Improving Reliability of Intelligent Agents for Network Management*

K. Marcus
Corporate Communication Department
Institut Eurécom
BP 193, 06904 Sophia-Antipolis Cédex , France
marcus@eurecom.fr

The Intelligent Agent technology is being more and more used in treating all kind of information; in the case of network management, where machines monitor machines, a special care must be taken with respect to the reliability of the information.

In the DIANA (Distributed Intelligent Agents for Network Administration) project, the main objective is to achieve network management using Intelligent Agents delegating tasks in a simple and easy way, using mainly the deliberative and reactive properties of agents [1].

The network manager that uses an Intelligent Agents system must trust his agents. He has to be sure all the time that each agent is running and that it has correct and updated information. Of course in most of the distributed agent systems this should be true, but within the network administration domain this is a condition *sine qua non*, since the information collected is used to control the network, to diagnose the connectivity and security states, to change configurations, etc.

Faults in an Intelligent Agent system may occur: hosts going down, congested links, CPU overload, etc. and even the agent code may be corrupted. If an agent is not capable of accomplishing its goals, then either it must be replaced, repaired or the goals he has to achieve should be redistributed to the other agents. Hence, in order not to ruin the management system, the network manager and the system as a whole must be aware of the condition of its components, every possible faulty agent must be discovered as soon as possible, and the actual set of "faulty-free" agents must be known.

We use the System-Level Diagnosis (SLD) to update continuously the knowledge of the reliability degree of the Intelligent Agent system. The SLD model was introduced in [3] to diagnose faulty units in a system. In a nutshell, SLD considers each

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node in a network (in the present case, each agent) as a unit. One unit may test and be tested by the other units, each test is assumed to produce a binary result: faulty or fault-free. The result of all the tests is called the **syndrome**, and the diagnosis is done using the obtained syndrome.

Our algorithm is based on ideas from [2], with an underlying test graph built as described in [3]. Such a test graph was proven [3] to be sufficient to diagnose a system said "one-step diagnosable". In the DIANA project, the system is diagnosable if at least half of the number of agents is reliable; if more than this number are faulty, the system is considered to be undiagnosable and the SLD algorithm will not be able to find which are the faulty and fault-free agents.

Instead of talking about fault-free agents, we will say that an agent is **reliable**, i.e. if the data that it is supposed to possess is correct and updated. This should guarantee that an agent correctly perceives its domain, where **domain** here means the set of network elements the agent is responsible for, and that its data-base matches reality. Some representative elements are chosen in the agent domain, and the information about these elements will be used to test and diagnose the agent.

To each agent will be assigned a test domain, that consists of the agent's own representative elements and the representative elements of its neighbors agents. A minimum set of information must be stored for the elements in the test domain. This set of information must be the same for all agents and all representative elements, so that information may be easily exchanged and compared.

Periodically each agent sends to its neighbors the information it has collected of these neighbor representative elements, and also receives from each neighbor information about the neighbor representative elements. The received information is then compared to the data locally collected. If a certain percentage of the representative elements of one neighbor passes the test, then this neighbor is considered to be reliable.

This algorithm has been implemented in the DIANA project, where agents where designed to monitor the network. The reliability of monitor information was guaranteed by the SLD and the test scheme described above.

References

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