An Infrastructure for Open Interaction Systems*

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Infrastructure Overview We propose an infrastructure for the development of Open Interaction Systems (OISs), based on the OCeAN metamodel [1] and on solutions that pertain to the field of Agreement Technologies. OISs are open to diverse types of participants (i.e., software agents), and enable them to interact with each other to achieve their objectives. To do so the participants are allowed to act in compliance with previously agreed-upon regulations, which are provided and enforced by the system. The infrastructure we propose involves three layers: (i), the Interoperability Layer, which enables interactions between heterogeneous participants while respecting ownership boundaries; (ii), the Bridging Layer, in charge of interpreting the participants' actions in a form suitable for regulation; and (iii), the Regulation Layer, which holds the regulations and enforces them with respect to the participants' activities. In what follows we present this infrastructure, briefly describing its architecture and implementing technologies, and arguing that it meets the requirements of a framework for realizing an OIS, such as an e-marketplace.

Interoperability Layer At the lowest level, the infrastructure provides the means to enable heterogeneous participants to interact with each other in a fully interoperable fashion, while being respectful of their ownership boundaries. To this end the architecture prescribes a message transfer approach that is neutral to the internals of the participants, and that leverages standard technologies to facilitate a widespread adoption. In addition, to respect ownership boundaries, any form of coupling is eliminated with the introduction of an Intermediary acting as Registry, allowing agents to register and find each other [2]. To further the interoperability for a higher level of automation, the use of a flexible standardized approach for expressing the communicative aspect of the messages is also prescribed. The infrastructure provides a messaging protocol based on standard neutral technologies: HTTP, SOAP, WSDL[2]. More specifically, web-service technology is adopted for message transfer between participants, by prescribing a message transfer service, exposed via WSDL, in which HTTP is used for the transport of messages and SOAP for the structure. Then, the SOAP *body* is specified as a message of OCeAN-ACL: our agent communication language defined to be as close as possible to the FIPA-ACL standard. However, we provide a new commitment-based semantics, and adopt OWL 2 DL as content language [2].

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Regulation Layer Once heterogeneous participants possibly belonging to different owners can interact with each other as exposed above, it is necessary that they are provided with rules regulating their interactions. The Regulation Layer provides for both the specification and the enforcement of the regulating mechanism. According to the OCeAN metamodel, the former is defined in term of *artificial institutions*, which define *institutional actions* and *norms*. Such institutions extend the *Basic Institution* [1], which provides for an application-independent specification of commitment. All institutions are represented in OWL 2 DL. The state of the interactions is represented in an OWL ontology, the *State Ontology*: an integration of the shared application-specific knowledge, the set of relevant artificial institutions and the actual institutional actions happening [2]. Reasoning is then carried out over this state representation. To guarantee rule enforcement, the role of the Intermediary is upgraded to that of a third-party system state manager and regulation enforcer. The Intermediary is therefore enabled to observe the participants' interactions, to represent the state of the interaction accordingly, and to carry out actions related to regulation [2]. To this purpose the Intermediary makes use of a general-purpose OWL reasoner.

Bridging Layer It is the part of the architecture that bridges interoperability with regulation. This is obtained by assigning institutional meanings to the agents messages, which in the case of communicative acts is achieved through their commitment-based semantics. Other Non-ACL based Messages are interpreted through a *count-as* relationship specified within the relevant institution. To concretely seemingly achieve this correspondence from message to institution, application-independent concepts specification (such as agent, action, object, etc.) must be shared among the processes concerned with ACL syntax, ACL semantics, the institutional effects of message exchange, and the Institutions' representation. Furthermore, for the system to reason on application-dependent concepts, application ontologies must also be aligned so as to be integrable. To meet such requirements, we have provided a suitable ontological infrastructure based on OWL 2 DL [2]. The OWL API is used to manipulate the State Ontology at runtime and for representing the semantics of messages, thus creating the conditions for subsequent monitoring and regulation.

Conclusion The infrastructure presented here is being implemented as part of an ongoing project funded by the Swiss National Research Foundation. We are currently working on the semantics of messages, and plan to turn to the general regulation of interactions in the near future.

References

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