

Organisation-Oriented Programming of MAS

The MOISE Framework

O. Boissier⁽¹⁾, J.F. Hübner^(1,2), R. Kitio⁽¹⁾,
M. Piunti⁽³⁾, A. Ricci⁽³⁾, J.S. Sichman⁽⁴⁾

(1) MAS/G2I/ENSM.SE France (2) GIA/DSC/FURB Brazil (3) DEIS/Univ. Bologna Italy (4) LTI/USP Brazil

Outline

1. Introduction

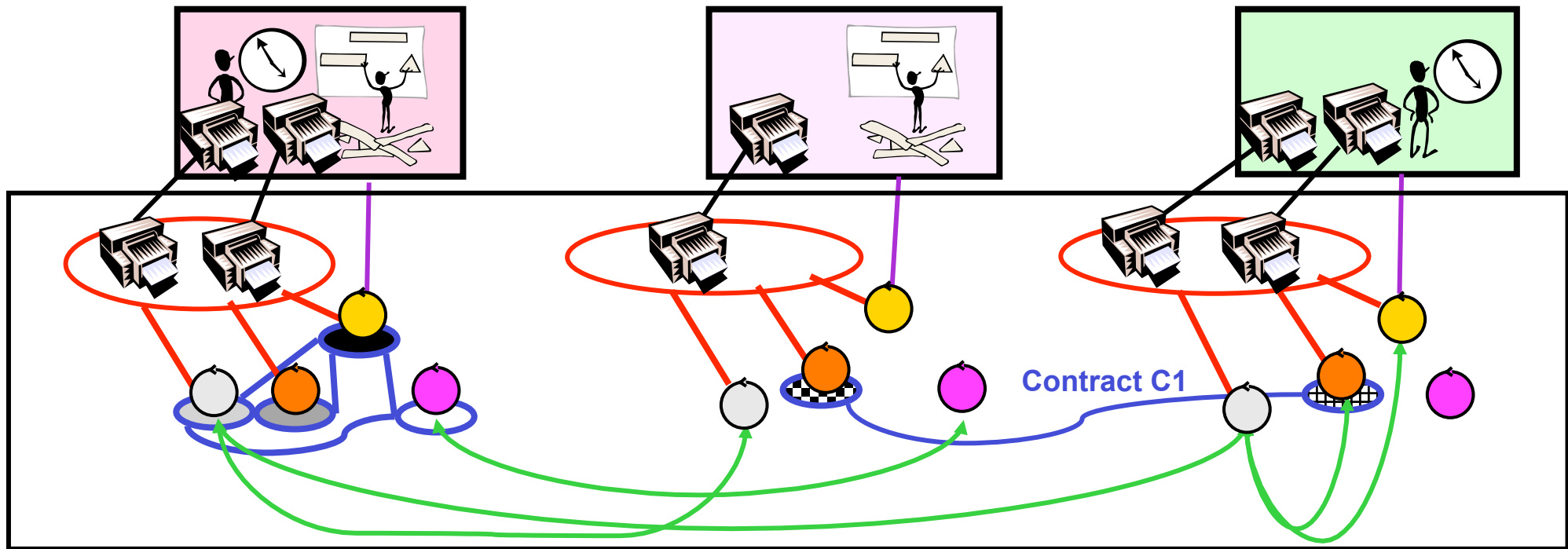
2. Global picture of MOISE Framework

3. MOISE Organisation Modeling Language

4. MOISE Organisation Management Infrastructure

5. Conclusion and Perspectives

Agents in a Multi-Agent World



-  Agent for the user-interaction with a Printshop
-  Agent for the management of Negotiations on behalf of a Printshop
-  Agent for the management of the Contracts on behalf of a Printshop
-  Agent for the management of the Alliance

— Environment — Interaction — Organisation

Ecole Nationale
Supérieure des Mines
SAINT-ETIENNE

E-Alliance

Xerox Research Centre Europe
xrce

45

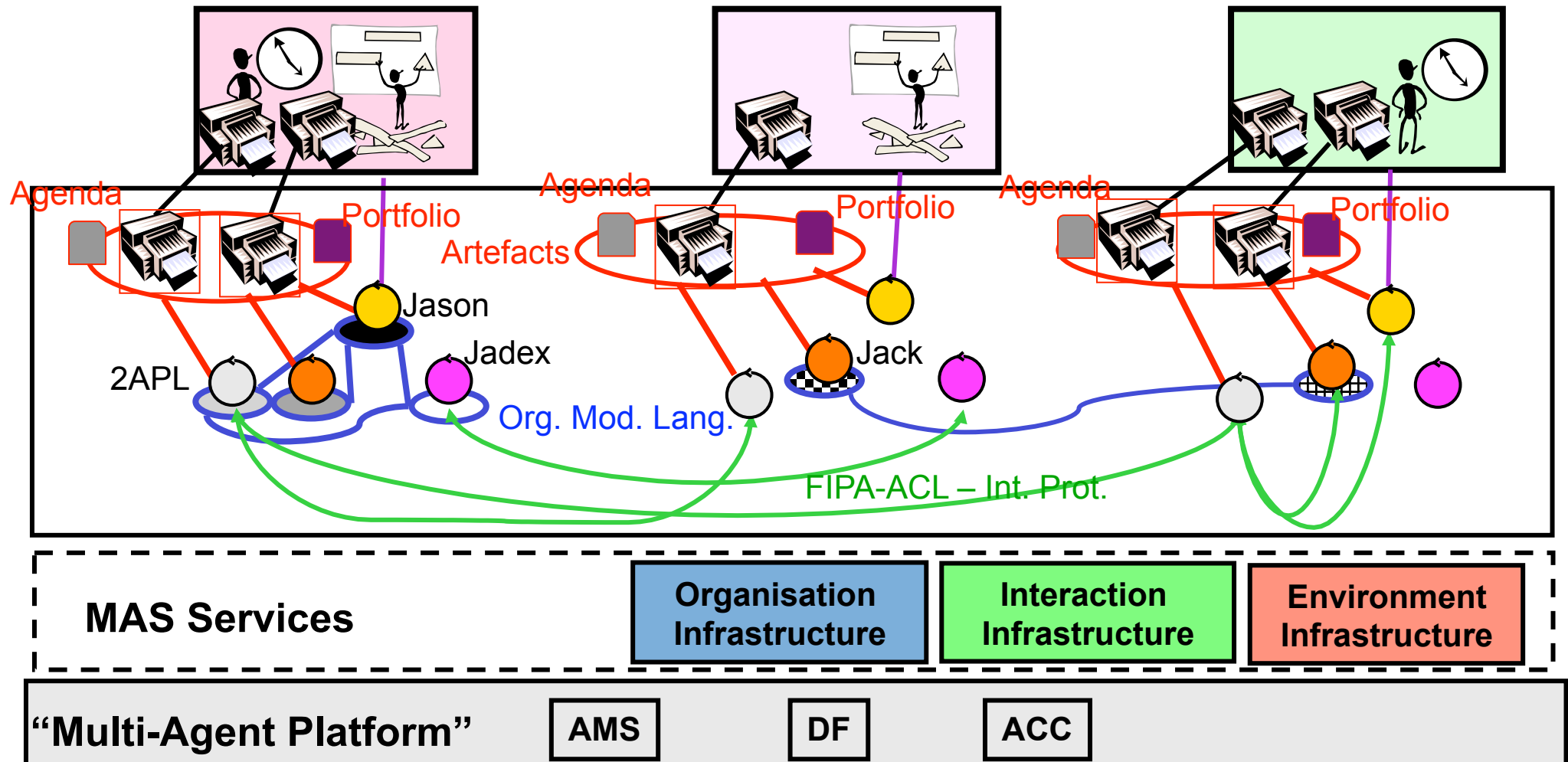
REGION RHONE-ALPES
réunir pour réussir

[Castellani 03]
[Hübner 05]

Organisations in MAS

- Organisation in MAS is
a purposive supra-agent pattern
of **emergent** or **(pre)defined** agents cooperation,
that could be defined by the designer or by the agents
themselves.
- Pattern of emergent/potential cooperation
 - Organisation entity, institution, social relations, commitments
- Pattern of (pre)defined cooperation
 - Organizational structure, norms, ...

Programming Multi-Agent World



- How do we engineer Environment, Interaction, Organisation, Agent ?
- What is the control flow between E, I, O and A ?



Agent



Environment



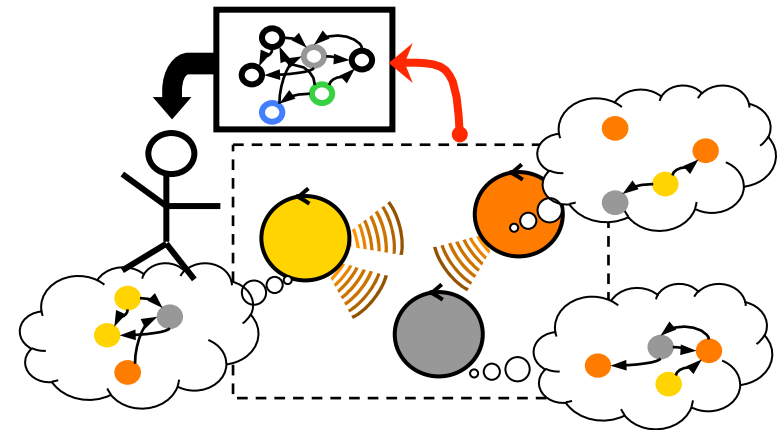
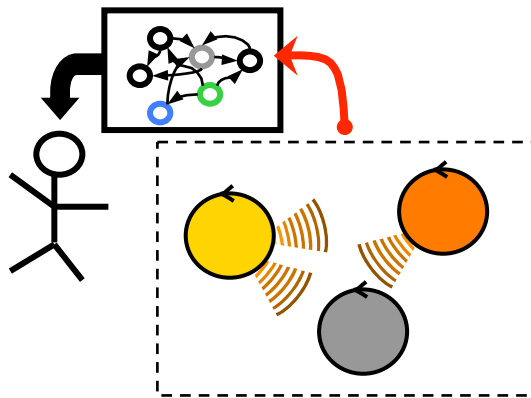
Interaction



Organisation

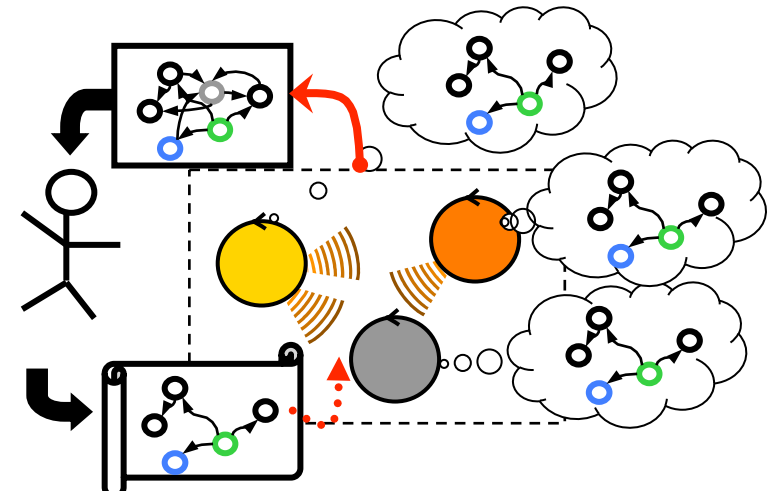
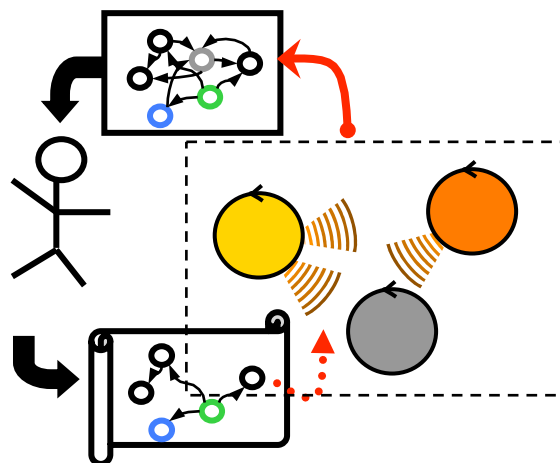
Organisations in MAS (global picture)

Agent Centred



Agents don't know
about organisation

Agents know
about organisation



Organisation Centred



Organisation Specification
Organisation Entity



Local Representation
Observed Organisation



Designer / Observer

Bottom-up... Top-down

Organisations in MAS (global picture)

Agent Centred

Swarms, AMAS, SASO
Self-organisations ...

Organisation is observed.
Implicitly programmed
in Agents, Interactions,
Environment.

Social Reasoning
Coalition formation
Contract Net Protocol ...

Organisation is observed.
Coalition formation
mechanisms programmed
in Agents.

Agents don't know
about organisation

Agents know
about organisation

AOSE
MASE, GAIA, MESSAGE, ...

Organisation is
a design model.
It is hard-coded
in Agents

TAEMS, STEAM, AGR
MOISE+, OPERA, ...

**Organisation-Oriented
Development of MAS**

Organisation Centred



Organisation Specification
Organisation Entity



Local Representation
Observed Organisation



Designer / Observer

Bottom-up ... Top-down

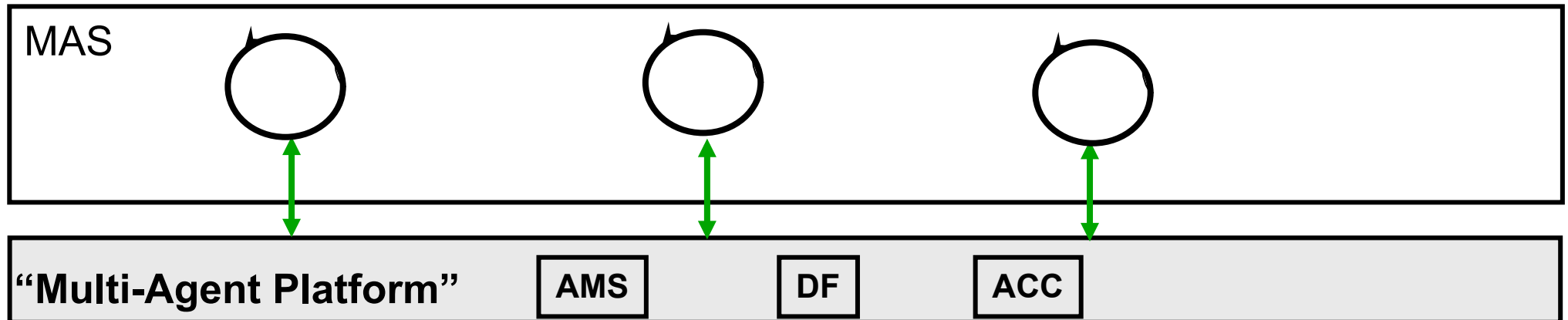
Outline

1. Introduction
- 2. Global picture of MOISE Framework**
3. MOISE Organisation Modeling Language
4. MOISE Organisation Management Infrastructure
5. Conclusion and Perspectives

Foundations

- The MOISE Framework is a normative MultiAgent System:
 - “A multiagent system organized by means of *mechanisms* to represent, communicate, distribute, detect, create, modify, and enforce *norms*, and mechanisms to deliberate about norms and detect norm violation and fulfilment.” [Boella et al. 08]
- That manages Normative MultiAgent Organisations
 - Norms are part of the the organisation specification
 - Expressed in the Organisation Specification, Organisation Entity
 - Anchored/situated in the organisation, i.e. norms refer to organisational concepts (roles, groups, ...)
 - Mechanisms are complemented with organisation management mechanisms

Supporting Infrastructure



Infrastructure/Platforms for MAS in which domain agents operate on top of a middleware layer

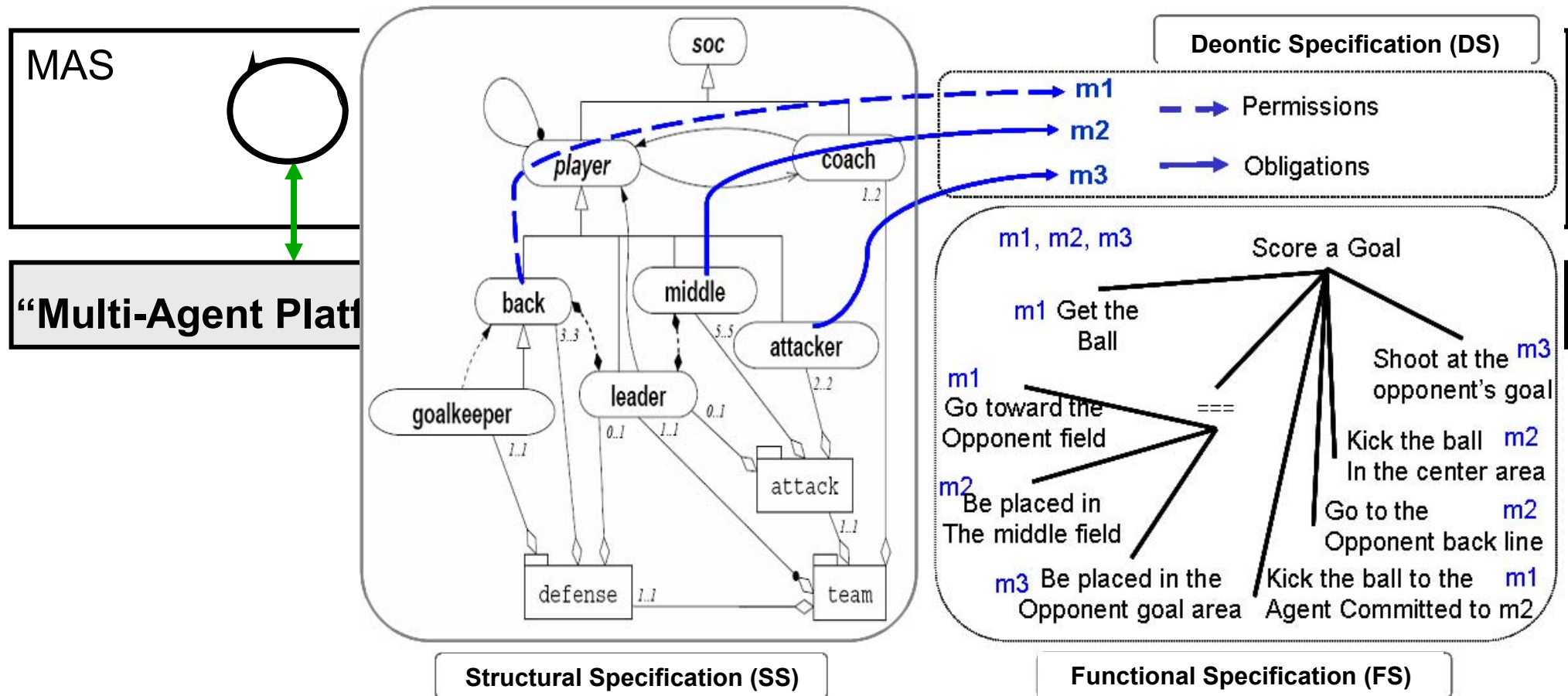
- Supporting the implementation of agents
- Providing fundamental global generic services

e.g. JADE, FIPA-OS, SACI, ...

Req 1: Openness

- Explicit representation of Organisation
- Agents are able to “reason” about the organisation to enter into/leave from the organisation during execution
- Agents are able to “reason” about the organisation to change/adapt the organisation
- Agents are able to “reason” about the organisation to obey/disobey the organisation
- Organisation is no more a regimentation

Components of the Framework (1/2)



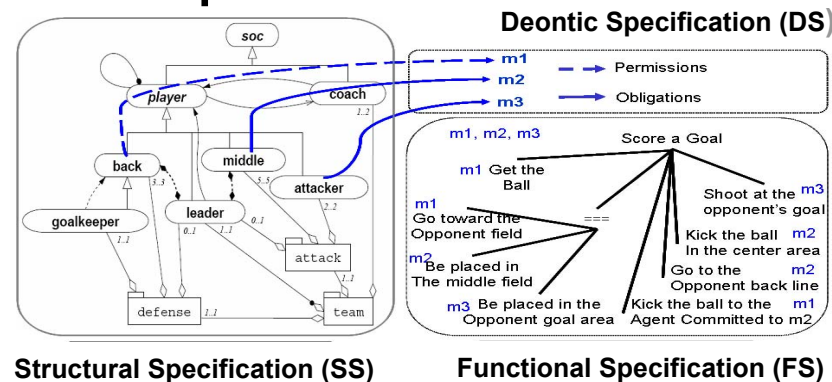
Organisation Modeling Language (OML): Declarative specification of Multi-Agent Organisation(s), collecting and expressing specific constraints and cooperation patterns imposed on the agents

e.g. AGR [Ferber 98], Teamwork [Tambe 98], Islander [Esteva 01], Moise+ [Hubner 02], ...

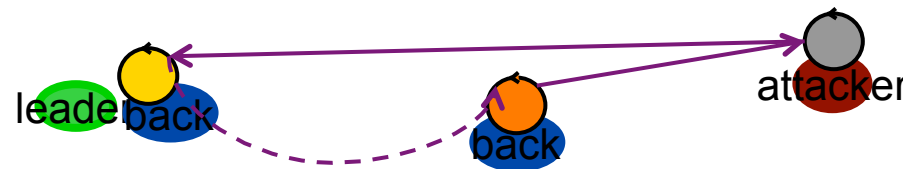
Req2: Managing Normative Organisations

- Three different levels of representation:

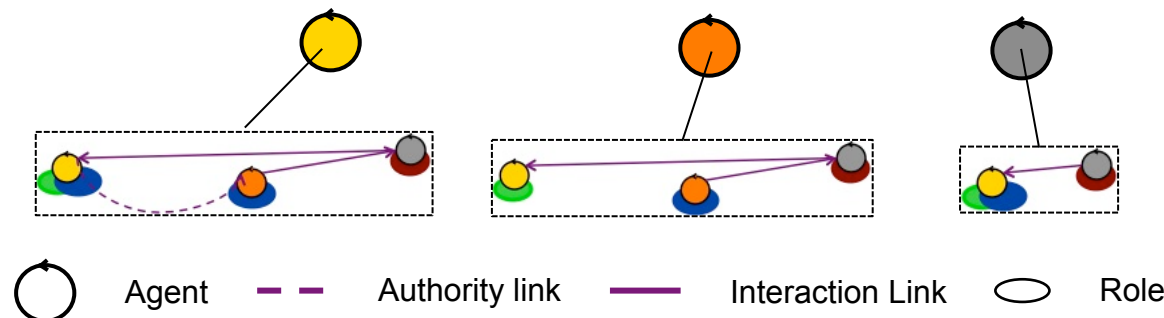
Normative
Organisation
Specification



Normative
Organisation
Entity



Internal
Normative
Organisation
Entities



Req3: Regulating Agent's Autonomy

- Regimented Norms prevent agents' autonomy
 - e.g. *“the access to computers requires an username”*
 - e.g. in organisation defined with MOISE+: roles which cardinality is full cannot be adopted, agents cannot adopt incompatible roles
- It is necessary to manage their status and to prevent their violation
- Enforced Norms regulate agents' autonomy
 - e.g. *“a master thesis should be written in two years”*
 - e.g. in organisation defined with MOISE+: based on its roles, an agent is obliged to commit to certain missions, based on its missions, an agent is obliged to achieve some goals
- It is necessary to manage their status, to decide about their violation and to apply sanctions

Components of the Framework (2/2)

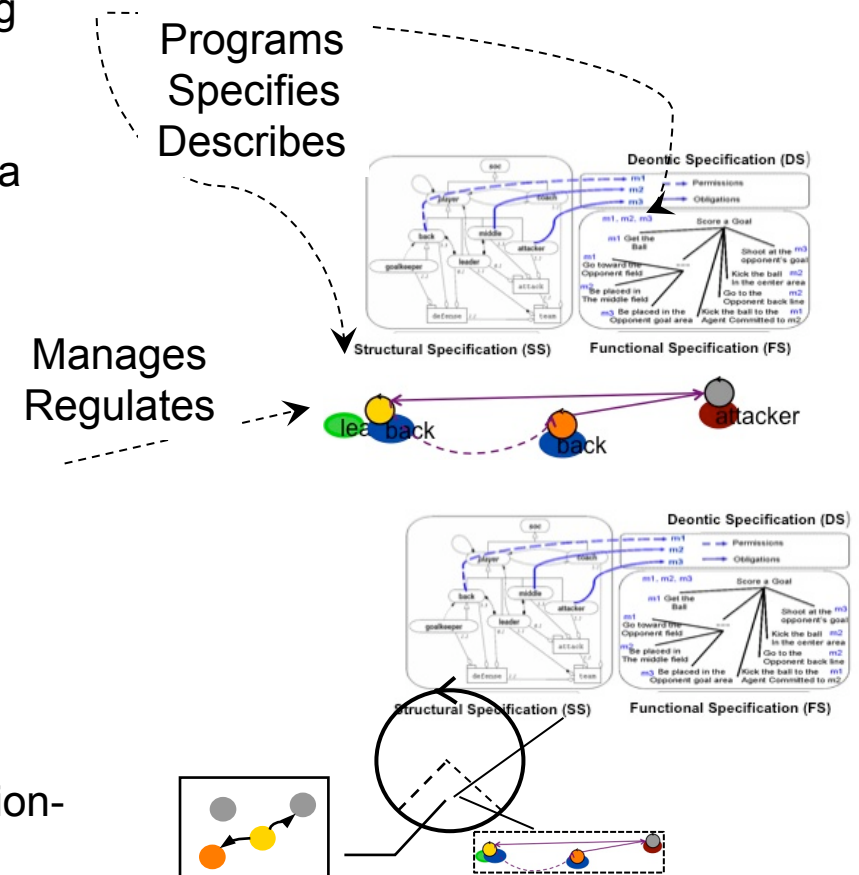
Organisation Modeling Language (OML): Declarative specification of the Organisation(s), collecting and expressing cooperation patterns as specific norms (regimented and enforceable) imposed on the agents in a particular context e.g. AGR [Ferber 98], Teamwork [Tambe 98], Islander [Esteva 01], Moise+ [Hubner 02]

Organisation Management Infrastructure (OMI):

- **Coordination mechanisms:** enabling aspects
 - **Regulation mechanisms:** governing aspects
- e.g. Madkit [Gutknecht 98], Karma [Pynadath 03], Ameli [Esteva 04], S-Moise+ [Hubner 05], SYNAI [Gateau 07], ...

Organisation-awareness agent mechanisms:

- Interaction mechanisms with the OMI
- Reasoning mechanisms transforming agents into organisation-deliberative agent to modify, obey/violate the norms, ...
e.g. Jason-MOISE [Hubner 06], Autonomy based reasoning [Carabelea 07]



Outline

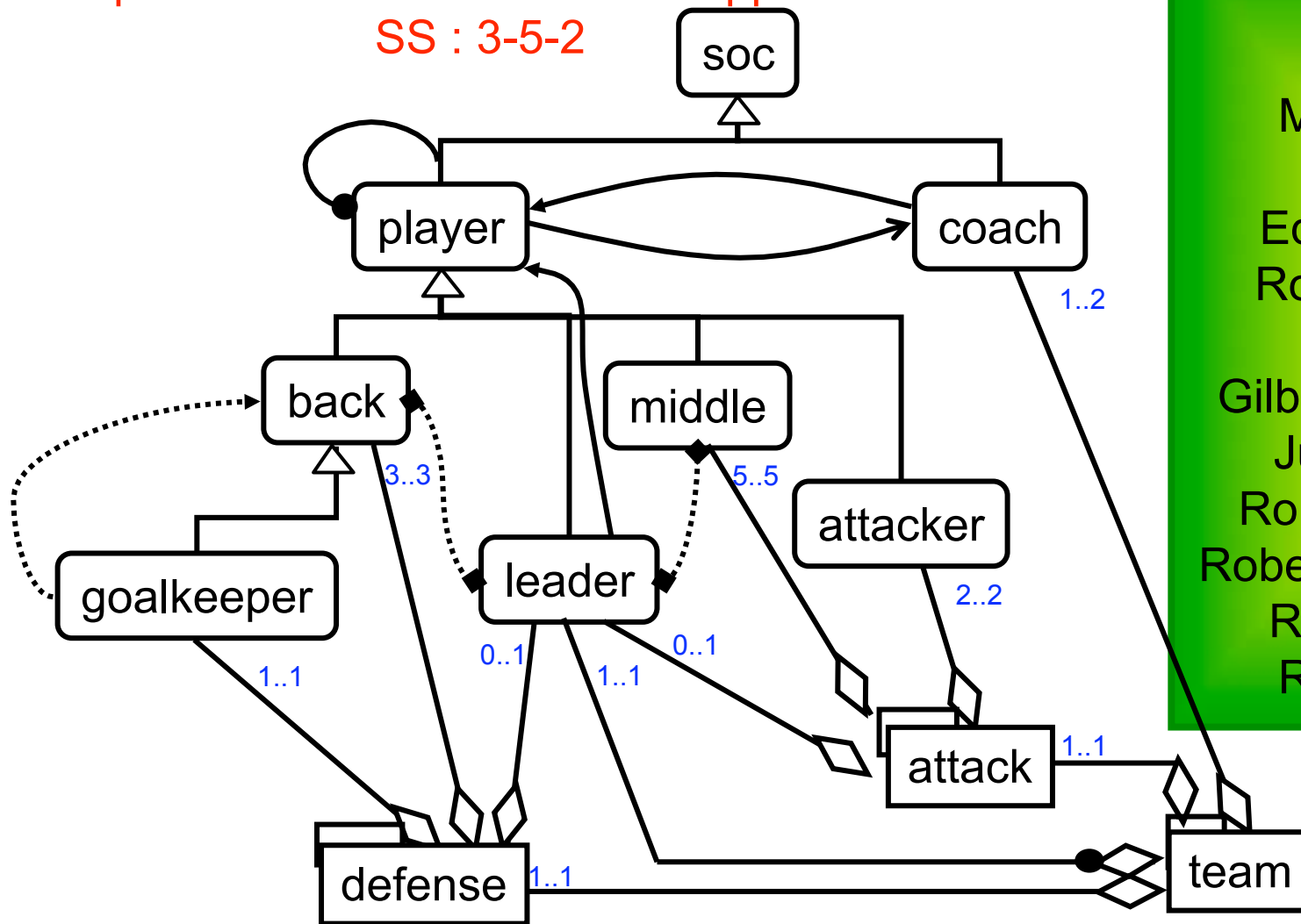
1. Introduction
2. Global picture of MOISE Framework
- 3. MOISE Organisation Modeling Language**
MOISE+, MOISE^{inst}, ...
4. MOISE Organisation Management Infrastructure
5. Conclusion and Perspectives

MOISE+ Organisation Modeling Language

- **M**odel of **O**rganisation for multi-**I**-agent **S**yst**E**ms
[Hannoun 98, Hübner 03]
- <http://moise.sourceforge.net/>
- Distinguishes three main dimensions in the organisation of a Multi-Agent System:
 - Structural Specification
 - Functional Specification
 - Deontic Specification

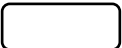
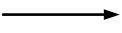
MOISE+ OML: Structural Specification

Graphical view of SoccerGame Application
SS : 3-5-2



Organisation Entity
from OS 3-5-2

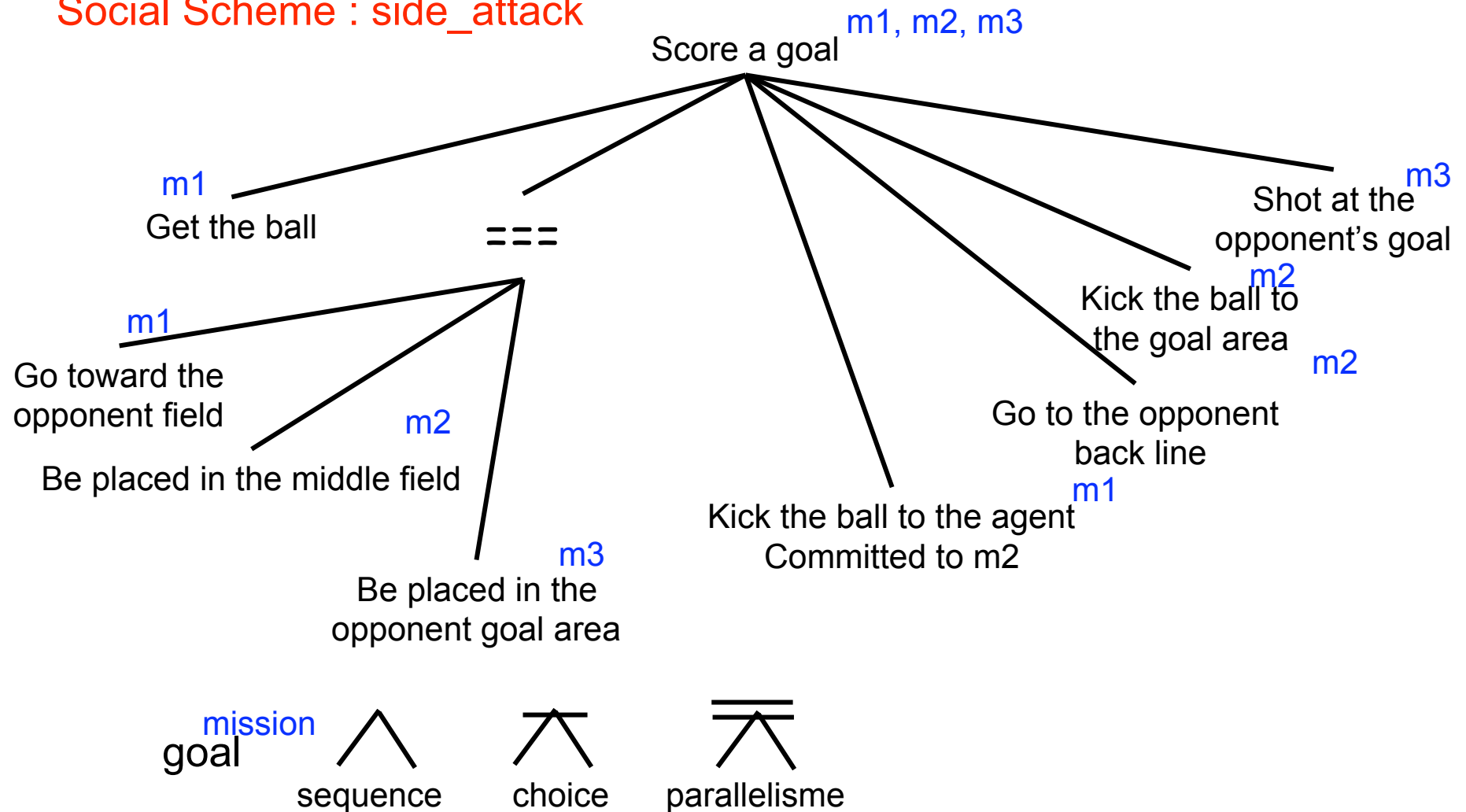
Marcos — goalkeeper
 Lucio — back
 Edmilson — back
 Roque Jr. — back
 Cafu — leader
 Gilberto Silva — middle
 Juninho — middle
 Ronaldinho — middle
 Roberto Carlos — middle
 Ronaldo — attacker
 Rivaldo — attacker

- Roles 
- Links 
- Groups 

MOISE+ OML: Functional Specification

Graphical view of SoccerGame Application FS

Social Scheme : side_attack



MOISE+ OML: Deontic Specification

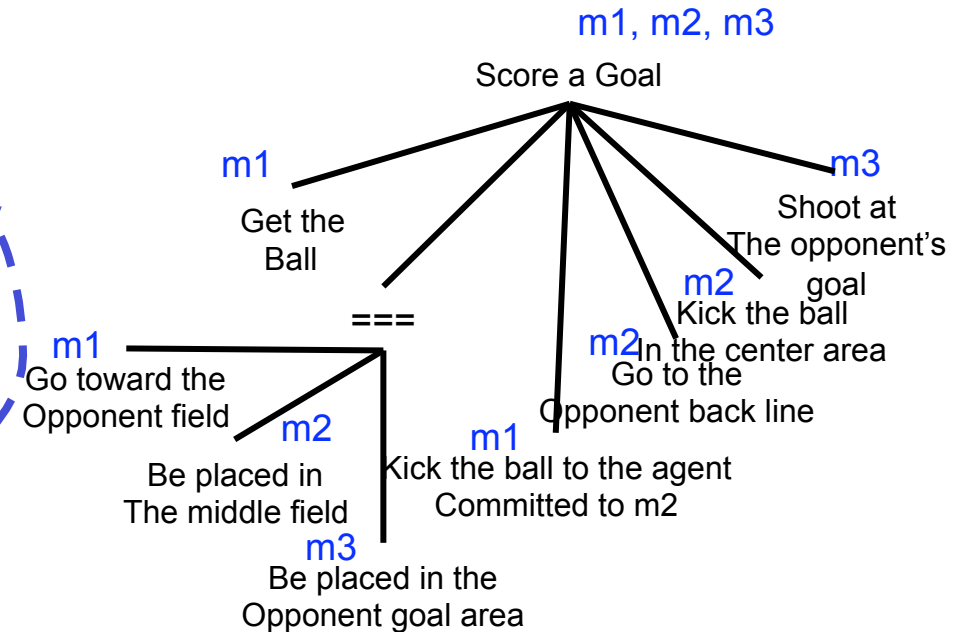
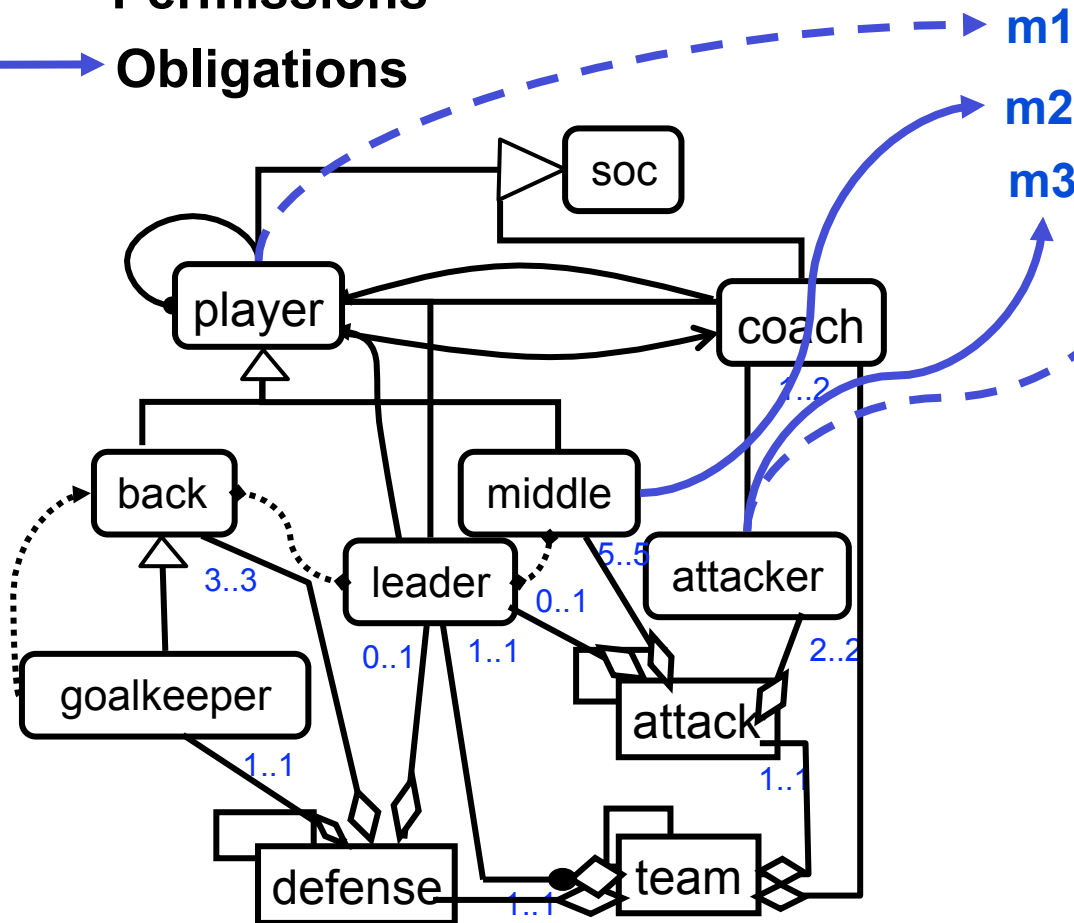
- Explicit relation between the functional and structural specifications
 - Permissions and obligations to commit to missions in the context of a role
 - To make explicit the normative dimension of a role

Role	Deontic Relation	Mission	Temporal Constraint (cf. [carron 01])
Back	Permission	m1	In [0 30]
Middle	Obligation	m2	during [Attacker]
Attacker	Obligation	m3	Any

MOISE+ OML: Deontic Specification

- - - -> Permissions

- - - -> Obligations



Organisation Entity

Lucio ----- m1

Cafu ----- m2

Rivaldo ----- m3

Graphical view of SoccerGame Application DS

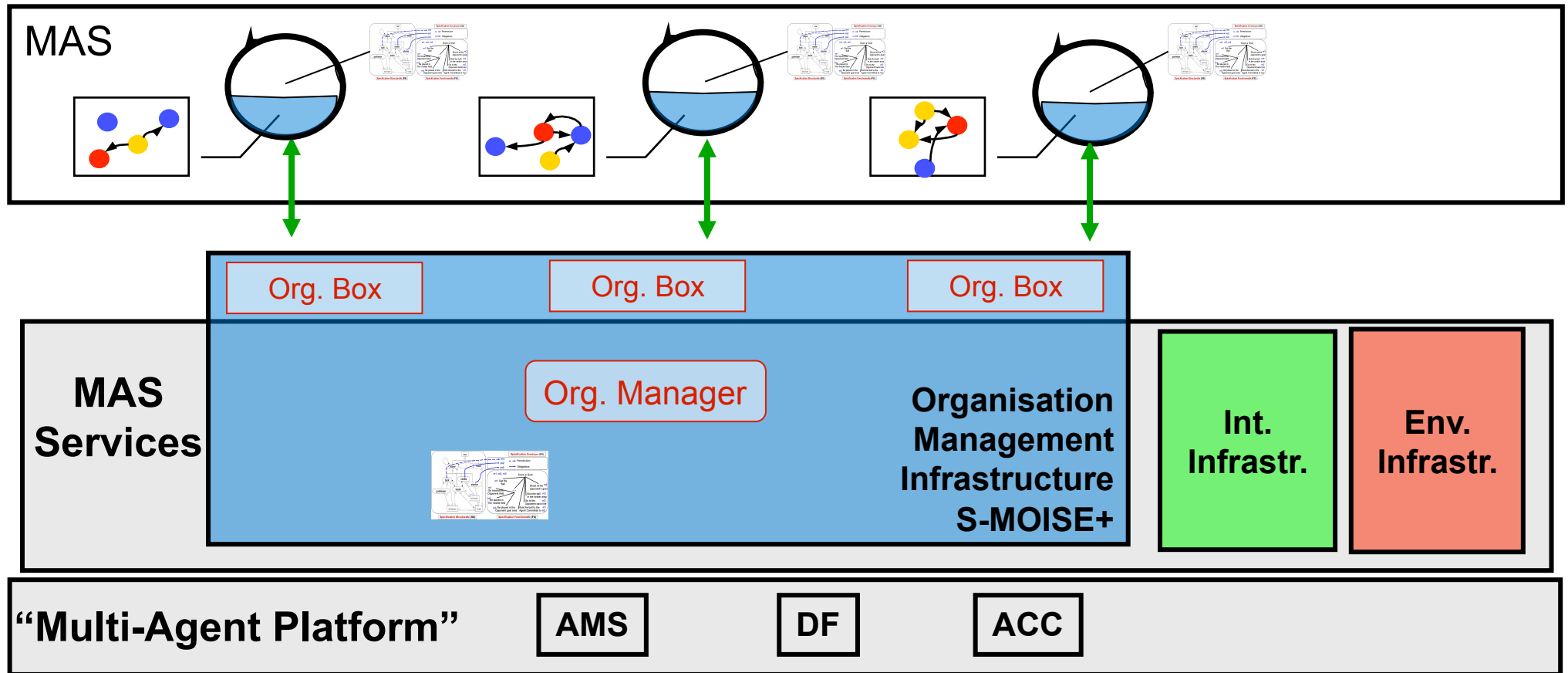
Outline

1. Introduction
2. Global picture of MOISE Framework
3. MOISE Organisation Modeling Language
- 4. MOISE Organisation Management Infrastructure**
S-MOISE+, SYNAI, ORA4MAS
5. Conclusion and Perspectives

How is/should be engineered the OMI?

- "Classical" approaches:
 - "MiddleAgents" approach
(e.g. Ameli [Esteva 04], S-Moise+ [Hubner 05], SYNAI [Gateau 07])
 - "Openness syndrome": Org. Management Infrastructure is outside of the MAS

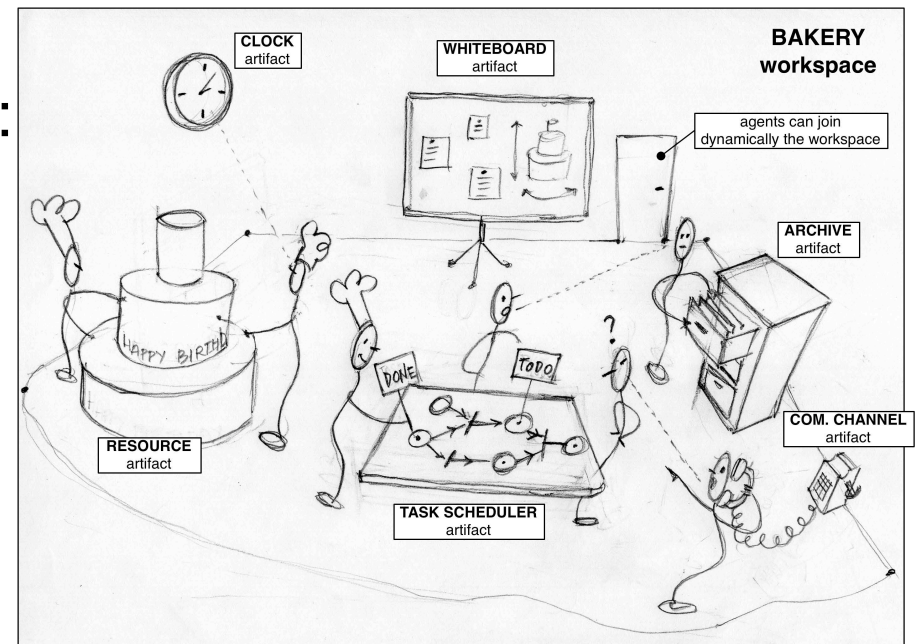
S-MOISE+ : OMI by Middle-Agent



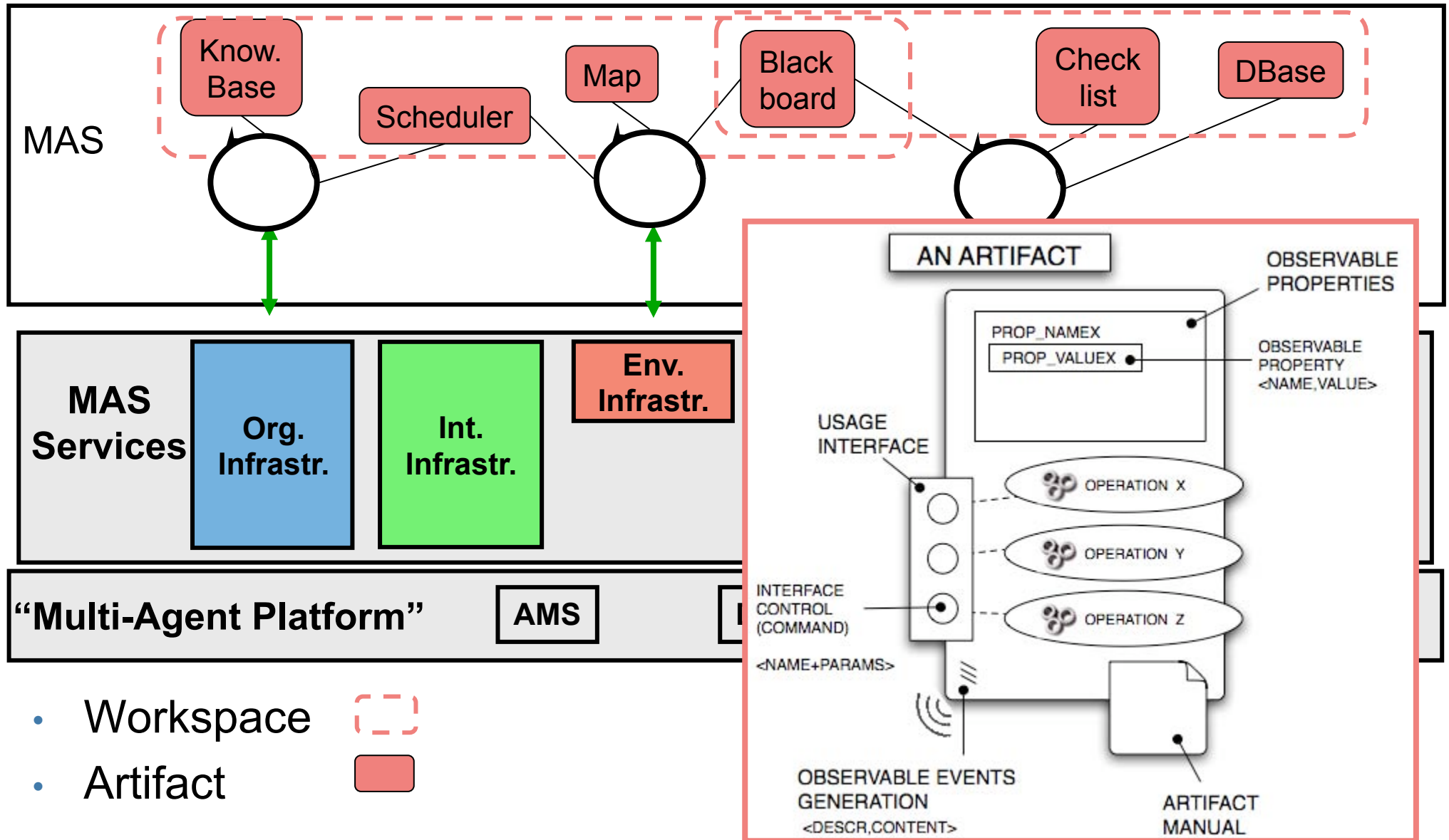
- OML: MOISE+ [Hubner 02]
- OIA: S-MOISE+ [Hubner 05], J-MOISE+ [Hubner 06]

How is/should be engineered the OMI?

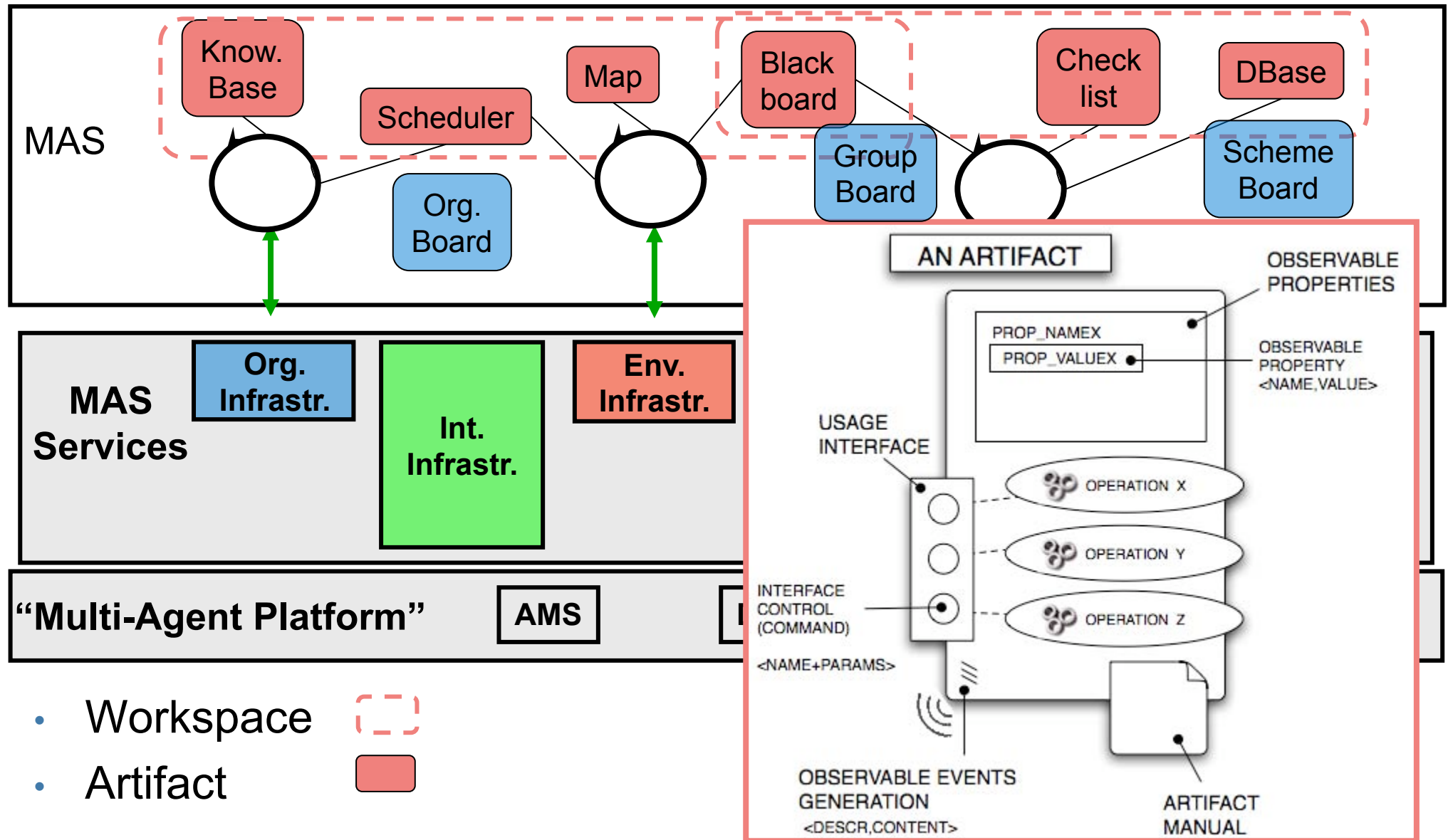
- "Classical" approaches:
 - "MiddleAgents" approach
(e.g. Ameli [Esteva 04], S-Moise+ [Hubner 05], SYNAI [Gateau 07])
 - "Openness syndrome": Org. Management Infrastructure is outside of the MAS
- "Working Environment" approaches:
 - Environment promoted to first class entity of MAS [Weyns 06], [Schumacher 06]:
 - Environment becomes a Working environment for Agents
 - e.g. Artifacts & Agents [Ricci 07]



ORA4MAS: Foundations



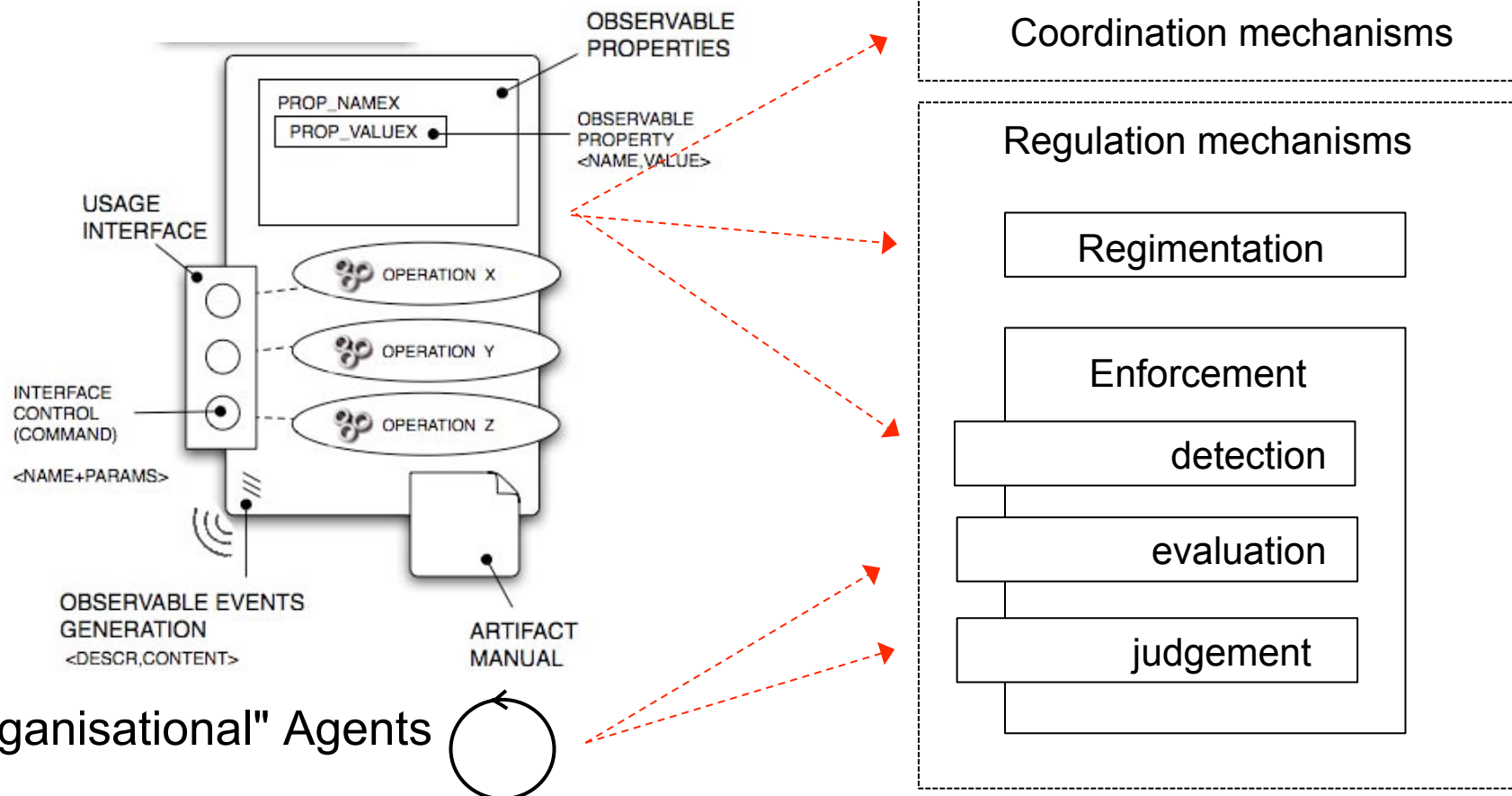
ORA4MAS: Foundations



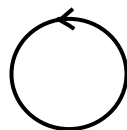
- Workspace 
- Artifact 

OMI as Organisation Working Environment

- Organisational artifacts :
 - non autonomous, function oriented entity encapsulating parts of the management of the organisation,
 - Deploying the organisation entity in the system
 - Mediating the access to the organisation → "abstract" artifacts

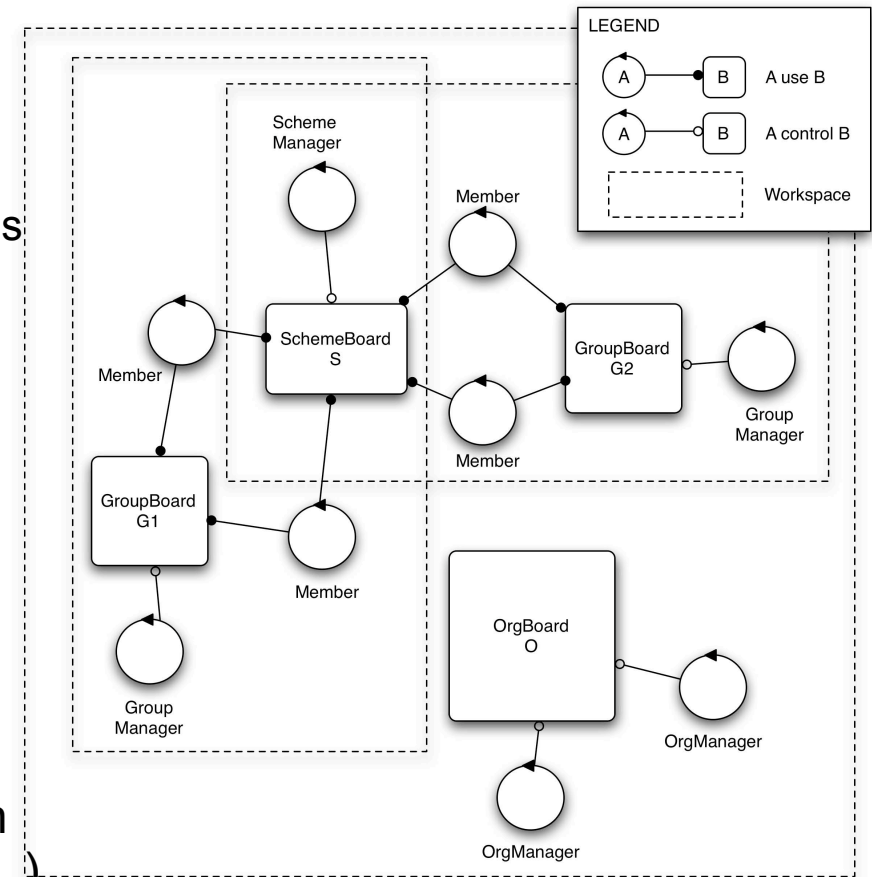


- "Organisational" Agents



Normative Organisation Framework

- Organisation Modeling Language
 - Organisation Working Environment
 - Organisational Artifacts
instrumenting the organisation entity, in charge of:
 - enactment of regimentations / evaluation of norms compliance
 - Two kinds of Artifacts
 - Organisational Artifacts for Organisation Coordination
 - Organisational Artifacts for Organisation Regulation
 - Agents:
 - Embed organisation awareness mechanisms
 - Use/control (perceive/act on) the organisational artifacts: i.e observe, monitor their state, reason and decide about the organisation (sanctions, ...)
 - Try to achieve their goals
- + other artifacts
- + communication medium



Global functioning

Given an OS programmed using the OML

1. The agents' behaviours within the organisation are supported and mediated by the organisational artifacts with respect to the roles that the agents play.

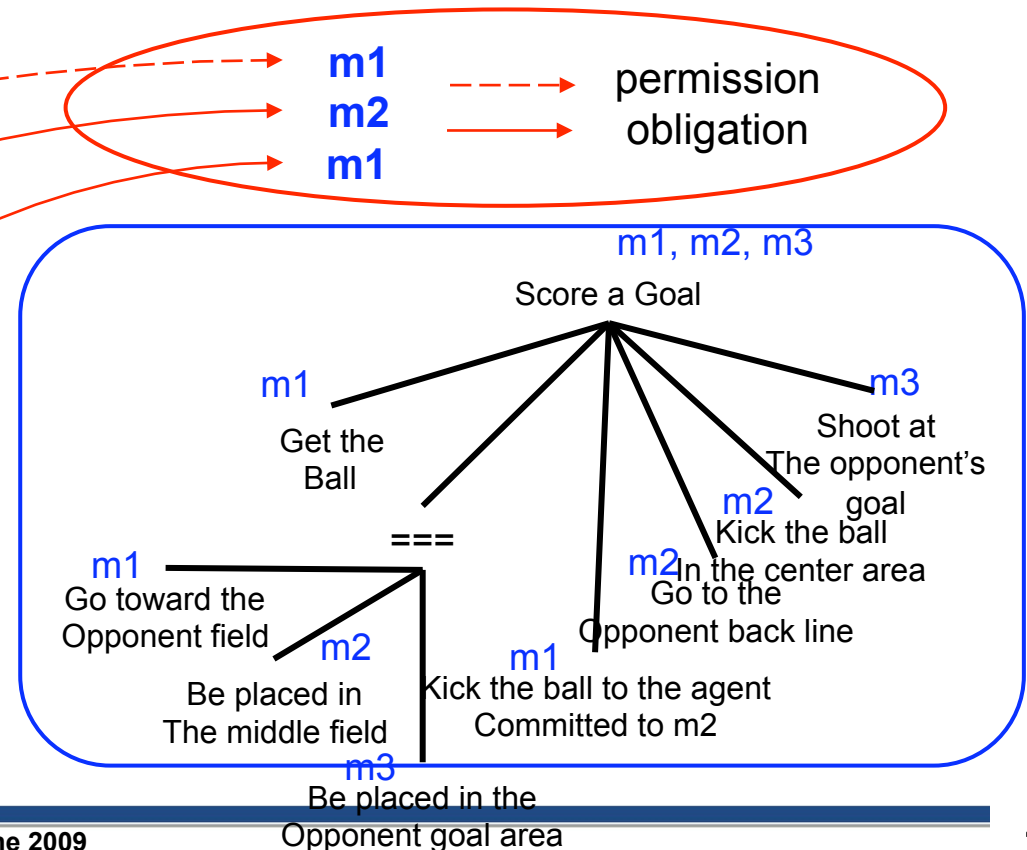
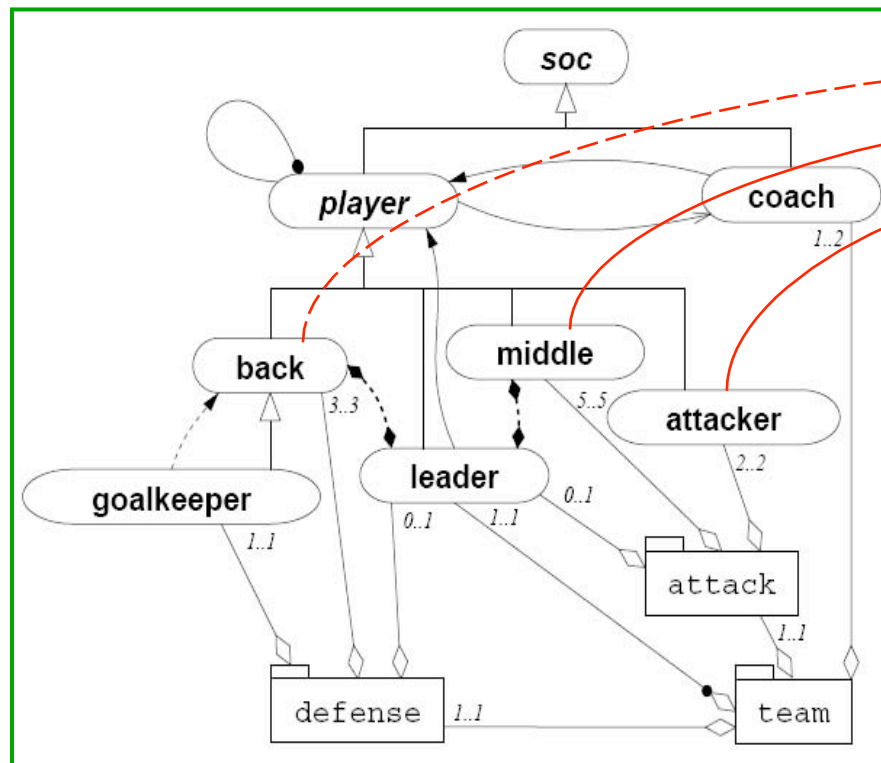
- Violation of regimentations are prevented
- Non compliance to norms are detected

Organisation state, status of norms are published/made accessible to the agents through the artifacts

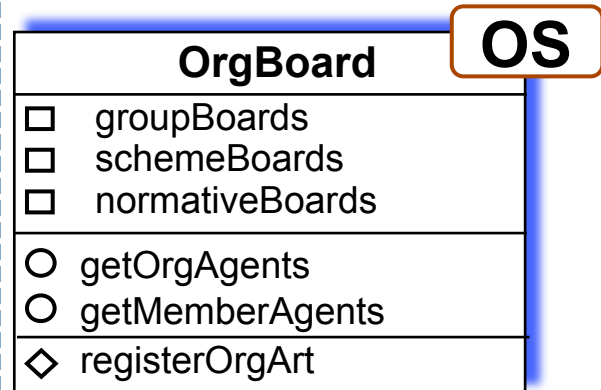
2. Using this information,
 - agents decide about norm violation and corresponding sanctions to apply
 - agents take care/or not of the sanctions and behave accordingly or not
 - Agents may decide to change the OS, the OE, the deployed set of artifacts,
- Our current work is currently focused on point 1.

Shaping OR4MAS on MOISE+ OML

- Organisation is specified along three dimensions:
 - Structural Specification (SS) : groups, roles, ...
 - Functional Specification (FS): social schemes, missions, goals, ...
 - Deontic Specification (DS): obligations, permissions



Organisational Artifacts for Coordination

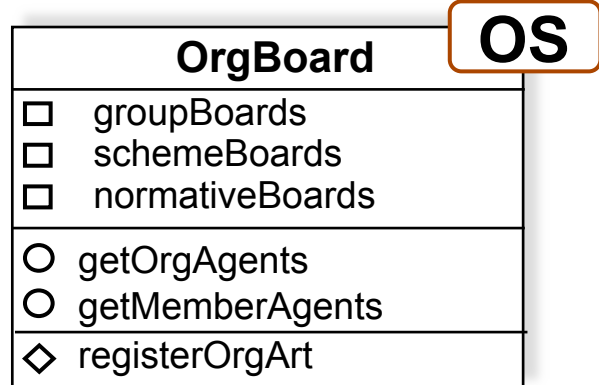


OrgBoard:
Management of the entry/exit/
access to the organisation

Legend

- ☐ Operation
- ☐ Observable property
- ☒ Link Operation

Organisational Artifacts for Coordination

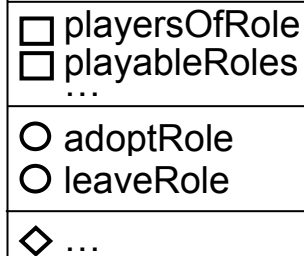


GroupBoard:

- Management of the life cycle of an instance of group in the organisation according to its specification in the structural specification
- Regimentation of cardinality and compatibility norms

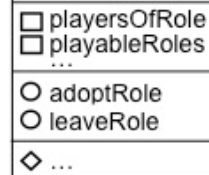
SS.Team

GroupBoard



SS.Defense

GroupBoard



SS.Attack

GroupBoard



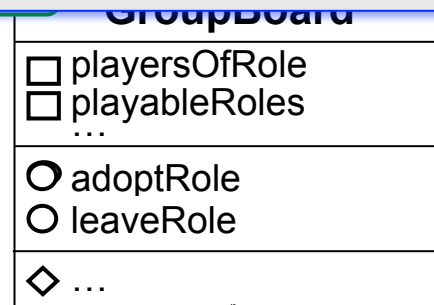
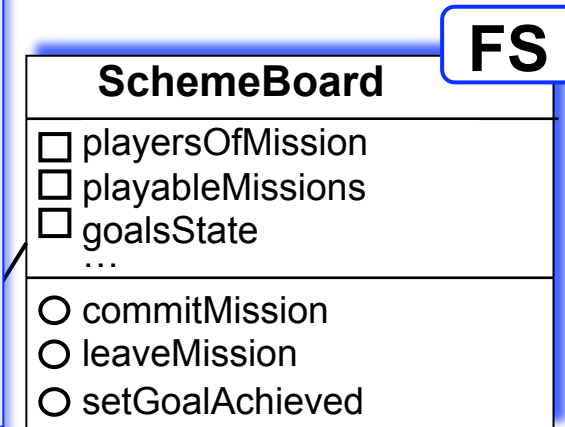
Legend

- ☐ Operation
- ☐ Observable property
- ☒ Link Operation

Organisational Artifacts for Coordination

SchemeBoard:

- Management of the life cycle of the collective plan expressed by the social scheme
- Attached to a group instance according to its specification in the specification
- Coordination of the agents for the execution of collective plan
- Regimentation of commitment mission norm



SS.Defense



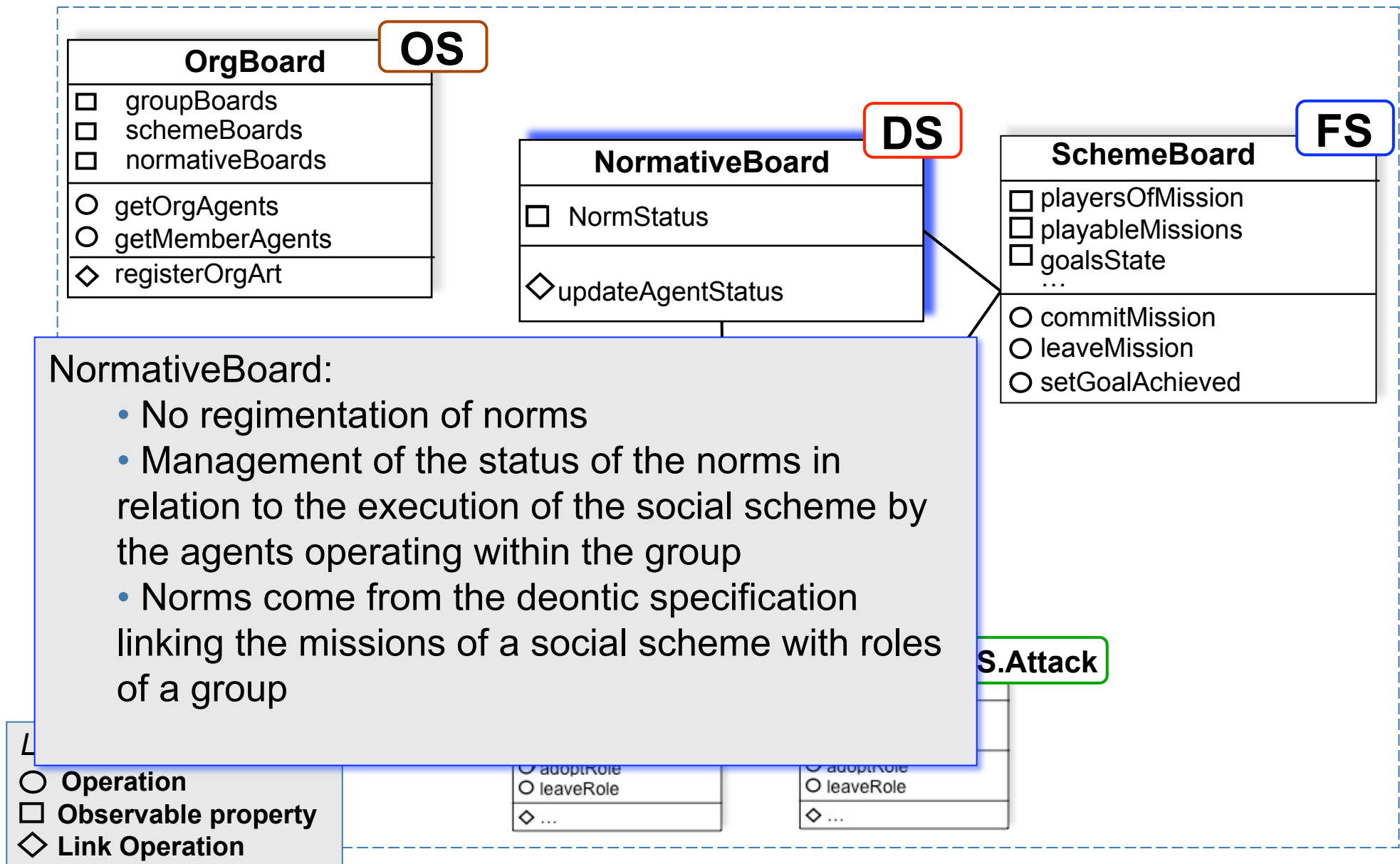
SS.Attack



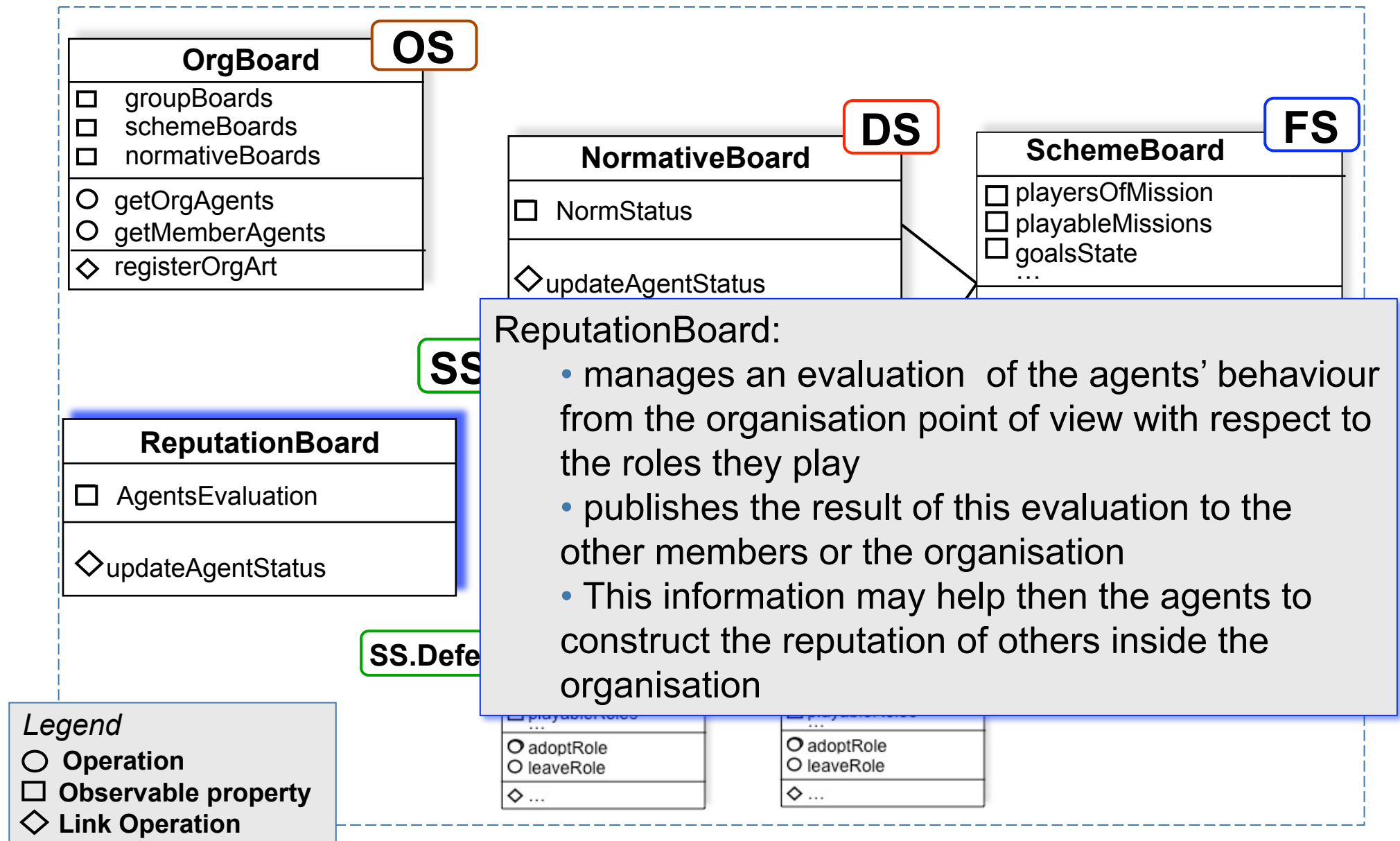
Legend

- ☐ Operation
- ☐ Observable property
- Link Operation

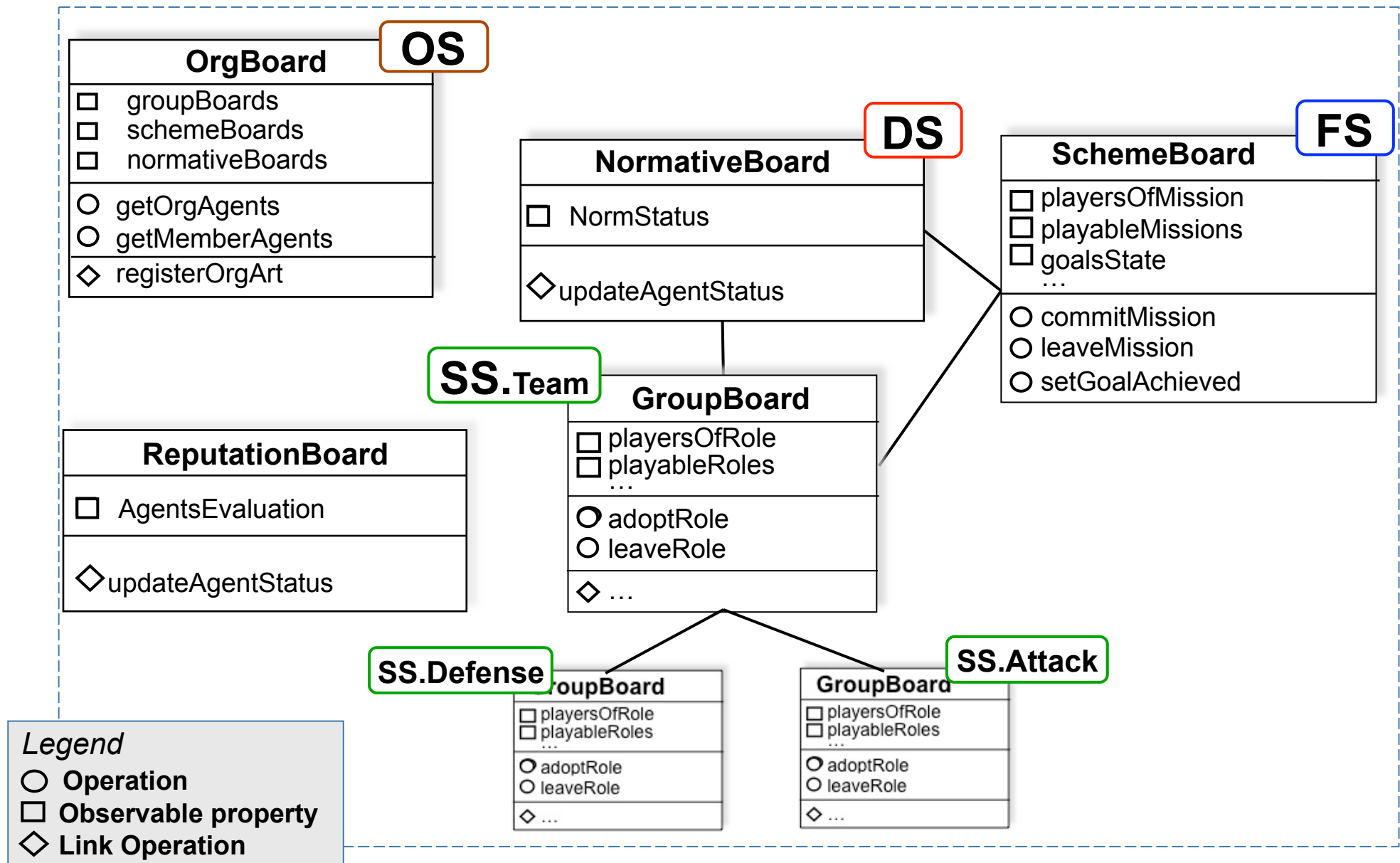
Organisational Artifacts for Regulation



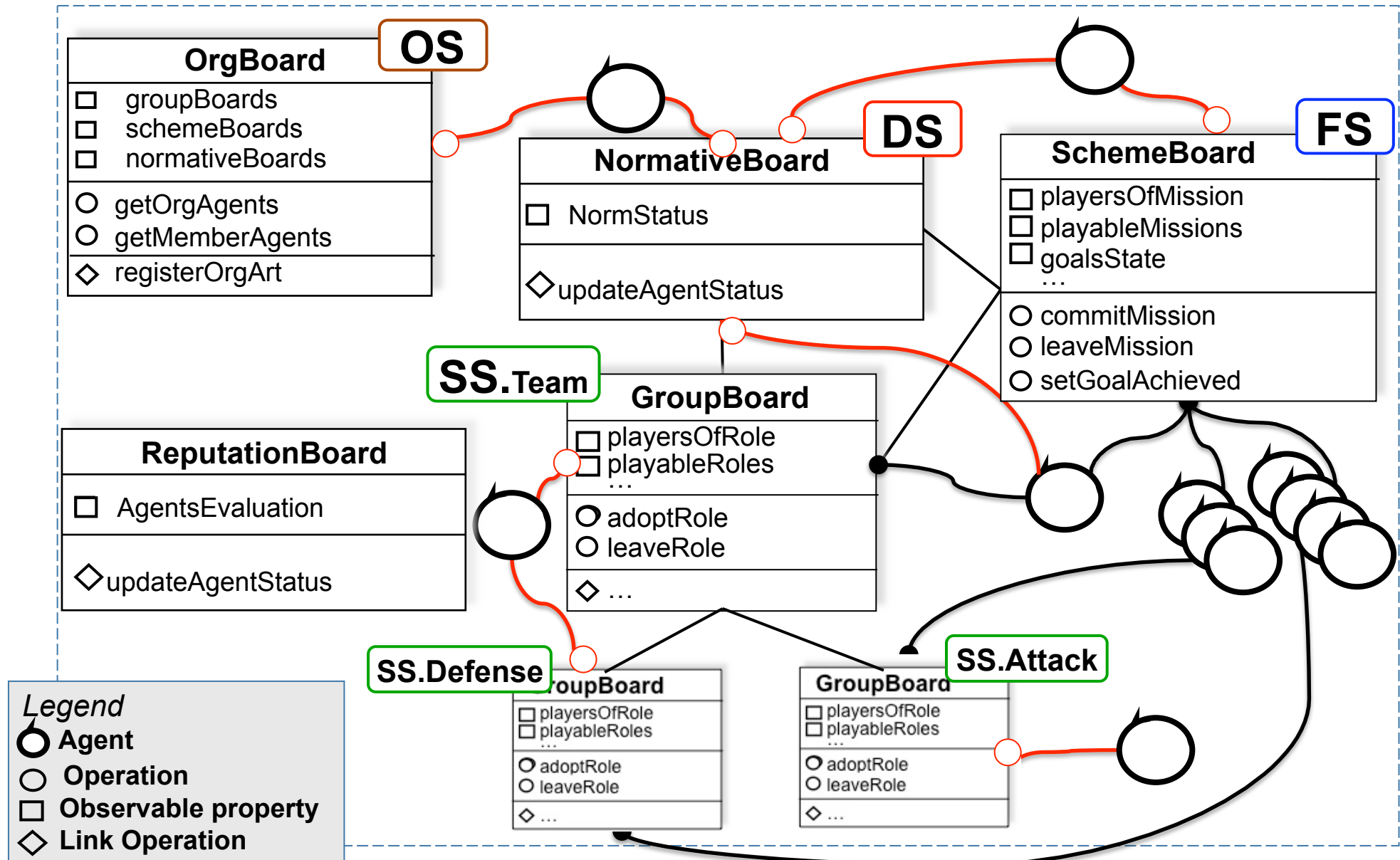
Organisational Artifacts for Regulation



Organisational Artifacts for Moise+



Agents within ORA4MAS for MOISE+



Outline

1. Introduction
2. Global picture of MOISE Framework
3. MOISE Organisation Modeling Language
4. MOISE Organisation Management Infrastructure
- 5. Conclusion and Perspectives**

Conclusion and perspectives

- Status
 - First prototype of ORA4MAS/MOISE+ implemented on top of Cartago
 - Experiments under realisation with Jason Agents and Jadex Agents
 - Future experiments with 2APL Agents
 - Organisation is no more outside of the MAS
 - Orwell's nightmare cannot become reality ;-)
- Where we have to go - Further works and questions
 - Other organisational artifacts? (e.g. "Reputation" artifact [Hubner 08])
 - How to link organisational artifacts with "cognitive artifacts" (i.e. tools, resources, ...)?
 - Situated organisation? Situated organisational artifacts?
 - RBAC on the organisational artifacts
 - Organisational agents

References

- [Grossi 07] D. Grossi, H. Aldewered, and F. Dignum. Ubi Lex, Ibi Poena : Designing norm enforcement in e-institutions. In P. Noriega, J. Vasquez-Salceda, G. Boella, O. Boissier, V. Dignum, N. Fornara, and E. Matson, editors, Coordination, Organizations, Institutions, and Norms in Agent Systems II, volume 4386 of LNAI, pages 101–114. Springer, 2007. Revised Selected Papers.
- [Hannoun 00] M. Hannoun, O. Boissier, J. S. Sichman, and C. Sayettat, Moise : An organizational model for multi-agent systems In M.C. Monard and J.S. Sichman, editors, Advances in Artificial Intelligence, volume 1952 of LNAI, pages 156—165, Springer, 2000. International Joint Conference IBERAMIA-SBIA
- [Hubner 02] J. F. Hubner, J. S. Sichman, and O. Boissier. Using the MOISE+ for a cooperative framework of MAS reorganisation. In A. L. C. Bazzan and S. Labidi, editors, Proceedings of the 17th Brazilian Symposium on Artificial Intelligence (SBIA'04), volume 3171 of LNAI, pages 506–515, Berlin, 2004. Springer.
- [Hubner 05] J. F. Hubner, J. S. Sichman, and O. Boissier. S-MOISE+: A middleware for developing organised multi-agent systems. In O. Boissier, V. Dignum, E. Matson, and J. S. Sichman, editors, Proceedings of the International Workshop on Organizations in Multi-Agent Systems, from Organizations to Organization Oriented Programming in MAS (OOP'2005), volume 3913 of LNAI, pages 64–78. Springer, 2006.
- [Gateau 05] Gâteau, B., Boissier, O., Khadraoui, D., Dubois, E.: MOISE-Inst : An organizational model for specifying rights and duties of autonomous agents. In van der Torre, L., Boella, G., eds.: 1st International Workshop on Coordination and Organisation (CoOrg 2005) affiliated with the 7th International Conference on Coordination Models and Languages, Namur - Belgium (2005)
- [Hubner 07] J. F. Hubner, J. S. Sichman, and O. Boissier. Developing organised multi-agent systems using the MOISE+ model: Programming issues at the system and agent levels. International Journal of Agent-Oriented Software Engineering, 1(3/4):370– 395, 2007.
- [Ricci 07] A. Ricci, M. Viroli, and A. Omicini. The A&A programming model & technology for developing agent environments in MAS. In M. Dastani, A. El Fallah Seghrouchni, A. Ricci, and M. Winikoff, editors, Post-proceedings of the 5th International Workshop “Programming Multi-Agent Systems” (PROMAS 2007), volume 4908 of LNAI, pages 91–109. Springer, 2007.
- [Kitio 07] R. Kitio, O. Boissier, J. F. Hubner, and A. Ricci. Organisational artifacts and agents for open multi-agent organisations: “giving the power back to the agents”. In J. Sichman, P. Noriega, J. Padget, and S. Ossowski, editors, Coordination, Organizations, Institutions, and Norms in Agent Systems III, volume 4870 of LNAI, pages 171–186. Springer, 2008. Revised Selected Papers.
- [Hubner 08] Jomi Fred Hubner, Laurent Vercouter, and Olivier Boissier, Instrumenting Multi-Agent Organisations with Reputation Artifacts, COIN Workshop at AAI 08.