Chapter VII
Agent Feedback Messaging:
A Messaging Infrastructure for Distributed Message Delivery

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ABSTRACT

This chapter presents a generalized messaging infrastructure that can be used for distributed agent systems. The principle of agent feedback messaging, upon which the infrastructure is built, is presented with examples. Agent feedback messaging allows agents to function as an intelligent agent ecosystem that spans multi-node computing clusters and facilitates agent communications in a way that mimics naturally occurring biofeedback mechanisms. An implementation of agent feedback messaging, AFM, is also described. Biosimulation and a solution to the travelling salesman problem are also presented as examples.

INTRODUCTION

Developing an agent communicatons infrastructure that supports scalable multi agent systems will help accelerate the adoption of intelligent agents within AI specializations and industry alike. Unfortunately, however, relatively little work has been done directly on agent communications infrastructures compared to other challenges and opportunities in agent design. There is a large body of literature documenting the application of intellligent agents to solve higher level problems such as knowledge representation (Picard & Gleizes, 2002), beleivability (Bates, 1997), and distributed content management (Zhang & Lesser, 2004). Multi-agent systems applied to business problems such as supply chain management (Hillersberg *et al,* 2004) are also fairly common. Approaches to agent communications and agent organization based on newer network architectures such as wireless networks like Shah, Nixon and Ferguson propose (Shah, Nixon, & Ferguson, 2004) are less commonly found. However, in most of the literature researched for this chapter, the agent systems discussed were developed toward a narrowly focused problem. And very little attention was paid toward developing a general messaging framework that utilizes the

capabilities of networking technologies developed after the year 2000. Finally, no literature is presently found that makes attempts to simultaneously deal with higher level knowledge representation, agent communication, agent organization, and practical modeling of real world processes. Agent feedback messaging aims to provide a single, multi-agent architecture and communications framework that gives agent developers the means to deal with all of these issues. The resulting multi-agent architecture, agent feedback messaging, meets this goal by separating intelligent agents from their message communication infrastructure.

Agent Feedback Messaging achieves scalability in multi agent systems design by functionally separating intelligent agents from their communications infrastructure at the application level. The task of agent communications is relegated to a communications infrastructure. The communications infrastructure runs in its own thread space at the application layer of the network protocol. Agents are not allowed to control other agents or invoke their methods directly. Each agent resides in its own thread space and communicates with other agents by interacting with the communications infrastructure. Agents also listen for responses (feedback) delivered by other agents. Hence, the name of the architecture, agent feedback messaging

How the communication infrastructure sends messages between hosts is an implementation level detail. The example implementation presented in this chapter uses the Internet Inter-Orb Protocol (IIOP) to transmit messages between hosts. The federation design pattern for agents catalogued by Hayden et al (Hayden, Carrick, & Yang, 1999) is the closest example of a similar approach, however in implementation described below, federation is used only to transmit messages between multiple hosts running agents, and not between agents directly.

Agent feedback messaging is an effective way to develop arbitrary ecosystems of cooperating agents and enforces message delivery characteristics that: a) eliminate dependencies between agents; b) removes the need to include network code in agents such as sockets or datagram programming; and, c) allows the physical layer of the network to change without affecting agent functionality.

This chapter will provde you with an understanding of agent feedback messaging and provide

examples of its usage. An implementation is also presented.

AGENT COMMUNICATIONS AND THE PRINCIPLE OF FEEDBACK

Agent feedback messaging is an approach to agent communications that relies on a message transport mechanism which functions independently from the activities of the agents themselves. The idea, in a nutshell, is to remove the burden of communications management from the agents and relegate it to a reliable message delivery subsystem. At the same time, the message delivery subsystem is built to guarantee that messages between agents are delivered according to a well defined set of rules, so that message delivery is both reliable and predictable.

Another key characteristic of agent feedback messaging is the way it allows agent designers to embody naturally occuring and man made processes. This is done by allowing agent developers to break down processes into communities of agents with varying agent granularity. The phases and steps of a given process can also be changed around at will by simply telling each agent what messages it should respond to and what messages it needs to generate. Even the ordering of code execution in a program can be rearranged by dispursing a large program among multiple agents.

Agent feedback messaging also allows agents to appear and disappear at will throughout the agent community without requiring the multi agent system to be stopped and restarted. That is, an agent can appear and dissappear in the system during runtime without disrupting the functioning of the other agents. And finally, agents are able to operate as both service providers and clients to other agents simultaneously.

Agent Feedback Messaging was inspired by the kinds of "communication" that occurs between organs of a human through the cardiovascular system. Consequently, agent feedback messaging can be made clearer if we compare the approach to the cardiovascular system. The cardiovascular system can be seen as the backbone of a large, complex chemical communications infrastructure. It transports nutrients, minerals and oxygn around the body which can be seen as biological messages.

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