Demonstration: WS-Agreement Based Resource Negotiation in AgentScape

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ABSTRACT

Mobile agents require access to computing resources on heterogenous systems across the Internet. They need to be able to negotiate their requirements with systems on which they wish to be hosted. To this purpose, a negotiation infrastructure has been developed with which agents acquire time-limited resource contracts through negotiation with one or more mediators instead of individual hosting systems. Mediators represent groups of autonomous hosts. The negotiation protocol and language are based on the WS-Agreement Specification, and have been implemented and tested within the AgentScape framework. The demonstration shows in detail how this negotiation framework can be used for agents negotiating for resources on remote hosts.

1. INTRODUCTION

One of the assumptions behind the mobile agent paradigm in open, heterogeneous environments is that agents will have access to computing resources. Little thought has been given to the way in which this can be implemented. Not only do they need access, they need to be able to plan coordinated resource usage across multiple domains. Recently, negotiation of the conditions and quality of service of resource access has been considered to be an important capability for distributed, service-oriented architectures. This demonstration focuses on the negotiation of resource access for mobile agent applications deployed on Internet-scale, open distributed systems. The resources required by agents can vary from CPU type, bandwidth, to the provision of specific services (e.g., databases, web servers, etc.), and level of security required, depending on the task at hand. Well-defined, open protocols and mechanisms are necessary for agents to negotiate their resource access requirements with heterogeneous hosts.

Mobach et al [3] present a negotiation infrastructure within which individual agents acquire time-limited contracts for the resources they need, through negotiation with one or more system domain coordinators: mediators representing multiple autonomous hosts. The protocols with which agent applications, domain coordinators, and hosts interact, are based on the WS-Agreement Specification [1] with application dependent domain ontologies for specific resources.

AAMAS '07 Honolulu, Hawaii USA

2. NEGOTIATION INFRASTRUCTURE

The overall goal and use of the negotiation infrastructure is to allow for the negotiation of terms of conditions and quality of service of resource access by agents. The negotiation model includes the exchange of agreement offers and acceptance of the offers between different parties.

The negotiation infrastructure has to deal with (i) large numbers of heterogeneous agents, and (ii) dynamic groups of heterogeneous hosts each with their own specific sets of requirements. From the agent's perspective, the negotiation infrastructure should define a straightforward interface to acquire resources, but should hide specific allocation details. On the other side, hosts need to keep full control over the use of their resources by agent applications. Negotiation policies spanning multiple hosts, allowing specification of resource access and usage policies over a set of hosts (e.g., for load balancing purposes or virtual organization-wide policies, etc.) must also be facilitated.

In our negotiation model, *hosts* (H) are autonomous entities that provide *resources* (R) to *agents* (A) under specific usage and access policies. Hosts are aggregated into *virtual domains*. The *domain coordinator* (DC), represents the hosts within a virtual domain in the negotiation process, negotiating with both agents and hosts. Figure 1 shows an overview of the model.

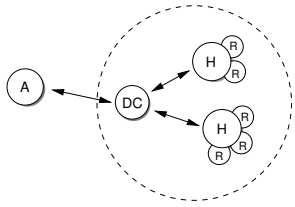

Figure 1: Negotiation model overview.

Negotation is a two-layered process: Agents negotiate resource access with domain coordinators, and domain coordinators, in turn, negotiate with groups of host managers in virtual domains to obtain the actual resources agents require. The results of negotiation are time-limited contracts specifying which resources may be accessed during the time span of the contract, and under which conditions the re-

sources may be used. Agents can negotiate with multiple domain coordinators.

In our demonstration, the domain coordinator hides the individual resources from the agents. The task of selecting one appropriate offer (based on the available resources at a specific point in time) has been delegated to the domain coordinator. Alternatively, a domain coordinator could return a set of possible offers, letting a requesting agent choose the most appropriate. The model supports both options, but only the first is demonstrated.

The negotiation protocol and language used in our negotiation model are based upon the *WS-Agreement Specification* [1]. The specification defines an XML-based language for agreements between resource providers (hosts) and consumers (agents), and a protocol for establishing these agreements. An agreement contains *terms* and a *context*. Agreement *terms* are used to describe the (levels of) service involved. The context contains meta information about the agreement, such as the parties involved or the duration. The specification of domain-specific term languages is explicitly left open.

In the proposed negotiation protocol, agents can request agreements from domain coordinators, coordinating the resources made available by hosts (resource providers) by issuing an agreement *request* based on available agreements *templates*, which, if accepted, result in new *agreements*.

Hosts, the actual resource providers, also provide an agreement interface to the domain coordinator. The domain coordinator aggregates the templates offered by the hosts into composed templates. The domain coordinator makes these combined templates available to agents. Agreement requests made by agents are received by the domain coordinator. The domain coordinator negotiates an agreement with the hosts for the requested resources.

Figure 2 shows the interaction model between agent and Domain Coordinator. This model extends the original WS-Agreements protocol with two extra interactions: the *request for templates* at the start and the explicit *accept/reject* interaction at the end. The initial *request for templates* allows for the initial exchange of information between agents and a domain coordinator, for example for authentication purposes. The final *accept/reject* interaction allows agents to negotiate with multiple domain coordinators simultaneously, and accept the best offer from the set of offers received.

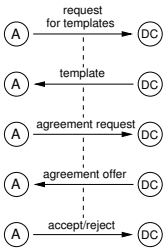

Figure 2: Extended WS-Agreement protocol.

3. AGENTSCAPE

The negotiation architecture described above has been implemented in AgentScape [4, 2], a framework for heterogeneous, mobile agents. The AgentScape middleware creates a distributed environment that supports multiple, mobile agents. Middleware processes running within AgentScape provide services to agents. For example, *agent servers* provide a run-time environment for agents, a *Message Center* enables agents to communicate with other agents, and a *Web service gateway* enables agents to communicate with web services using the SOAP/XML protocol. In AgentScape, virtual domains are called *locations*. An AgentScape location consists of one or more hosts running the AgentScape middleware, typically within a single administrative domain.

In addition to the middleware processes described above, each host has a *host manager* middleware process. This process is responsible for managing the middleware components running on the host, and implementing the required negotiation functionality. Furthermore, each AgentScape location runs a *location manager* process on one of the hosts in the location. This process manages the AgentScape hosts, and implements the functionality of the domain coordinator, enabling agent applications to enter into resource negotiations with locations. Figure 3 shows an overview of an AgentScape location.

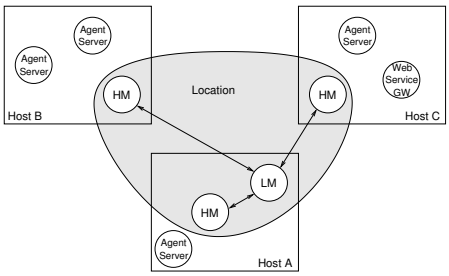

Figure 3: Overview of an AgentScape location.

Agents can start negotiations with a number of locations, and given the offers the locations provide, select the location offering the best options. The agent then migrates to the location with which agreement has been reached. A domain specific ontology used during negotiation describes the resources that can be allocated and used by agents in AgentScape. These resources include: CPU-time, communication bandwidth, memory, web service access, and disk space.

4. REFERENCES

[1] A. Andrieux, K. Czajkowski, A. Dan, K. Keahey, H. Ludwig, T. Nakata, J. Pruyne, J. Rofrano, S. Tuecke, and M. Xu. Web services agreement specification (WS-Agreement) (draft). https://forge.gridforum.org/projects/graap-wg, 2006.

[2] IIDS. AgentScape Agent Middleware. http://www.agentscape.org.

[3] D. G. A. Mobach, B. J. Overeinder, and F. M. T. Brazier. A ws -agreement based resource negotiation framework for mobile agents. *Scalable Computing: Practice and Experience*, 7(1):23–36, 2006.

[4] B. J. Overeinder and F. M. T. Brazier. Scalable middleware environment for agent-based Internet applications. In *Proceedings of the Workshop on State-of-the-Art in Scientific Computing (PARA'04)*, pages 675–679, Copenhagen, Denmark, June 2004. Published in Applied Parallel Computing, LNCS 3732, Springer, Berlin, 2006.