

## Environment and Agreement Technologies<sup>★</sup>

E. Argente, O. Boissier, C. Carrascosa, N. Fornara, P. McBurney, P. Noriega, A. Ricci, J. Sabater, M. I. Schumacher, C. Tampitsikas, K. Taveter, G. Vizzari, and G. Vouros

{eargente, carrasco}@dsic.upv.es, olivier.boissier@emse.fr,  
nicoletta.fornara@usi.ch, peter.mcburney@kcl.ac.uk,  
{pablo, jsabater}@iia.csic.es,  
{michael.schumacher, charalampos.tampitsikas}@hevs.ch,  
kuldar.taveter@ttu.ee, giuseppe.vizzari@disco.unimib.it, georgev@aegean.gr

The notion of Multi-Agent System (MAS) environment, as remarked by recent literature, has gained a key role, becoming a mediating entity, functioning as enabler but possibly also as a manager and constrainer of agent actions, perceptions, and interactions<sup>1</sup> while addressing the requirements of openness and scalability. According to such a perspective, the environment is not a merely passive source of agent perceptions and target of agent actions which is, actually, the dominant perspective in agency, but a *first-class abstraction* that can be suitably designed to encapsulate some fundamental functionalities and services, such as coordination and organization, besides agent mobility, communications, security, etc [2].

Then, the environment dimension appears to intersect with all the dimensions that should be addressed to define an *agreement* between autonomous agents, that is, all the different *Agreement Technologies* giving support to the building, development and management of agreements in decentralized and open systems between autonomous agents. Those dimensions are the ones related to the development of technologies dealing with: Semantics, Norms, Organizations, Argumentation & Negotiation, and Trust. Though some works have already been done on the connections between environment and organizations or norms, the links and interactions of the environment with the other dimensions of these agreement technologies are still to be explored.

Given the characterization of the environment and the analysis done along the different dimensions, its benefits for Agreement Technologies can be broadly framed at two different (but related) levels: (i) *conceptual level* — improving the modeling and design of the strategies and mechanisms that allow for achieving agreements, conceiving solutions that don't rely necessarily only on agents and message passing as unique abstractions, (ii) *practical level* — improving the separation of concerns, the modularity, reusability, openness and extensibility in designing and implementing agent-based agreement technologies.

It appears that the level at which the environment is exploited to regulate the access and mediate interaction (i.e. *interaction mediation-support level* defined in [4]) may be understood as an “institutional layer” implementing the high level constructs of a coordination metamodel and ensuring that the actual specification of a particular instance of the coordination conventions is properly implemented and the corresponding conventions dully enforced [1]. The term “institutional” is meant to clarify two key

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<sup>1</sup> see [4] for comprehensive surveys

Dimension	Challenge
Semantics	Support of application-dependent ontology: domain-specific objects and language interpretation.
	Explicit and exploitable representation of environment aspects and semantics.
	Combining knowledge in large-scale open settings & reconciling subjective views.
	Learning the semantics of everything, out of cases of inspecting and exploiting the interactions of others with the environment (within specific contexts of interaction) .
Norms	Inventing commonly agreed languages (symbols, syntax and semantics) for interaction.
	To define a standard way for representing the events and actions that happen in an environment.
	To define in a standard way how to represent the context of the interactions in terms of properties of resources and their value.
	To define general mechanisms for contextualizing abstract norms defined at design-time into norms situated in specific spaces.
Organisation	To easily extend the functionalities/services provided by the environment for adding those required for norms management.
	To provide facilities to enter or exit a given organization to allow run-time recruitment of new members as well as voluntary desertion and/or expulsion of members
	To support on-demand creation, deletion and modification of organizations.
	To give support to the institutional components of an organization, i.e. norms, powers, agreements.
Argumentation	Agents must be able to make use of the elements of the environment, such artifacts, that provide all these previous functionalities and facilities.
	Scaling up existing work, which typically considers single interactions between a small number of agents.
	Management of libraries and database of ontologies, protocols and agreements
	Participating agents in a system then need the ability to reason about ontologies and interaction protocols and to invoke them as required.
Trust	To exploit the existing strong link between trust/reputation and the environment in electronic environments.
	To give the trust and reputation system the capacity to influence the actions of the agent to modify the environment so it becomes more trust and reputation “friendly”.

elements: (i) the creation (at run-time) of a virtual agreement space—or “institutional”, in the sense of Searle [3])— where only certain messages are deemed acceptable and thus processed, and (ii) that the admission of messages and their subsequent processing in the environment comply with those conventions that have been specified. To achieve this double purpose of translating the specification into a run-time agreement space and enforcing the coordination conventions within that agreement space, that institutional layer needs to include appropriate data structures that mirror the conceptual coordination devices, operations that apply to those data structures and just enough governance functionalities to ensure that the actual interaction flow complies with the coordination conventions that have been specified for the particular socio-technical system. Thus, in particular, the institutional layer would need to mirror the metamodel properly by providing support to basic services such as Time keeping, Interface with external environments for instance.

Besides these basic and common features, we claim that the environment dimension plays an important role in Agreement Technologies, raising different challenges shown in the table. They show that the environment is source of multiple and interesting research directions for supporting and developing Agreement Technologies.

## References

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