

# Pervasive Patient Tracking for Mass Casualty Incident Response

Alexander M. Alm, Tia Gao, MS, David White, PhD

Johns Hopkins University Applied Physics Laboratory, Laurel, MD, USA

*Transportation officers at mass casualty incidents are faced with the daunting task of tracking large amounts of patients as they leave the disaster scene. Patients often leave under their own power without notifying any authorities, presenting an organizational problem for personnel attempting to account for every patient they have treated. This paper describes a system to provide seamless tracking of patients at disasters and en route to hospitals using electronic triage tags registered with an external database.*

## Background

A major challenge for disaster response information systems is to provide capabilities without being obtrusive to the already overburdened responders. The Advanced Health and Disaster Aid Network (AID-N) has developed electronic triage tags that provide ubiquitous and automated geolocation of patients in both indoor and outdoor settings. When patients are tagged with electronic triage tags, they are automatically tracked by the software system, with no additional input from the medics is required. The tags, based upon the smart dust hardware platform, are small, lightweight, easy to apply, and cost-effective for easy employment at mass casualty disasters. Unlike GPS-based tracking technologies, these tags are low-power and do not require a clear line of sight. To this end, AID-N provides a sophisticated patient tracking mechanism that meets the needs of the emergency responders.

## Implementation

After any MCI, emergency response services are required to account for any patients they registered at the disaster scene. The current system requires a transportation officer at the scene to fill out a form with patient details and destination information each time a patient is put in an ambulance. However, during a chaotic disaster scene, the overwhelmed responders often neglect to fill out the paperwork or lose the paperwork. Under our new system, all of the patient locality logging is electronic and automated. Emergency personnel can now locate any patient from a MCI in real-time, instead of waiting until after the MCI is concluded.

The location of patients wearing tags is based on the proximity of the tags to: 1) handheld device carried by nomadic medics, 2) base stations laptops installed inside ambulances coming in and out of the disaster site, 3) laptops stationed at designated zones of the disaster site, and 4) other tags in the wireless mesh network. Each base station and handheld device is equipped with a GPS sensor. Indoor geolocation beacons are being installed at designated triage and treatment centers in the Washington, DC metropolitan area to provide detailed

indoor location data with 1 meter resolution. Our tracking technology is integrated with Michaels, an existing patient management system installed in all ALS ambulances in Arlington, VA.

When a patient is triaged and their tag is turned on, the nearest base station registers that patient as residing nearby. Each tag contains a unique identification number that specifies a patient within the system. The base station sends the location information and unique ID of a patient to an external server that is then accessed remotely by emergency response personnel.

Laptops, acting as base stations inside ambulances, are equipped with GPS receivers to allow the ambulances to be tracked when they are traveling between hospitals and the disaster. GPS receivers use the SiRFstarIII chipset to acquire signals down to -159dB, thus making pervasive patient tracking possible by its ability to acquire GPS satellite signals in diverse environments such as indoor settings and urban canyons. GPS data is sent to the server and then relayed to emergency response officers responsible for coordinating resources at the scene. This helps transportation officers, charged with the task of preparing patients for transport to a hospital, by giving them information on exactly when an ambulance is going to arrive.



**Figure 1.** Information flow of geolocation data between patients, ambulances, and providers

## Conclusion

We have successfully created a system to track patients at a disaster scene and during transport to hospitals in a non-intrusive manner. This system allows first responders, emergency departments, and transportation officers to locate any patient at a MCI at any time for any reason they may have and guarantees that patients do not get lost or forgotten during or after a MCI.