Workflow Management Systems in MANETs

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INTRODUCTION

The widespread availability of network-enabled handheld devices (e.g., PDAs with WiFi) has made *pervasive computing* environment development an emerging reality. Mobile (or multi-hop) Ad-hoc NETworks (MANETs—Agrawal & Zeng, 2003) are mobile device networks communicating via wireless links without relying on an underlying infrastructure. Each device in a MANET acts as an endpoint and as a router forwarding messages to devices within radio range. MANETs are a sound alternative to infrastructure-based networks whenever the infrastructure is lacking or unusable, for example, military applications, disaster/relief, emergency situations, and communication between vehicles.

Generally, the use of a MANET requires a strong collaboration among users/devices constituting the network; more often, that collaboration is translated into a list of activities executed in sequence or concurrently by applications running on mobile devices, thus resulting in *cooperative works*. Therefore, in such situations, MANET users would benefit from software supporting their collaboration. Such a *coordination software* would enable them to execute their *activities* through specific applications—for example, computer-supported cooperative work tools (Grudin, 1994), *workflow management* applications (Leymann & Roller, 2000), and so forth—running on handheld devices, thus enabling cooperative processes to be run. All such applications typically require continuous inter-device connections (e.g., for data/information sharing, activity scheduling and coordination, etc.), but these are not generally guaranteed in MANETs, due to the high mobility of the nodes in the network.

Collaborative Scenarios

Consider a scenario of emergency situations, for example, the case of an aftermath of an archeological disaster. A team is equipped with mobile devices (laptops and PDAs) and sent to the affected area to evaluate the condition of archeological sites and buildings, with the goal of drawing a situation map to schedule rebuilding activities. A typical cooperative process to be enacted by the team would be as shown in Figure 1 (depicted as a UML Activity Diagram—De Rosa, Malizia, & Mecella, 2005):

1. The team leader has previously stored all area details (not included in the process), including a site map, a list of the most important objects located in the site, and previous reports/materials.
2. The team is considered as an overall MANET, in which the team leader's device (requiring the most computing power, therefore usually a laptop) coordinates the other team members' devices, by providing suitable information (e.g., maps, sensitive objects, etc.) and assigning activities/tasks.
3. Team members are equipped with handheld devices (PDAs), which allow them to run some operations but do not have much computing power. Such operations, possibly involving various hardware items (e.g., digital cameras, GPRS connections, computing power for image processing, main storage, etc.) are provided as software services to be coordinated. Team member 1 might fill in some specific questionnaires (after a visual analysis of a building), to be analyzed by the team leader using specific software in order to schedule subsequent activities; team member 3 might take pictures of the damaged buildings, while team member 2 may be responsible for specific processing of previous and recent pictures (e.g., for initial identification of architectural anomalies).

In this case, it might be useful to match new pictures with previously stored images. The device holding the high-resolution camera must therefore be connected to the one containing the stored pictures. But in a situation such as the one shown in Figure 2, the movement of the operator/device equipped with the camera may result in its disconnection from the others.

A pervasive architecture should be able to predict such a situation, alert the coordination layer, and possibly have a

Figure 1. Cooperative process

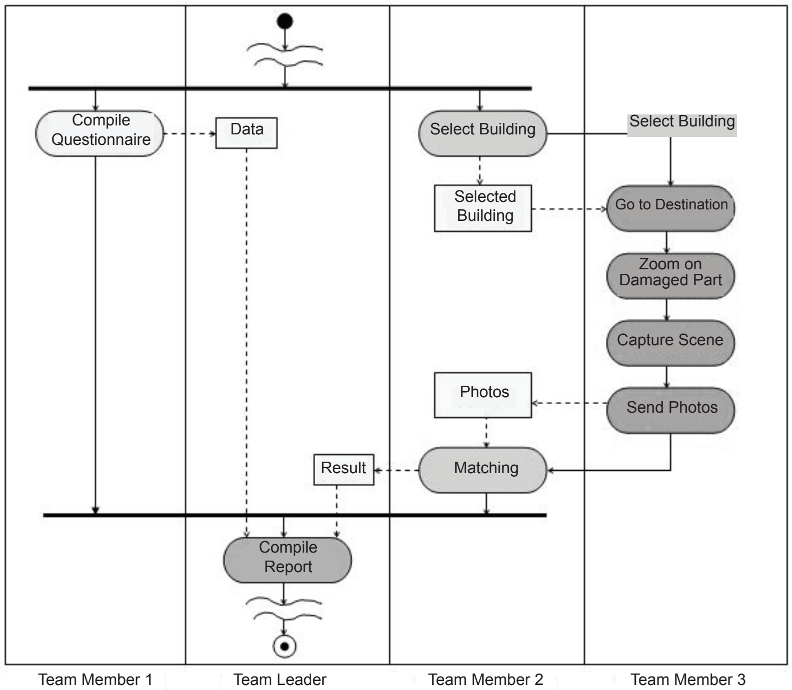
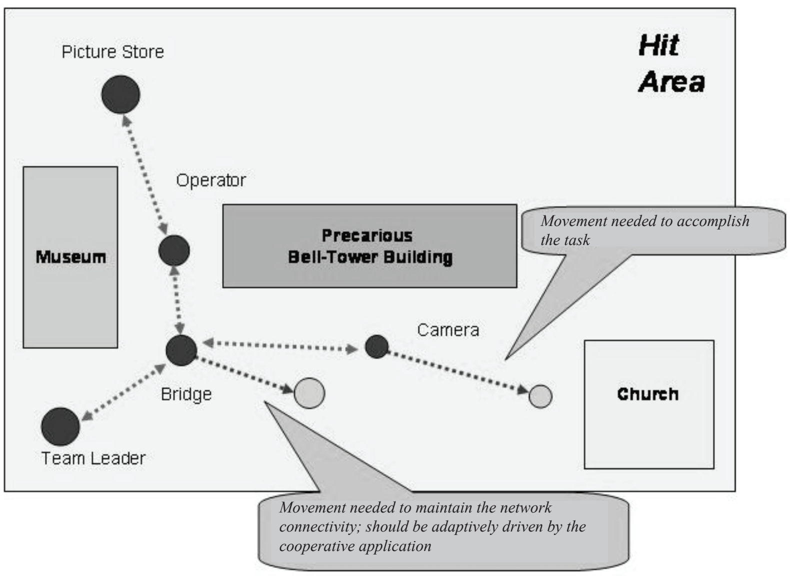


Figure 2. Critical situation and adaptive management



"*bridging*" device (team member 4's device) to follow the operator/device moving out of range, maintaining the connection, and ensuring a path between devices. In this way the coordination layer schedules the execution of new activities based on the prediction of a disconnection, as shown in Figure 3 (note the new activity for team member 4).

The process's adaptive change is centrally managed by the coordination layer, which has "global" knowledge of the status of all operators/devices and takes into account idle devices, operations that can be safely delayed, and so forth.

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