Intelligent Agents and UICDS

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Introduction

UICDS is a prototype system being developed for the Department of Homeland Security (DHS) Science & Technology (S&T) Directorate [1]. UICDS will provide a middleware foundation supporting better information awareness and sharing between commercial and government incident management systems to prevent, protect, respond, and recover from emergency and catastrophic situations. Its current architecture is founded on design requirements from the National Response Framework [2], National Incident Management System [3] and the Incident Command System [4].

The aim of UICDS is to allow emergency responders to capture important incident-related information, analyze captured information, more effectively disseminate mission critical information to emergency responders, present decision guidance options for emergency response community, effectively coordinate efforts of emergency responders, and store incident related information for analysis.

Background

In the era of mainframe computing, companies and applications were typically command-and-control oriented and organized in vertical silos. With the coming of high-speed Internet and ubiquitous computing, the playing field has been flattened. New practices may then evolve that encourage less vertical command and control and more horizontal connecting, collaborating, and competing as peers.

At the same time, web services have opened up a whole new domain of heterogeneous information and transactional functionality between diverse world-wide interests.

However, while web services exhibit a certain amount of openness and autonomy, they are still built on a passive, hierarchical, client/server modality. They are islands of functionality much like a cashier at a store that simply rings up customers in order to complete a sales transaction. A shopper, on the other hand, may go from store to store to find the best deal at the right quality and initiate a buying transaction when it has found what it wants. Likewise, a buyer may look for shoppers that want their product at a reasonable profit in a timeframe when it is available to be delivered. While it may be possible to

manage all cashiers, there is no centralized controller that can manage all shoppers and buyers on an internet-wide basis. There may simply be too many, they are too complex, and too dynamic at very large scales.

Agents and Multi-Agent Systems (MAS)

Many definitions of agents exist, and there is still no complete consensus as to what mandatory characteristics an agent must have. In theory, agents are capable of autonomous decision making and action in order to satisfy their goals. They can interact and react with their environment, including with other agents and humans, to coordinate, cooperate, and negotiate by means of messaging. Some agent systems are built on a simple activity or workflow paradigm; some are built on cognitive reasoning and/or expert systems; some include neither. However, all platforms encompass the ability of agents to process and communicate in a parallel, autonomous, and distributive fashion instead of simply a hierarchical client/server fashion. There no longer has to be just one centralized controller.

Intelligent Agents

We use the term *intelligent agents* (IA) somewhat loosely and intend it to include a range of techniques that include both automated and semi-automated approaches [5]. Some of this work is already being done by other UICDS contractors. In particular, examples of IA technologies which might be appropriate for IUCDS include the following.

- *Multiagent system techniques* for coordination and collaboration, e.g., for negotiation and for argumentation to resolve conflicting assumptions or information.
- *Interface agents* that learn user preferences both explicitly and implicitly and use these to better support user interactions.
- *Learning agents* that build, maintain and use classifiers to classify incidents, notifications and users.
- *Context agents* that integrate information from multiple sources to provide an overall context for individual incidents or a set of incidents occurring in or impacting a region.
- *Visualization agents* that integrate and fuse relevant information from different data sources into a timeline or geo-political view.
- *Information extraction agents* that can extract semantic information from the text in incident reports, notifications and related news sources, including named entities (references to people, places and organizations) as well as simple relations between them and events in which they participate.

Adding more Intelligence to UICDS

Here we briefly describe some functions and services that exhibit more 'intelligence' that could be added to UICDS. Not all of these can or should be done. We'll need more study to evaluate the ideas and get feedback from DHS and SIAC as to which of them will be most useful to do.

- Adding a thumbs up and thumbs down on the human interface for alerts and notifications so that the user can indicate if the notifications were helpful or desirable . This data could then be used to adapt the distribution rules.
- Adding collaborative filtering to suggest new notifications that someone might want to sign up for. "Responders like you also have subscribed to X and Y" or "Responders who subside to X often subscribe to Y as well."
- Use machine learning (probably SVM) to build classifiers for incident reports and other documents. Possible targets for the classification categories might be: level of urgency, topics, etc. These can be used to assign different features to the reports and notices.
- Figure out if there are some practical planning work we can draw on, especially distributed planning involving several units that need to coordinate their activities to respond to several unfolding events.

Summary

The ability of agents to perform logistical and scheduling support has been well proven. However, these systems have typically been encased inside of a closed architecture. More recent research has greatly pushed the ability of agents and agent platforms, not only to co-exist in a web-based world with open architecture, but to extend that world. Agents can not only used web services, but can dynamically become web services themselves. There have been great strides made in developing agent applications in business-to-business and business-to-customer applications to orchestrate and coordinate new compositions of services dynamically using newer web service standards such as BPEL (Business Process Execution Language). UICDS SOA architecture may be greatly enhanced by the use of agents to coordinate, integrate, and collaborate with the information that has been shared by organizations involved in emergency response.

References

1. Morentz JW. Unified Incident Command and Decision Support (UICDS): A Department of Homeland Security Initiative in Information Sharing. Conference on Technologies for Homeland Security, 2008 IEEE;: 321-326.

2. NRF Resource Center. Retrieved from < http://www.fema.gov/emergency/nrf/> on July 21, 2009.

3. NIMS Resource Center. Retrieved from <http://www.fema.gov/emergency/nims/> on July 21, 2009.

4. Incident Command System. Retrieved from <http://www.fema.gov/emergency/nims/IncidentCommandSystem.shtm> on July 21, 2009.

5. Russell, Stuart J.; Norvig, Peter (2003), Artificial Intelligence: A Modern Approach (2nd ed.), Upper Saddle River, NJ: Prentice Hall.