Role of Multiagent System on Minimalist Infrastructure for Service Provisioning in Ad-Hoc Networks for Emergencies

Juan R. Velasco
Miguel A. López-Carmona
Departamento de Automática
Universidad de Alcalá
Edificio Politécnico – Crtra N-II, Km. 31,600 – 28871 Alcalá de Henares (Spain)
{juanra|miguellop}@aut.uah.es

Marifeli Sedano
Mercedes Garijo
Departamento de Ingeniería de Sistemas Telematicos
Universidad Politécnica de Madrid
ETSI Telecomunicación – Ciudad Universitaria, s/n – 28040 Madrid (Spain)
{marifeli|mga}@dit.upm.es

David Larrabeiti
María Calderón
Departamento de Ingeniería Telemática
Universidad Carlos III de Madrid
Escuela Politécnica Superior – Av. Universidad, 30 – 28911 Leganés (Spain)
{dlarra,maria}@it.uc3m.es

ABSTRACT
In this position paper, the agent technology used in the IMPROVISA project to deploy and operate emergency networks is presented. The paper begins by describing the main goals and the approach of IMPROVISA. Then we make a brief overview of the advantages of using agent technology for the fast deployment of ad-hoc networks in emergency situations.

Categories and Subject Descriptors
C.3 [Special-Purpose And Application-Based Systems] - Real-Time and Embedded Systems

General Terms
Performance, Security, Human Factors.

Keywords
Catastrophes; multi-agent systems; semantic ad-hoc networks; intelligent routing; multilayer-multipath video transmission.

1. INTRODUCTION
IMPROVISA Project (from the Spanish translation of "Minimalist Infrastructure for Service Provisioning in Ad-hoc networks") addresses the issue of real service provisioning in scenarios lacking a fixed communications infrastructure, where the cooperation of humans and electronic devices (computers, sensors/actors, robots, intelligent nodes, etc) is paramount. As an example of this sort of scenario, emergency management in natural catastrophes will be used. Besides fixed infrastructure such as cellular 3G networks, for mobility reasons we shall also exclude satellite communications from the target scenario – although it may be available in a subset of nodes–. This assumption is specially valid for in-door rescue squadrons, communication with personal devices, or in dense forest zones.

This target scenario introduces a number of challenges at all layers of the communication stack. Physical and link layers are still under study and rely mainly on the usage of technologies such as OFDM (Orthogonal Frequency Division Multiplexing), phased-array antennas, and FEC (Forward Error Correction) techniques. Technological solutions to the routing problem can be found in the field of ad-hoc networking. Mobile Ad-hoc Networks (MANETs) [5] are made up of a set of heterogeneous, autonomous and self-organising mobile nodes interconnected through wireless technologies. Up to the date, most of the research in MANETs has focused on the design of scalable routing protocols. However, very few complete prototype platforms have shown the effectiveness of the ad-hoc approach for emergency support.

This project is focused on the development of real concrete application-oriented architectures, by the synergic integration of technologies covering practical ad-hoc networking, security frameworks, improved multimedia delivery, service-oriented computing and intelligent agent platforms that enable the deployment of context-aware networked information systems and decision support tools in the target scenario. This position paper focuses on the role of the multiagent system into the main architecture.

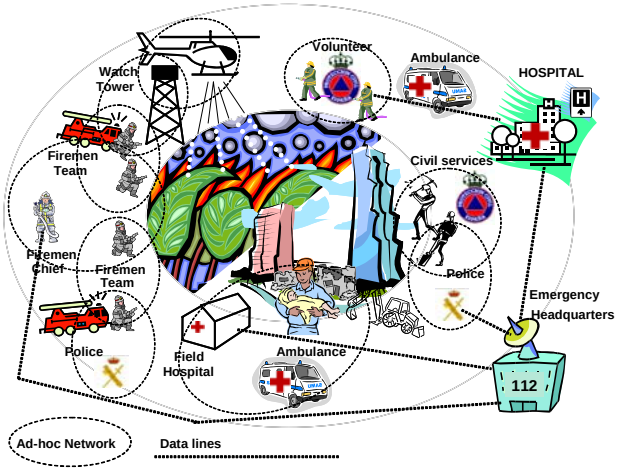

Figure 1 Networks for disaster management

Figure 1 shows how different groups of professional and volunteer workers act together to solve a natural catastrophe. Computers (in different shapes) are everywhere: every worker has their own PDA; cars, ambulances or helicopters have specific computer and communication systems; and central points, like hospital, army or civil care units have their main servers. The goal of the project is to develop a general architecture that may be used over any situation where conventional communications are not allowed: apart from disasters, during terrorist attacks GSM communications are disabled to prevent GSM-based bomb activation.

2. AD-HOC NETWORKS AND MULTI-AGENT SYSTEMS

Agents may be used into three main aspects:

One of the main problems on ad-hoc networks is how to route information across the network ([9] and [2]). In our scenario, different groups may be far one from the other, so routing problem has to deal with separate ad-hoc networks. We plan to work over intelligent routing and the use of an upper level intelligent system to use other mobile systems, like cars or helicopters that move over the area to "transport" data among the separate ad-hoc networks. In this case, security is one of the most important aspects. [4] and [13] propose some good starting points for our security research, both on trust and intrusion detection.

On most of these scenarios, video transmission [11][12] is a must (remote medical support, dynamic maps displaying the location of potential risks, resources, other mobile units, fire advance, wind direction, remote control of robots, etc.). Ad-hoc networks provide new challenges for multilayer-multipath video distribution due to the typically asymmetric transmission conditions of the radio channels and the possibility of exploiting path multiplicity in search of increased performance (video quality and resilience).

Communication support is needed, but not enough to create a useful ad-hoc network. In order to develop an efficient application level, an expressive language and a service discovery protocol are needed. These kinds of solutions are available for fixed networks. This project will provide an agent-based intelligent level to support ad-hoc semantic web. [10] presents a first approach to adapt conventional semantic web languages to ad-hoc networks, that may be useful as starting point.

Analyzing the main goals of the project, agent technology appears to be the best option to support the system infrastructure. While the first idea may be use of a well known agent platform, like JADE [8] (that researchers have used for several projects, fruitfully), that complies with FIPA standards [3] and has a version suitable for small devices, like PDA's (JADE-LEAP), ad-hoc networks have special aspects that make us believe that FIPA standard architecture, that is implemented by JADE, is not directly useful. There is a proposal (still on an initial stage) to adapt FIPA agents to ad-hoc networks [1]. While it seems to be a valid proposal from a theoretical point of view, there are some practical issues that make difficult its implementation. We propose the design and implementation of a specific architectural extension to FIPA/FADE to enhance the scope of application of this sort of agents to the proposed scenario. Main project researchers have long experience on agent platform [7] and methodology design [6]; previous research project results will be taken into account.

3. CONCLUSIONS

Multi-agent systems may be used to provide an intelligent layer for an ad-hoc network over computer systems. IMPROVISA project will use agent technology on three main aspects: ad-hoc network routing, multilayer-multipath video transmission and semantic ad-hoc networks. The project plans to deliver an integrated demonstration platform to assess the real applicability and added-value of the ad-hoc approach.

4. ACKNOWLEDGMENTS

This work is being funded by Spanish Education Ministry under project IMPROVISA (TSI2005-07384-C03)

5. REFERENCES

[1] Berger, M. and Watkze, M.: AdHoc Proposal – Reviewed Draft for FIPA 25. Response to 1st AdHoc Call for Technology, May 2002. <http://www.fipa.org/docs/input/f-in-00064>.

[2] Clausen, T. and Jacquet, P.: Optimized Link State Routing Protocol . IETF RFC 3626, 2003.

[3] FIPA: FIPA Homepage. <http://www.fipa.org>.

[4] Hu, Y.-C., Johnson, D. B. and Perrig, A.: SEAD: secure efficient distance vector routing for mobile wireless ad hoc networks. *4th IEEE Workshop on Mobile Computing Systems and Applications* (WM-CSA'02), 2002a, pp 3-13.

[5] IETF, MANET Working Group: Mobile Ad-hoc Networks. <http://www.ietf.org/html.charters/manet-charter.html> .

[6] Iglesias, C. A., Garijo, M., González, J.C., and Velasco, J. R. 1998. Analysis and Design of Multiagent Systems Using MAS-Common KADS. *4th international Workshop on intelligent Agents Iv, Agent theories, Architectures, and Languages*. LNCS, vol. 1365, pp 313-327.

[7] Iglesias, C.A., Gonzalez, J.C., and Velasco, J.R. MIX: A General Purpose Multiagent Architecture. *Intelligent Agents II. Second International Workshop on Agent Theories, Architectures, and Languages*, LNAI 1037. August 1995

[8] JADE: JADE Homepage. <http://jade.cselt.it>.

[9] Johnson, D.B., Maltz, D.A. and Hu, Y.-C.: The Dynamic Source Routing Protocol for Mobile Ad-Hoc Networks (DSR). Internet Draft: draft-ietf-manet-dsr-09.txt, IETF MANET Working Group,15 April 2003.

[10] König-Ries, B. and Klein, M.: *First AKT Workshop on Semantic Web Services*. 2004,. <http://www.ipd.uka.de/DIANE/docs/AKT-SWS2004-Position.pdf>.

[11] Liang, Y.J., Steinbach, E.G. and Girod, B.: Real-Time Voice Communication over the Internet using Packet Path Diversity. *Proc. ACM Multimedia*, Sept 2001, pp. 777-792.

[12] Miu, A. et al.: Low-latency Wireless Video over 802.11 Networks using Path diversity. *IEEE ICME*, 2003, 441-444.

[13] Ramanujan, R., Ahamad, A., Bonney, J., Hagelstrom, R. and Thurber, K.: Techniques for intrusión-resistant ad hoc routing algorithms (TIARA). *IEEE Military Communications Conference (MILCOM´02)*, 2002, vol 2, pp.890-894