Center for Transportation Analysis
Research Brief

Oak Ridge National Laboratory

Real-Time Traffic Information for Emergency Evacuation Operations

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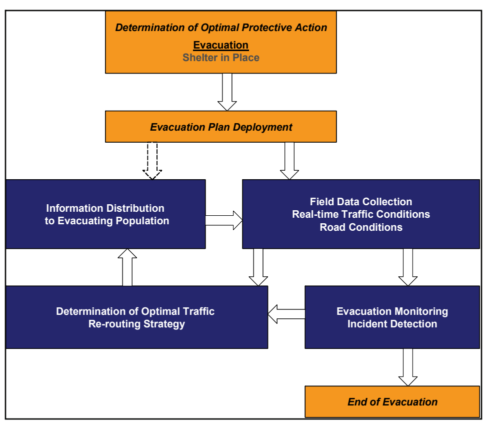
There are many instances in which it is possible to plan ahead for an emergency evacuation (e.g., an explosion at a chemical processing facility). For those cases, if an accident (or an attack) were to happen, then the best evacuation plan for the prevailing network and weather conditions would be deployed. In other cases (e.g., the derailment of a train transporting hazardous materials), there may not be any previously developed plan to be implemented and decisions must be made ad-hoc on how to proceed with an emergency evacuation.



Evacuation operations process.

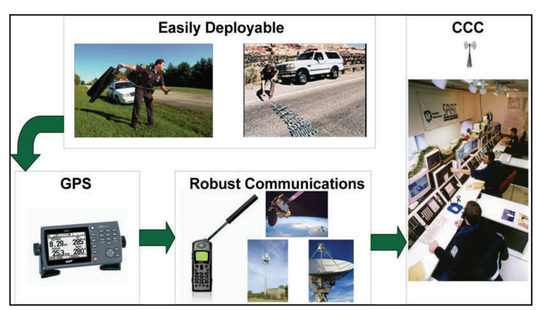
In both situations, the availability of real-time traffic information plays a critical role in the management of the evacuation operations. To improve public safety during a vehicular emergency evacuation it is necessary to detect losses of road capacity (due to incidents, for example) as early as possible. Once these bottlenecks are identified, re-routing strategies must be determined in real-time and deployed in the field to help dissipate the congestion and increase the efficiency of the evacuation.

Due to cost constraints, only large urban areas have traffic sensor deployments that permit access to some sort of real-time traffic information; any evacuation taking place in any other areas of the country would have to proceed without real-time traffic information. The latter is the focus of this project.

Objectives

The main objective of this project is on improving the operations during a vehicular emergency evacuation anywhere in the country by using newly developed real-time traffic information gathering technologies to assess traffic conditions and to detect incidents on the main evacuation routes.

The proposed system is composed of detectors that are engineered in such a way that they can be rapidly deployed in the field (e.g., taped to the roadway or through other means) at key points. Each one of these fast-deployable sensors is equipped with Global Position System (GPS) devices to auto-determine their spatial location on the transportation network under surveillance, and will assess traffic parameters by identifying specific vehicles in the traffic stream. The system of sensors will transmit through satellite links, or other robust communication means, real-time traffic information to a command and control center (CCC), including travel time and traffic volumes on each instrumented segment of roadway.



Traffic sensor system for emergency evacuations.

Benefits

The benefits that this project may help realize lay mainly on the response and recovery functions. Information gathering

Patricia S. Hu, Director
Center for Transportation Analysis
Oak Ridge National Laboratory
2360 Cherahala Boulevard
Knoxville, TN 37932
865.946.1349
(Fax) 865.946.1314

Website: cta.ornl.gov

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and distribution plays a critical role in the response phase since it is paramount to determine the status of the transportation system to help with the decision process and field operations (e.g., routing emergency vehicles around congested areas). The system developed can collect and provide traffic information in real or near-real time for both the system managers (transportation agencies, emergency management agencies, law enforcement agencies, fire and rescue agencies, emergency medical service providers, 911 dispatchers, and towing companies) and the public. The technology proposed in this project will augment existing Intelligent Transportation Systems deployments where available (usually, freeways in large urbanized areas), being in the remaining cases (e.g., arterials in instrumented urban areas, non-instrumented urban areas, and rural areas) the sole source of real-time traffic information. Since the same technologies and capabilities used during the response stage are applicable to the recovery phase, the system being developed will also provide aid in that phase.

Current Research and Development

Phase A of the project consisted in the development and testing of a prototype system composed of sensors that are engineered in such a way that they can be rapidly deployed in the field where and when they are needed. Each one of these sensors is also equipped with their own power supply and a GPS device to auto-determine its spatial location on the transportation network under surveillance. The system is capable of assessing traffic parameters by identifying and re-identifying vehicles in the traffic stream as those vehicles travel on top of the detectors. The system of sensors transmits, through wireless communication, real-time traffic information (travel time and other parameters) to a command and control center.

Sensor controller, location, and communication box.

The first part of the project centered on the development of the prototype system and a methodology to conduct an assessment of its capabilities. After that, ORNL in conjunction with Mississippi State University (MSU) conducted a series of tests, both in a controlled environment and in the field, to study the feasibility of rapidly deploying the system of traffic sensors and to assess its ability to provide real-time traffic information during an emergency evacuation. Specifically, the tests were aimed at evaluating the performance of the system of sensors under various traffic and weather conditions, and roadway environments. The controlled tests (i.e., deployment and testing of the prototype system in a parking lot with a very limited traffic) were performed first and the results obtained served as the basis to identify flaws in the system and make the necessary corrections to the prototype.

The working prototype that resulted from these R&D activities was then subjected to a series of real-world environment tests (Field Operation Tests, or FOTs). Those FOTs, which were aimed at studying the reliability and accuracy of the system in a more prolonged time frame, were conducted at two sites: Knoxville, Tennessee (using traffic in and out of an office complex during an entire week) and Starkville, Mississippi at the MSU campus (using traffic generated during college and high school commencements). The latter, although not exactly the same as an emergency evacuation, provided the opportunity to create scenarios that have many characteristics (e.g., congested roads) that are similar to those encountered during a real evacuation, particularly from the stand point of traffic.

The results of the tests showed that the system had a very good reliability (90%+ in lab tests and 55-85% in FOTs) and accuracy (95%+ in lab tests and 90%+ in the FOTs). An interface using the NTCIP standard was also developed for the sensors so they can operate with existing and future traffic management centers.

Future Research and Development

The results of Phase A indicated that the prototype sensors are reliable and accurate for the type of application that is the focus of this project. During an emergency, these sensors would be deployed by law enforcement or emergency management personnel, who are likely to be performing many other activities. Therefore, to make this a viable tool to be used in emergency evacuations, the loop detectors should be easy to deploy and the system should work on a “fire-and-forget” regime. That is, the emergency personnel involved in the deployment of the system should only be required to place the detectors on the pavement (e.g., by rolling the detector across the road) at key points within the evacuating area and to connect them to the sensor box. After that, the system of sensors should self-configure, calibrate, start gathering data and transmitting traffic parameters (travel time) to the designated emergency operations center, and be ready to interact with other systems. Phase B of this project will focus on these issues.

For more information regarding this research contact Oscar Franzese, Center for Transportation Analysis, Oak Ridge National Laboratory, phone (865) 946-1304 or email franzeseo@ornl.gov.