Mobile Agents versus Multicasting for Military Applications

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Abstract: Mobile agents compete with multicasting for applications in distributed military systems. Systems such as unmanned aerial vehicles (UAVS) and automatic target recognition (AiTR) devices utilize intelligent agents to sense the environment and make decisions regarding reporting or firing on a target. Mobile agents migrate between these distributed components and assist in the learning and deductive processes in specifying a military target. By facilitating information overflow from external sensors the mobile agents can make localized decisions based on patterns in the sensor data and profiles. Multicasting consists of publishing and subscribing to messages that are subject tagged and made available with the assistance of a rendezvous router daemon. Since both methods can be used to access and process intelligent sensor data from these distributed information agents this report summarizes a comparison between mobile agents and multicasting.

1 Operation

Tanenbaum defines a mobile agent as a process that can migrate to distributed sites and autonomously interact with the localized processes to obtain a final result that is delivered back to a central command process. [1] Brewington compares the advantages and disadvantages of using mobile agents versus messaging. Table 1 highlights this. [2]

Parameters	Mobile Agents	Remote Procedure Calls
Advantages	More adaptive. Conserves Bandwidth. Not network dependent. Strong mobility. Utilizes agent communication language(ACL)	Faster in code migration, execution and communications. TCP and UDP with exception handling. Does not rely on a specific agent as messages can be multicast on network.

Disadvantages	Slower in code migration, execution and inter agent communication. Not efficient for large systems or constant message updates.	Bandwidth and network dependent. Requires standardized protocols such as GIOP for CORBA, not adaptive. Requires high throughput for messages. Weak mobility.

Table 1
Advantages and Disadvantages of Mobile Agents versus Remote Procedure Calls

2 Applications

The military relies on modeling simulated battlefield environments using tools such as OTBSAF, OneSAF Testbed Baseline where SAF denotes Semi Automated Forces. By working in conjunction with localized intelligent agents that gather target data the mobile agent in a one way exchange updates the Dempster-Shafer algorithms used to provide situational awareness input to OTBSAF. This data consists of the classification of enemy targets in a Distributed Interactive Simulation, DIS, network. [3] Multicasting of messages is then utilized to obtain information pertaining to intent inferencing for predictions of an observed force's high level goals to OTBSAF. [4] As the information agents accumulate and broadcast this sensor data, the final result provides an overall picture of the battlefield conditions regarding avenues of approach, engagement areas, named areas of interest, and courses of action. In order to obtain this intelligence preparation of the battlefield these messages consisting of sensor data are fused at four levels. Levels 0 and 1 provide an identification of target entities. Level 2 aggregates individual entities into larger organizational structures called echelons. Level 3 then makes predictions of the expected behavior, intent and threat of these echelons. Finally, in Level 4 the information acquisition of all levels would be made more efficient. [5] Figure 1 illustrates the interaction of distributed information agents that have specialized data acquisition capabilities. [6] The numbers associated with each message exchange indicates the ordering of the messaging between components. Targets of interest are given an Entity ID by the OTB for tracking and cataloguing.

The X-Sim Manager receives update notifications and then the System Control Agent associates an X-Sim instance with a new OTB entity. Area scans are requested by the Cueing Agent whenever it sends messages to the X-Sim Manager. Any of the service requesting agents such as the Information Fuser Agent, Belief Display Agent or an interface agent can request notifications from the X-Sim Manager.

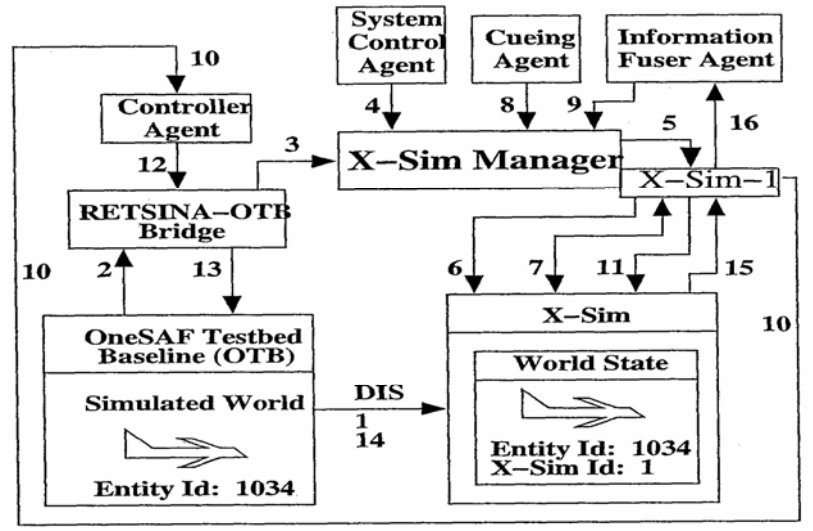

Fig. 1. Integration of OTB, X-Sim, and the Agents

The Controller Agent manages the scheduling of multiple message requests from other agents in this simulation system. Sensor data is published in the form of DIS Protocol Data Units and the X_Sim Manager subscribes to this subject tag.

Mobile agents could be broadcast as reference objects or XML scripts using UDP in order to download algorithmic updates in a one way exchange to a distributed information agent. Because these mobile agents marshal and un-marshal large packets of data or a method they are limited to soft real time applications of 100ms or slower. [7, 8] Because simpler RPC type message calls can be used in multicasting the marshaling and un-marshaling of data is smaller in size and these messages can satisfy hard real time applications that are considered to be of response times faster than 10 ms. [9, 10]

Conclusion

In distributed military systems mobile agents compete with multicasting. Multicasting uses notification services such as publish/subscribe which require a high throughput of messaging. These notification services also require a standardized interface protocol such as GIOP using CORBA which is complex and has a large memory size. But mobile agents have to be broadcast using UDP which CORBA is built upon. The broadcast of either method requires the use of a 128 bit private session key for encrypting and decrypting each message. For hard real time military systems mobile agents are too slow and do not allow constant message updating. Multicasting satisfies these hard real time requirements.

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References

[1] Tanenbaum A., Steen M., Distributed Systems Principles and Paradigms, New Delhi, India: Prentice Hall of India, 2005, pp 158-178

[2] Brewington B., Gray R., Moizumi K., Kotz D., Cybenko G., Rus D., "Mobile Agents for Distributed Information Retrieval", Intelligent Information Agents, pp. 355-395. Berlin: Springer-Verlag, 1999

[3] Yu. B., Sycara K., Giampapa J., Owens S., "Uncertain Information Fusion for Force Aggregation and Classification in Airborne Sensor Networks", AAAI-04 Workshop on Sensor Networks, AAAI Press, July 2004

[4] Glinton R., Giampapa J., Owens S., Sycara K., Grindle C., Lewis M., "Intent Inference Using Potential Field Model of Environmental Influences", Eight International Conference on Information Fusion, IEEE, 3 Park Avenue, 17th Floor, New York NY, July 2005

[5] Glinton R., Giampapa J., Owens S., Sycara K., Grindle C., Lewis M., "Integrating Context for Information Fusion: Automating Intelligence Preparation of the Battlefield", Proceedings of the 5th Conference on Human Performance, Situation Awareness, and Automation Technology, March 2004

[6] Giampapa J., Sycara K., Owens S., Glinton R., Seo Y., Yu B., "An Agent-Based C4ISR Test Bed", Eight International Conference on Information Fusion, IEEE, 3 Park Avenue, 17th Floor, New York NY, July 2005

[7] Nalla A., Helal A., Renganarayanan V., "aZIMAs – almost Zero Infrastructure Mobile Agent Systems", page 6, http://www.icta.ufl.edu/projects/publications/azima.pdf

[8] Jiao Yu., Hurson A., "Mobile Agents in Mobile Heterogeneous Database Environment – Performance and Power Consumption Analysis," p. 5, http://www.scs.org/scsarchive/getDoc.4m?id=1674

[9] Douglass B., Doing Hard Time, Developing Real-Time Systems with UML, Objects, Frameworks, and Patterns, Reading MA., Addison-Wesley, 2000, ch. 11

[10] Berding D., "White Paper: Distributed Computing Environment", http://www-306.ibm.com/software/network/dce/library/whitepapers/dceaixperf.html