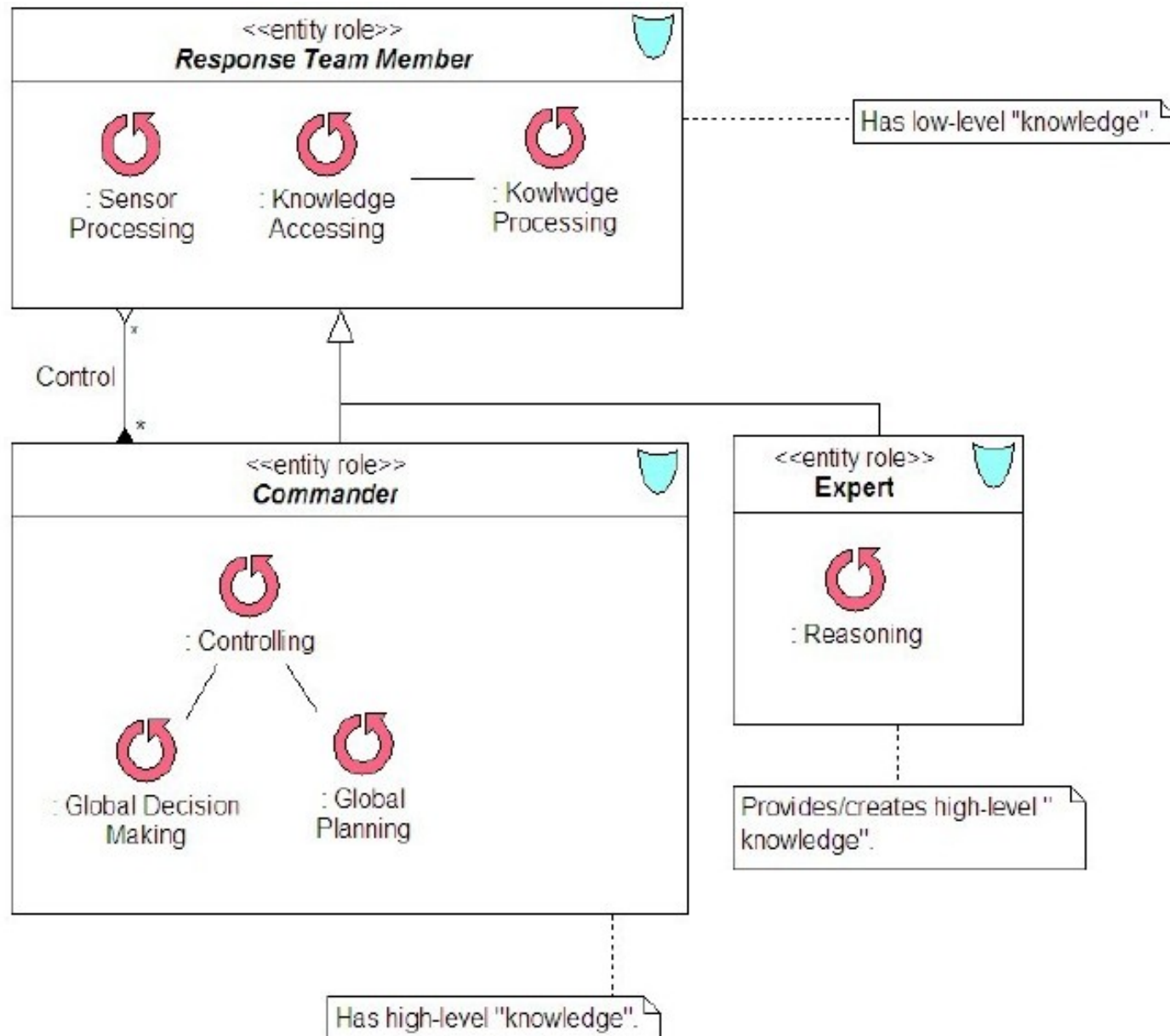




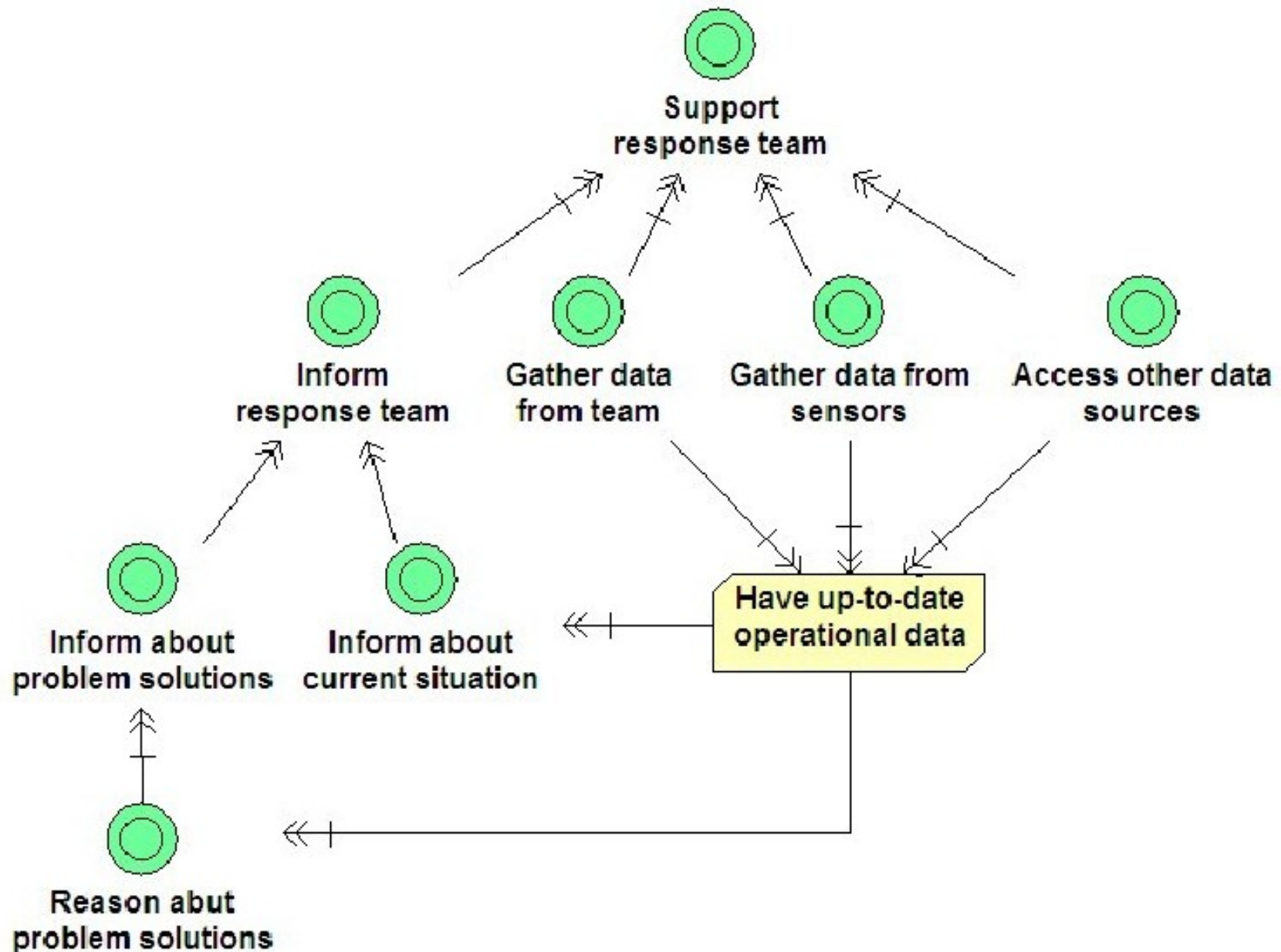
# Example: Social Model



# Example: Control Hierarchy



# Example: Plans



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# Resources (1)

- Slides
  - <http://www.ieee.ma/NATOASI/>
- MAPS
  - <http://maps.deis.unical.it/>
  - <http://maps.sourceforge.net/>
- SunSPOT
  - <http://www.sunspotworld.com/>

# Resources (2)

- AML
  - StarUML – <http://staruml.sourceforge.net/>
  - AML profile, examples, specifications – <http://www.whitestein.com/aml>

# Q / A

