

GCCM: Map-mediated Collaboration among Emergency Operation Centers and Mobile Teams

Guoray Cai

School of Information Sciences and Technology
Pennsylvania State University, University Park, PA 16802
Email: cai@ist.psu.edu

Alan M. MacEachren

Department of Geography
Pennsylvania State University, University Park, PA 16802
Email: maceachren@psu.edu

Levent Bolelli

Department of Computer Science and Engineering
Pennsylvania State University, University Park, PA 16802
Email: lub7@psu.edu

Managing crises requires collecting geographical intelligence and making spatial decisions through collaborative efforts among multiple agencies and task forces. Typically, one or more emergency operation centers (EOCs) work in cooperation with teams of field responders through communication of the situation and coordination of actions. In such collaborative processes, maps, when shared, can be an ideal media to facilitate the construction of team knowledge, and coordinate perspectives, as maps encourage efficient communication of knowledge, perceptions, judgment, and actions. Paper or electronic maps have been used in collaborative work environments. Unfortunately, current geographical information technologies are not designed for use by such collaborative applications. They were used mainly by technical experts in single user environment where desktop GUI interfaces are the norm. Among many impediments for wider use of GIS in crisis management (as identified in the literature (Zerger and Smith 2003)), the lack of support for same-time, different-place collaboration is a fundamental one.

We believe that geographical information science has much to offer to the development of collaboration technologies in terms of managing team knowledge and coordinate team actions. Towards this end, our current research focuses on a special case of collaborative

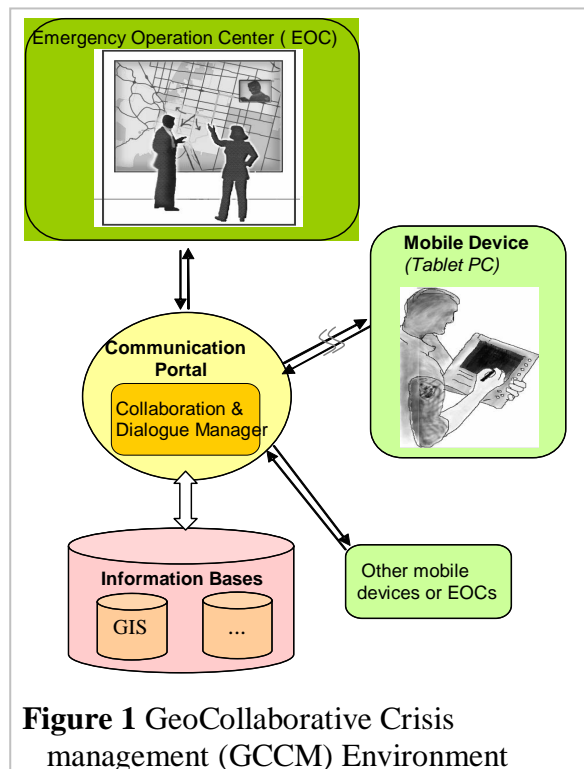


Figure 1 GeoCollaborative Crisis management (GCCM) Environment

applications commonly found in crisis management. Particular emphasis is given to the role of maps as visual mediator of communication and collaboration among distributed team players. This paper will describe our ongoing effort in developing a dialogue-enabled collaborative environment, called GCCM (*GeoCollaborative Crisis Management*) (see Figure 1). GCCM is a distributed multi-agent system that is designed to mediate collaborative activities among emergency managers in EOCs and first responders in the fields. It captures the mental states of participants and reasons about the role of maps in order to determine its contents, presentation format, and sharing requirements. The behavior of such a geocollaborative environment is exemplified through the analysis of a short session of EOC-mobile team collaboration.

Approach Group work with geographical information are not easily supported by the current GIS due to two problems. First, we still have limited knowledge about the dynamics of group work and the roles of maps during group activities. Earlier efforts by Armstrong and Densham (Armstrong et al. 1992, Armstrong and Densham 1995) revealed that there are a set of distinguishable map types during the process of making comparisons among alternative facility location scenarios. Jankowski and Nyerges (Jankowski and Nyerges 2001) found that maps were used more often in the phases of decision-making that involved conflict, thus those phases in which different perspectives needed to be represented, compared, and (perhaps) reconciled. Recently, MacEachren and Brewer (MacEachren and Brewer 2004) proposed three functions for visual signification in group work with geospatial information. Visual signification can be used as: shared *objects to talk about* (to signify the object of collaboration), shared *objects to think with* (to signify components of group knowledge and thinking), and shared *objects to coordinate perspectives and actions* (to signify components of group activity). These findings, although useful for categorize the types of map-related group work, have not been very informative on exactly how map works in collaborative activities from a computing perspective. The current work extends and refines previous findings by demonstrating that it is possible to enable map-mediated collaborations through multimodal dialogues.

Our approach for the mediation of human collaboration integrates the cognitive-semiotic approach sketched by MacEachren (MacEachren 1995) with collaborative discourse theories (Grosz and Sidner 1986, Grosz and Kraus 1996, Lochbaum 1998) developed in computational linguistics. Cognitive-semiotic theories characterize human interactions with maps as iterative process of human signification, sensing, interpreting, and knowledge construction processes. These cognitive processes are deeply contextualized by the collaborative activities of the group and the status of the discourse. In the same time, human collaboration involves communication to establish common grounds and joint action plans. Collaborative discourse theory models communication processes as intention-driven human behavior that can be understood by the underlying collaborative plans.

Architecture and Settings. GCCM is implemented as a number of cooperative modules as depicted in Figure 2. More detail will be given in the conference presentation. The person in front of large-screen display (at EOC) interacts with the map using speech and free-hand gestures. A second team member (at the simulated incident location) interacts with the same map using a tablet PC and the third collaborator (i.e., a transportation manager) participates in the activity from a desktop computer. Each team member can interact with the map and with each other multimodally. A wireless LAN is set up to enable communication between mobile devices and remote hosts. Here, users are organized by their roles in order to account for the dynamics of team formations. In the EOC setting, user's speech and free-hand gestures are captured by a multimodal interface platform, GeoMIP (Agrawal et al. 2004), while first responders in the field use pen-based gestures and speech for interaction. The desktop computer setting captures gestures from the user's mouse drawing events on the map display. Upon recognition of multimodal requests, the client application sends the request to the Communication Portal (CP) where the request goes through the authentication control and access control using stored profiles. *Session management* will identify the corresponding collaborative session, and determine the relationships between that session and other instantiated sessions. Such relationships are represented as a collaboration network, which indicates the inheritance rules among all sessions. Each session has its own discourse context, and can be either private or shared. *Collaboration management* is responsible for reflecting any changes on the maps and mediating communications between clients in real-time.

The *dialogue-manager* is built using an agent-based framework. It models human-map dialogue and human-human communications within a task as a collaborative discourse, which represents each individual's and group's intentions, actions and their contributions to the collaborative task. A detailed discussion about the implementation can be found in (Cai et al. 2004).

Functionalities. We use a hypothetical scenario for a typical crisis event as the way to demonstrate the functionalities

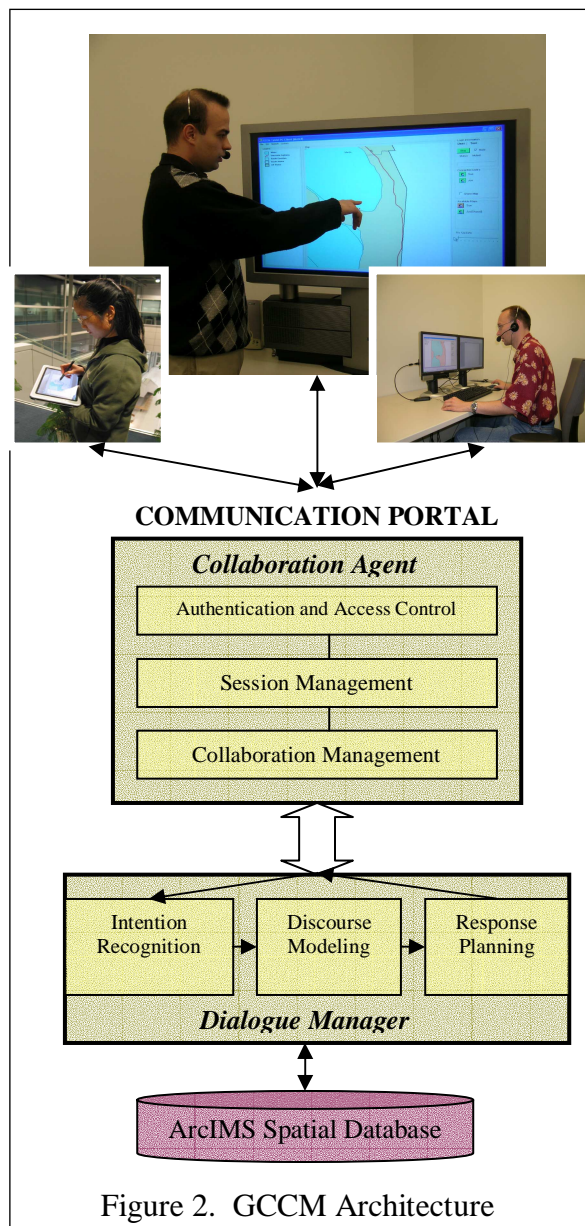


Figure 2. GCCM Architecture

of GCCM.

A category 4 hurricane has struck the south east part of Florida, potentially causing flooding that affects a number of counties along the coastal area. While evacuation alerts have been sent out to affected communities, state and local emergency management forces must make sure that all residents evacuate in time and (if needed) find shelter in designated facilities.

While he was searching a residential area in Palm Beach county, Matt (a member of the first responder team) found a group of people who need assistance getting to a shelter. These people are elderly and some have serious health care needs.

In the EOC, a manager, Sue, and her assistant, Dave, have access to a large-screen display which shows the overall situation in the whole flooded region. They get reports from multiple sources (sensors, satellite, 911 phone calls, field reports) and have the responsibility to help field team.

During this collaboration, GCCM works as a mediator that maintains synchronized actions and common ground across the team and subteams.

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