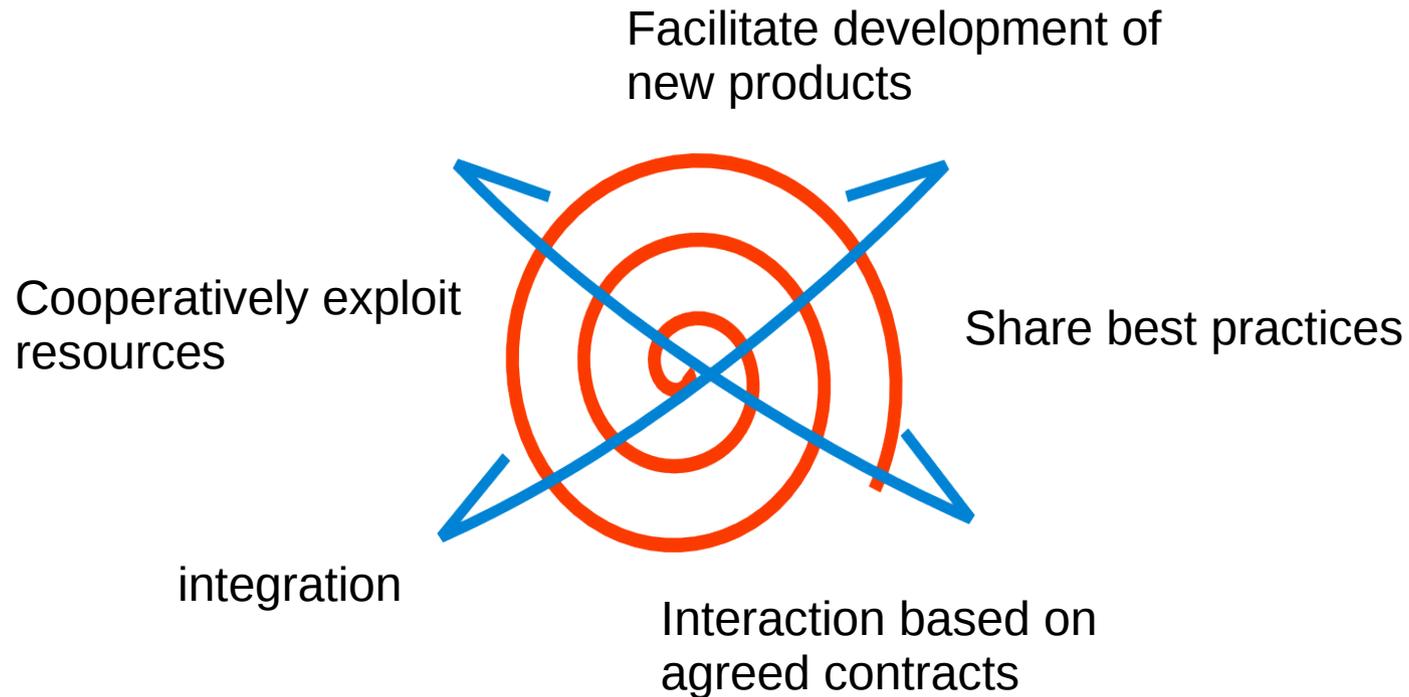


# MERCURIO: An Interaction-oriented Framework for Designing, Verifying and Programming Multi-Agent Systems

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# B2B and cross-business solutions



# B2B and cross-business solutions

- Interaction is crucial to any distributed application, but it becomes even more challenging in open contexts and when cross-business and business-to-business systems are to be developed.

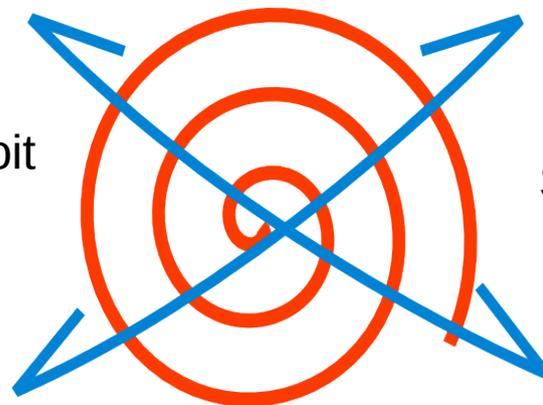
Support for C-Business collaborative production of goods and services

Facilitate development of new products

Cooperatively exploit resources

Share best practices

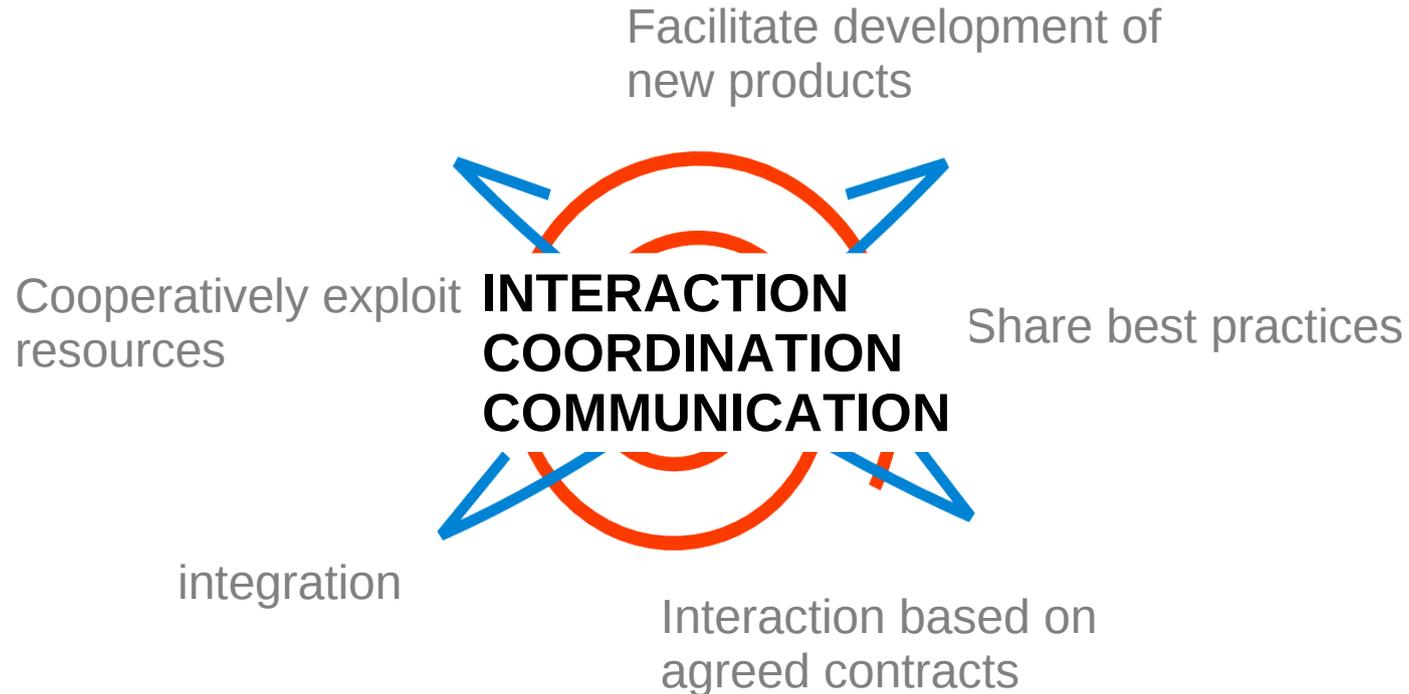
Business integration



Interaction based on agreed contracts

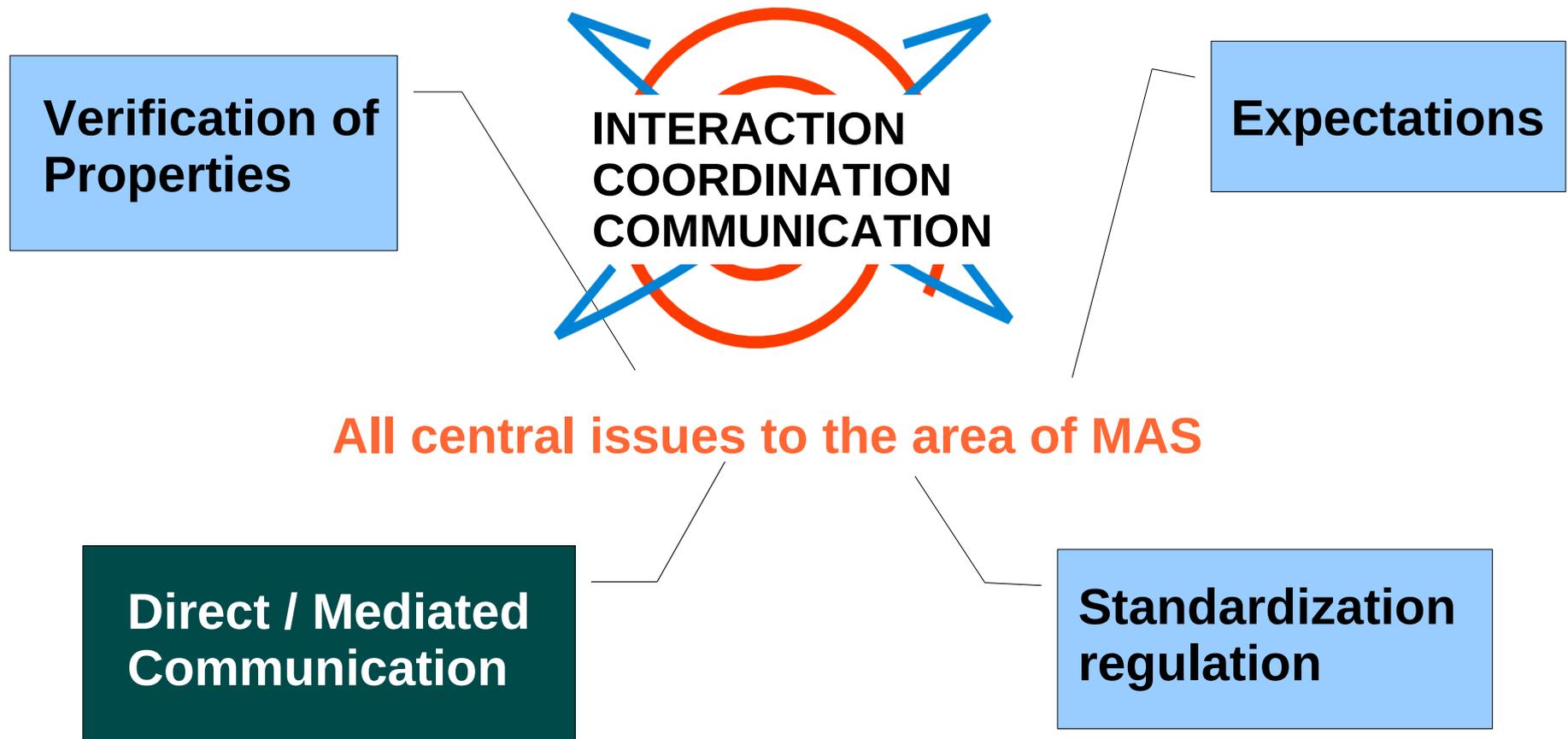
Here a group of heterogeneous and antecedently existing entities needs to **interact for some time, to share resources, to integrate their capabilities, stick to contracts, etc.**

# B2B and cross-business solutions



**All central issues to the area of MAS**

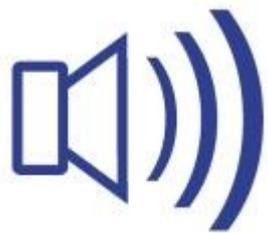
# B2B and cross-business solutions



# Direct forms of communication

most of existing platforms adopt **direct forms of communication**, with a mentalistic semantics

**JADE**: FIPA ACL is based on the mentalistic approach, the only abstraction is that of “agent”



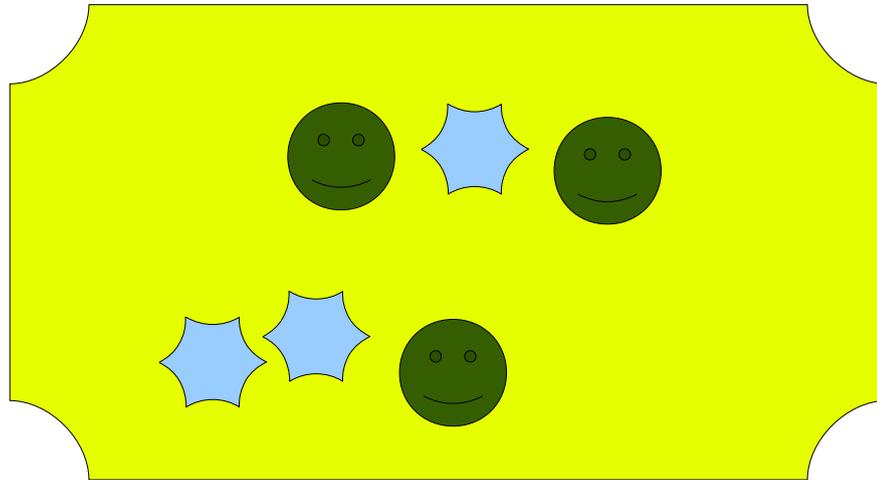
inform(I paid you)



I think  
he paid me

# Not only direct communication

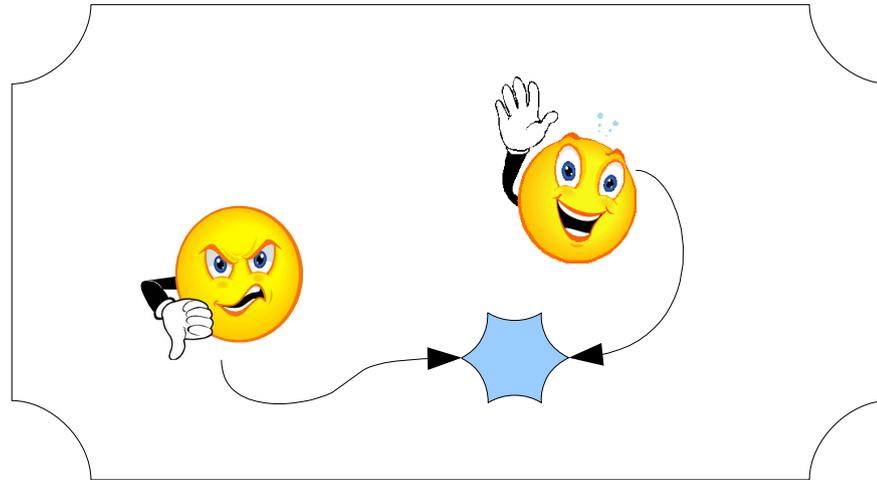
Other approaches propose models which encompass **agents**, their **environment** and **other elements**



**A&A meta-model** : agents immersed in a computational environment together with artifacts they can use, adapt, compose

# Not only direct communication

Environments / artifacts can be perceived, acted upon, observed, ...



Limiting to direct communication makes no sense

Environments/Artifacts can be **general, programmable channels** of communication

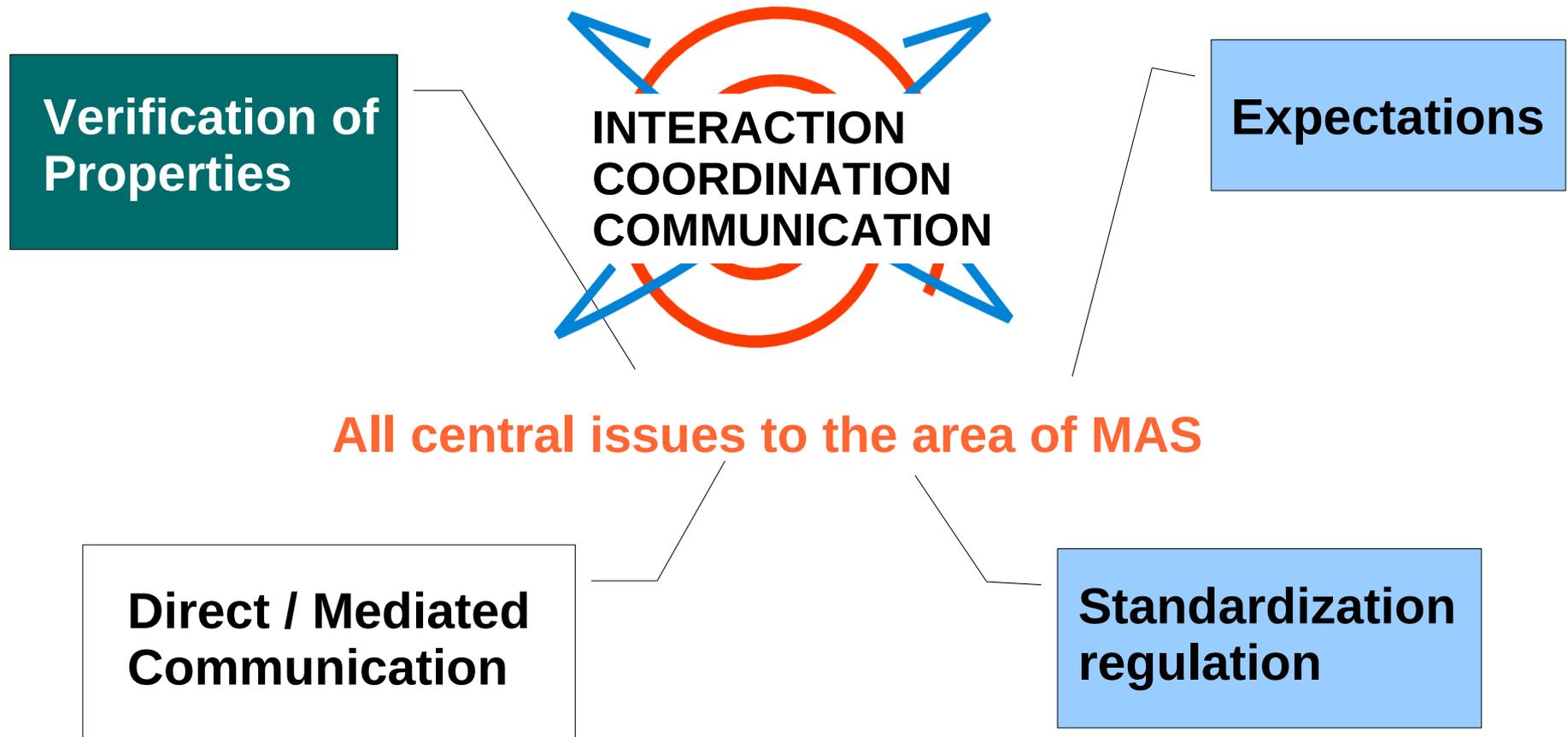
# Direct and mediated communication

## MODEL ABSTRACTIONS

## COMMUNICATION

Agents	Direct communication
Agents & Artifacts	Direct as well as mediated communication

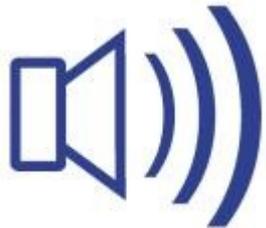
# B2B and cross-business solutions



# Mentalistic semantics: Drawback

Hindrance to the verification of properties

**No agent introspection**  
(typical in open systems)



inform(I will pay you)

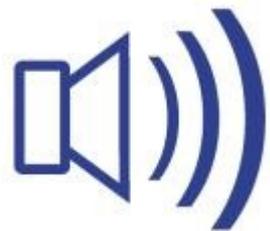
Will he believe me?

Mentalistic semantics is not useful when the goal is to verify global properties of the system interaction and when participants aim at checking if the system evolution meets their expectations

# Direct communication with a commitment-based semantics

**Commitments:** simple yet effective. Agents are expected to satisfy the commitments they have taken

(Protocol-based) communication is a matter of social expectations



Speech  
act

$C(x, y, \text{pay})$

**COMMITMENT STORE**

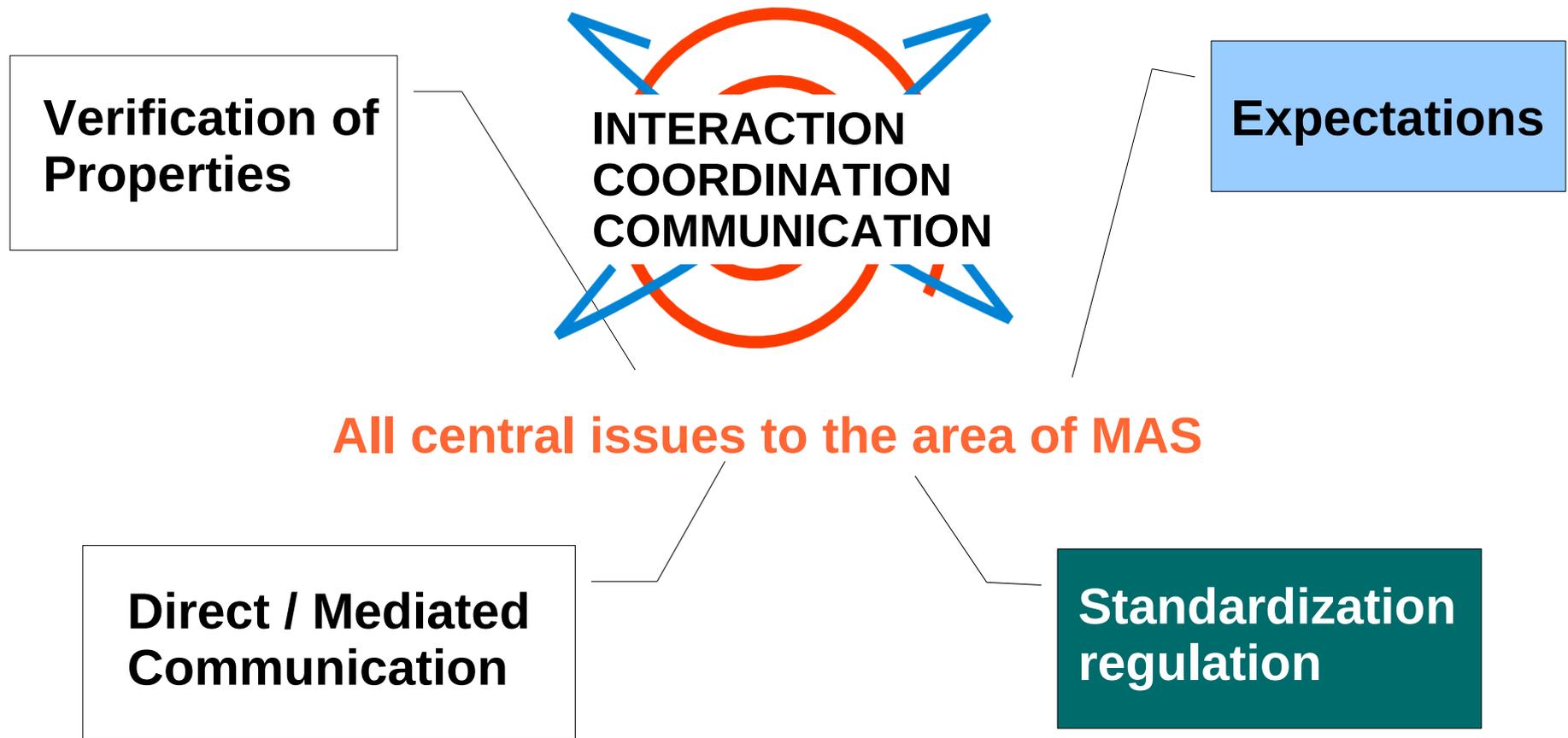


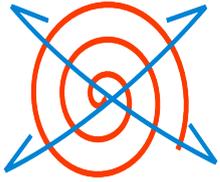
I expect him  
to pay

## PROS

**responsibility:** an agent that does not act according to its commitments is liable for a violation that can be detected

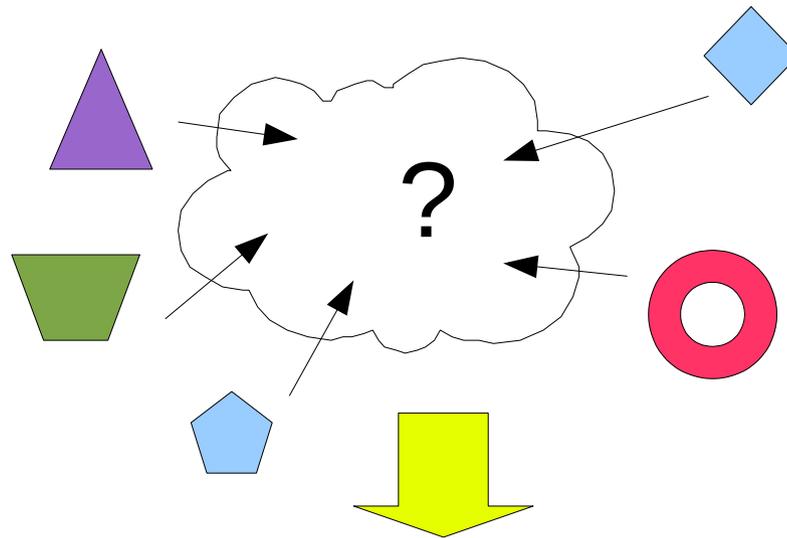
# B2B and cross-business solutions





# Regulation

**Standardization and regulation of interaction:** decisive factors in distributed and open systems, made of heterogeneous and changing parties

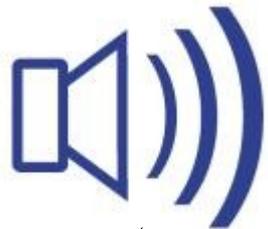


A **shared specification** of the interaction protocol and of the rules of the MAS

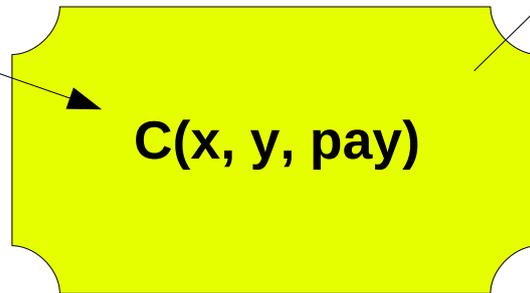
Preferably with an **observational** and **social semantics**

# Drawback

**Commitment-protocols:** no possibility of specifying **patterns of interaction**, important for taking into account laws and habits



I will pay



**COMMITMENT STORE**

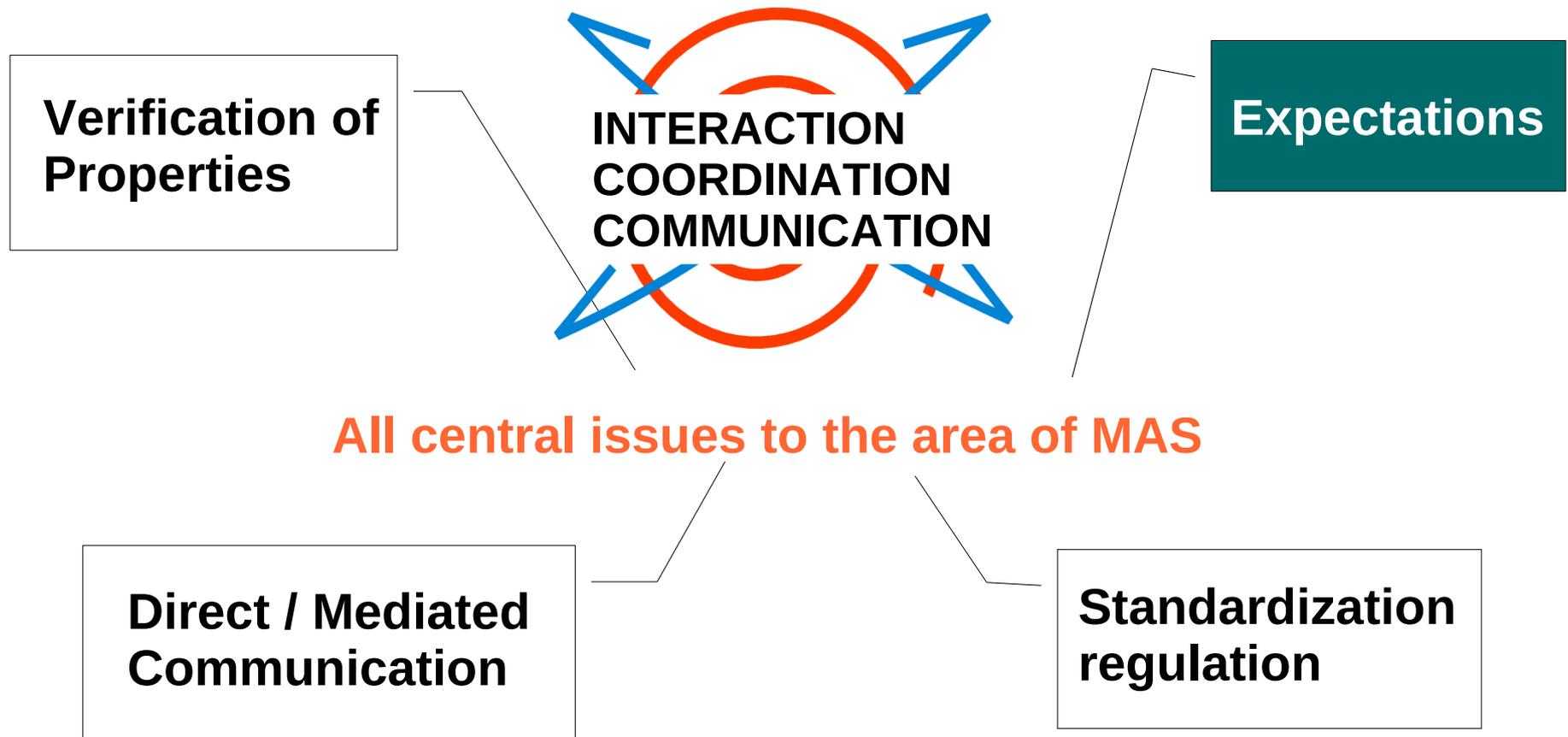


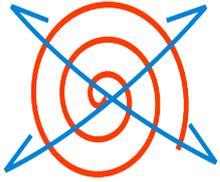
he will get some money and give it to me

**PROS**  
responsibility

**ISSUE**  
Not only what, also how

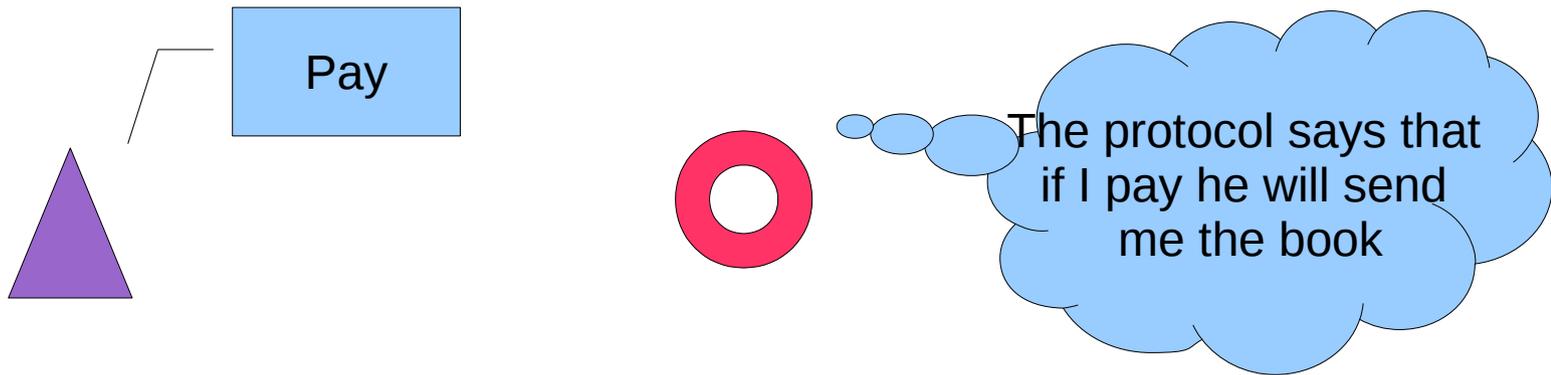
# B2B and cross-business solutions





# Regulation and expectation

Protocols should allow participants to broadly predict each other's behavior. Aren't they patterns of interaction?



Current proposals are **too rigid** (e.g. Procedural and prescriptive)

Or they **do not allow** a high-level representation of patterns of interaction, so forecasting cannot occur (e.g. Commitment-based protocols)

expectations

# MERCURIO

All these aspects are being faced by researchers and solutions for tackling them separately have been proposed

**MERCURIO** aims at identifying a **unified solution** that accounts for:

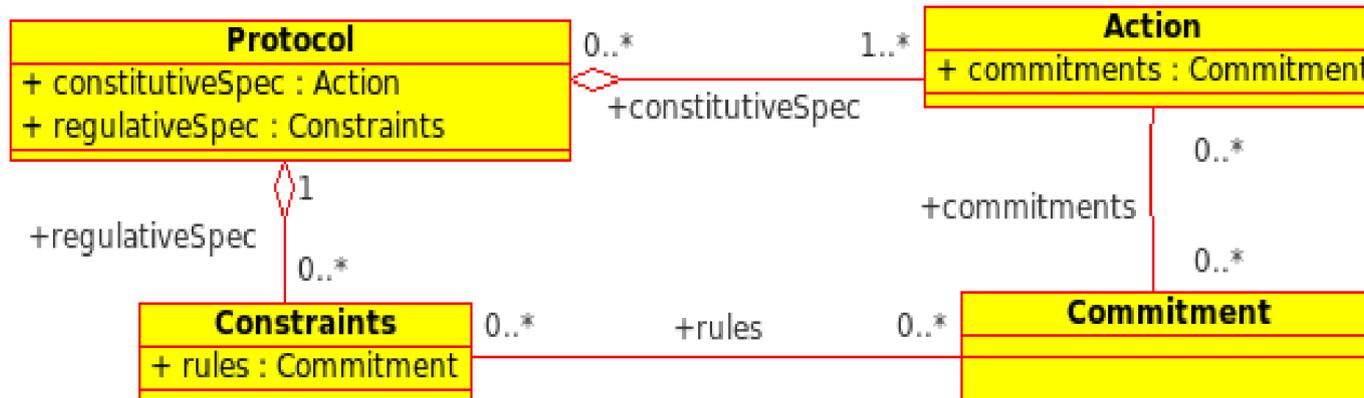
- **Direct + mediated forms of communication**
- **Representation of patterns of interaction**
- **Expectation and **property verification****

# Approach

To use a computational environment that plays the role of a flexible communication channel and to represent and manage interaction protocols by means of it

- To use **behavior-oriented commitment-based protocols** [*Baldoni et al. ECAI 2010*], based on the notion of commitment [*Castelfranchi, Singh*]
- To consider protocols as environments/artifacts
- To model the environment by means of the A&A meta-model [*Ricci et al.*]
- To model services and tools by means of artifacts

# Behavior-oriented commitment protocols



## Constitutive specification of social actions:

given in terms of their effects on the social state

## Regulative specification of the protocol:

given in terms of commitments and on constraints among commitments (on the evolution of the social state)

**DECOUPLING**

WOA 2010, Rimini (Italy), 7 settemb

# Advantages

- Specification of patterns of interaction, keeping the same flexibility of commitment-based protocols
- Introduction of a notion of violation not only of commitments but also also of the regulative specification (constraints)
- Modularity
- Openness
- Reusability

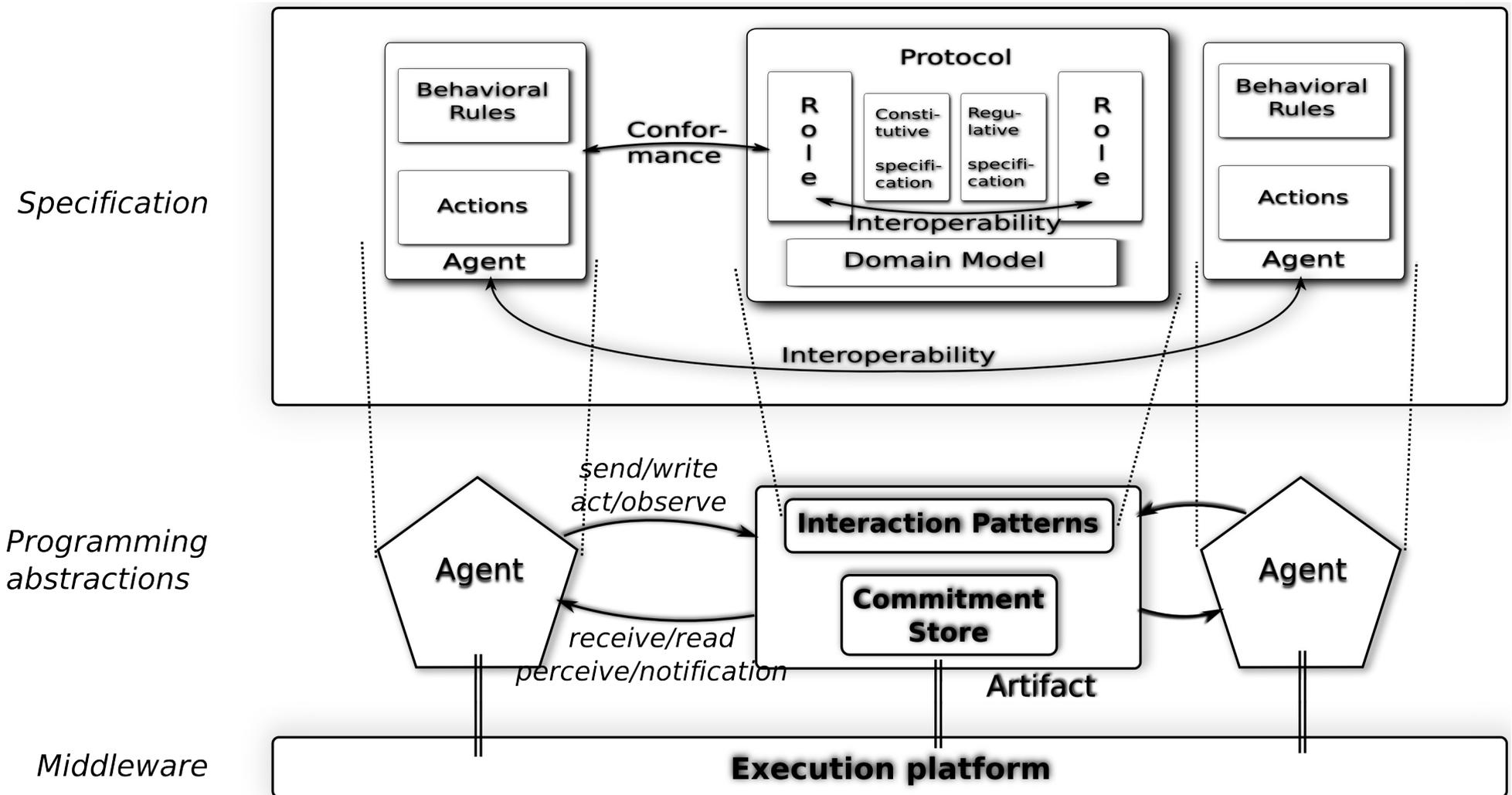
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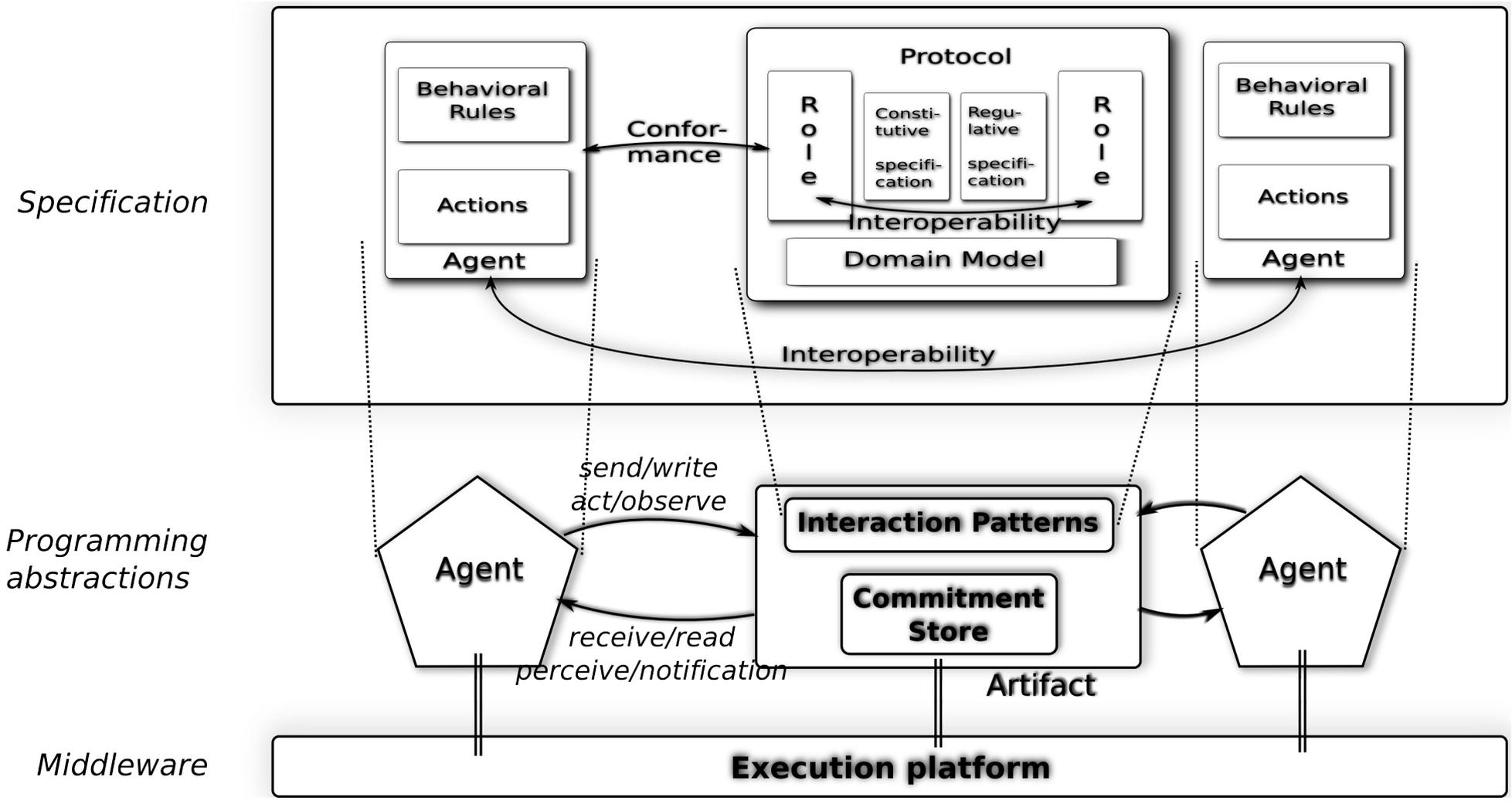
# MERCURIO's view

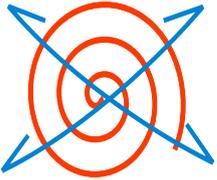
proposal



# MERCURIO's view

proposal





## MERCURIO's view

**Manage includes verifications at design, engagement and run-time**

### **At design time (examples):**

The designed pattern of interaction is interoperable (no deadlocks, livelocks, ...)

The designed pattern satisfies certain properties (some condition is always true, it is possible that, ...)

### **At engagement time (examples):**

As an agent, are my rules and constraints compliant to the protocol?

Can I play a role in such a way that a given goal is reached?

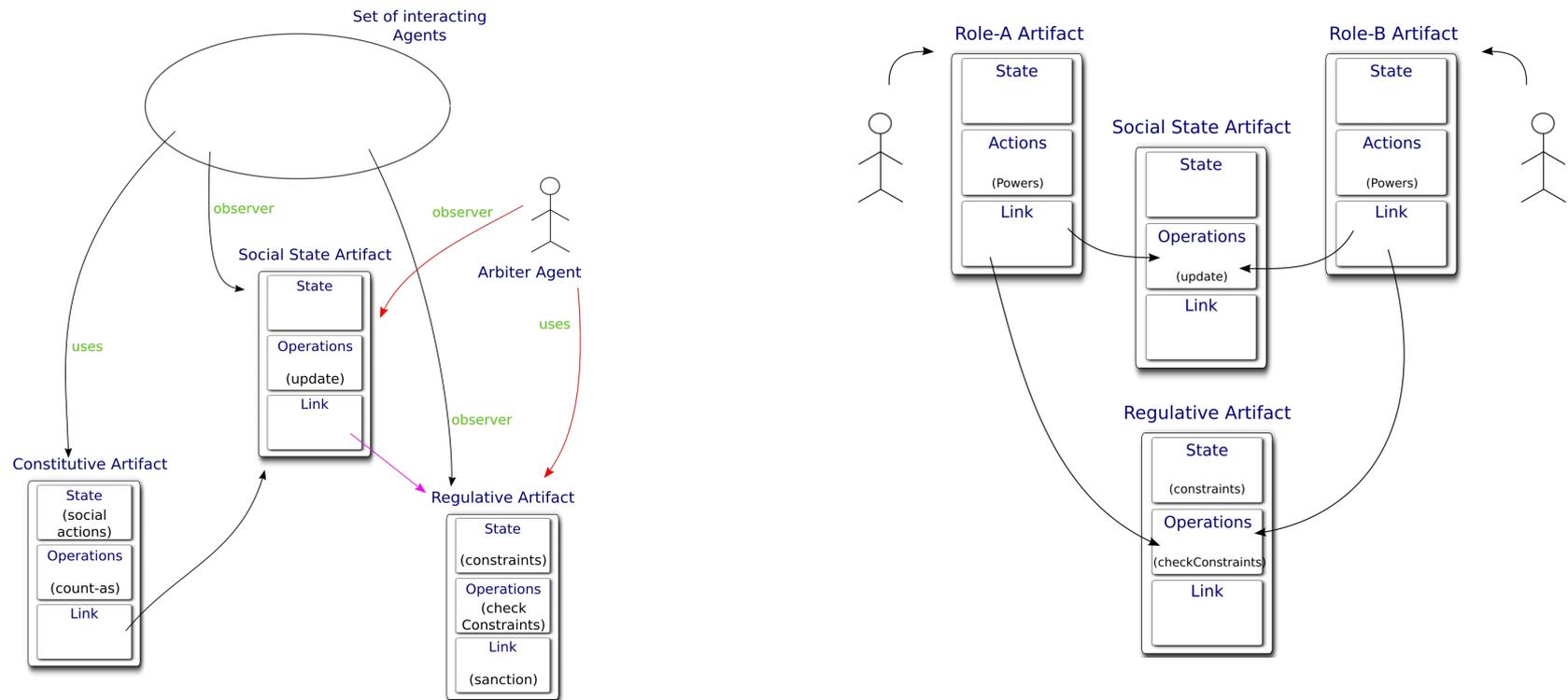
Can I implement the protocol actions?

### **At run-time (example):**

Violations are to be detected

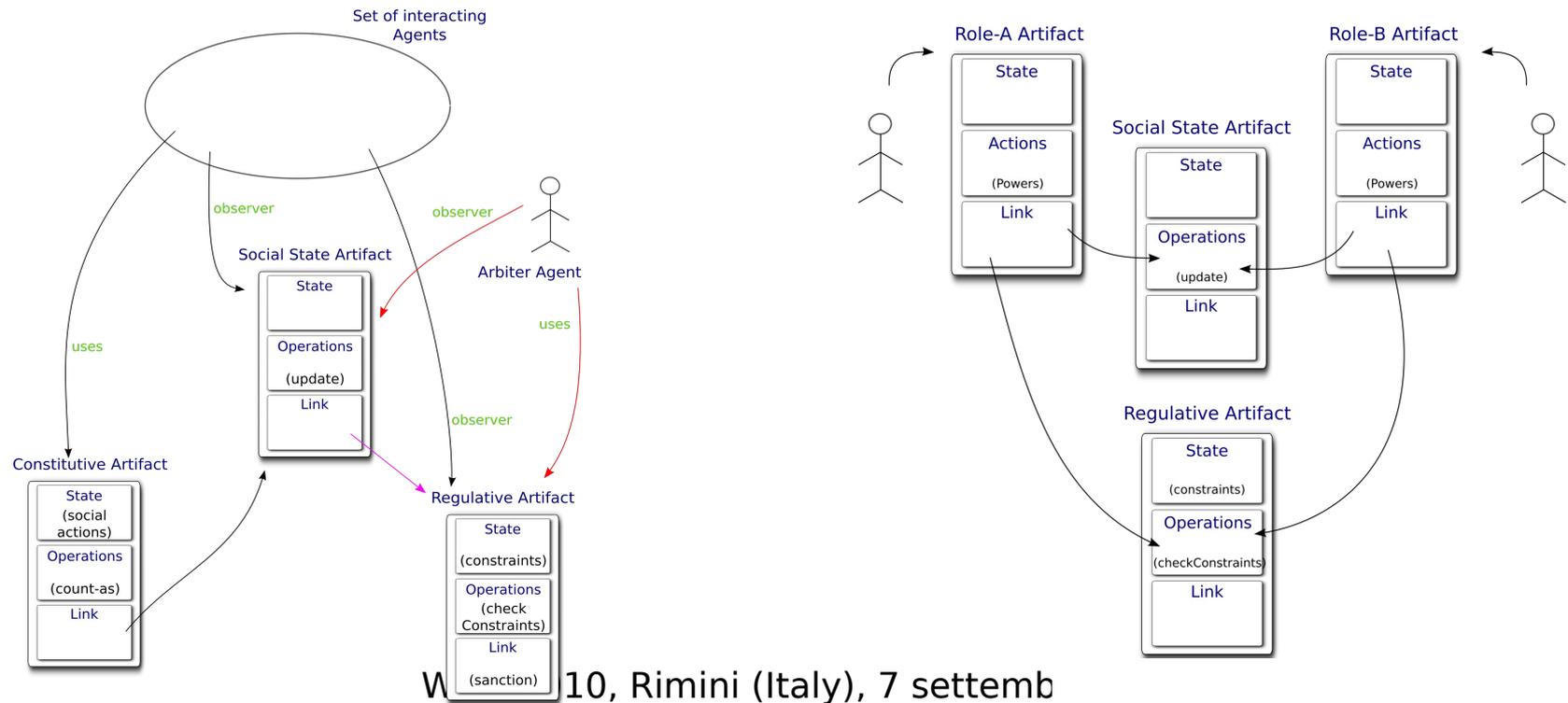
# MERCURIO's view

- As ORA4MAS and other proposals show A&A can be a basis for building organizations and e-institutions
- MERCURIO adds to A&A a social semantics and the possibility to specify patterns of interaction



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# Questions?

WOA 2010, Rimini (Italy), 7 settemb