Background.
Imperial College London and NCSR "Demokritos" have been collaborating for several years on the topic of temporal representation and reasoning, and norm-governed multi-agent systems. A collaboration between UB, IIIA and NCSR "Demokritos" was established in 2009 when Dr. Artikis visited Barcelona for a joint meeting. Given the common research interests of the aforementioned institutions, a joint meeting was hosted by Dr. Pitt at Imperial College London in January 2010 in order to initiate a 4-institution collaboration.

Problem Description.
Multi-agent systems where the members are developed by parties with competing interests, and where there is no access to a member's internal state, are often classified as 'open'. The specification of protocols and norms for open agent systems of this sort is largely seen as a design-time activity. Moreover, there is no support for run-time specification modification. Due to environmental changes, social agreements, or other conditions, however, it is often required to revise the specification during run time (i.e. the activity of the multi-agent system). Consider, for instance, the case of a malfunction of a large number of sensors in a sensor network, or the case of manipulation of a voting procedure due to strategic voting, or when an organisation conducts its business in an inefficient manner.

Discussions.
Various research issues related to the above problem were discussed. Dr. Artikis presented an infrastructure for 'dynamic' protocol specifications, that is, specifications that may be modified at run-time by agents [1]. The proposed infrastructure allows agents to alter the rules of a protocol *P* during the protocol execution. *P* is considered an 'object' protocol; at any point in time during the execution of the object protocol the participants may start a 'meta' protocol in order to decide whether the object protocol rules should be modified. Moreover, the participants of the meta protocol may initiate a meta-meta protocol to decide whether to modify the rules of the meta protocol, or they may initiate a meta-meta-meta protocol to modify the rules of the meta-meta protocol, and so on.

A protocol specification with *l* replaceable rules, or Degrees of Freedom (DoF), creates an *l*-dimensional specification space where each dimension corresponds to a DoF. A point in the *l*-dimensional specification space, or specification point, represents a complete protocol specification. In the proposed infrastructure for dynamic specifications, a proposal for protocol modification is evaluated by modelling a dynamic specification as a metric space. More precisely, given the set of specification points of a protocol, we define a 'desired' specification point, and compute the 'distance' between the desired point and the specification point that would be reached if the proposal for protocol modification was accepted --- resulting point. We constrain the process of run-time protocol modification by forbidding

agents to propose a modification in a way that the resulting specification point is 'far' from the desired point.

The proposed infrastructure is formalised in executable action languages such as the Event Calculus (EC), and the action language C+. EC is a simple and flexible formalism that is very easily and efficiently implemented for an important class of computational tasks. It thus provides a practical means of implementing an executable system specification. C+ has an explicit transition system semantics and thus has a direct link to other tools based on transition systems. Moreover, C+, like EC, has direct routes to implementation.

Dr. Lopez-Sanchez presented the work done with Dr. Esteva and Mr. Campos on adapting organisational structures for MAS. In order to endow a MAS with self-adaptation capabilities, they advocate for incorporating a distributed meta-level in charge of adapting system's organisation [2]. Specifically, the meta-level is composed by a set of agents that perceive partial information about environment and agent properties, and use this information to adapt the organisation taking into account its goals. Dr. Lopez-Sanchez also presented a simulator they have developed for testing adaptation mechanisms in a Peer-to-Peer sharing network scenario.

Adaptation mechanisms can be programmed by system designers or learnt by meta-level agents at run time. We discussed both approaches and results were shown for each one on norm adaptation in the Peer-to Peer scenario. In particular, regarding the learning approach meta-level agents use Case-Based Reasoning techniques to learn how to adapt norms. Presented simulations show that in the Peer-to-Peer scenario better results are obtained when agents use Case-Based Reasoning for norm adaptation. The conducted work has raised several research questions that can be addressed from different research perspectives and application scenarios. Experiences of applying Case-Based Reasoning techniques to learn norm adaptation were shared, and proposals for further collaboration were made.

On the topic of applying Case-Based Reasoning techniques for norm adaptation, Mr. Carr presented joint work with Dr. Pitt and Dr. Artikis on navigating the specification space of a dynamic protocol. More precisely, he presented how case-based reasoning may be used to determine the desired specification point, that is, the desired specification instance, given a set of environmental conditions. He presented experimental results on a dynamic resource-sharing protocol.

References.

1. Artikis A. Dynamic Protocols for Open Agent Systems, in Proceedings of International Conference on Autonomous Agents and Multi-Agent Systems (AAMAS), pp. 97-104, ACM, 2009.
2. Jordi Campos, Maite Lopez-Sanchez, and Marc Esteva. Multi-Agent System adaptation in a Peer-to-Peer scenario. In ACM SAC09 - Agreement Technologies, pages 735-739, 2009.

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