Featured Case Study:

Palm Beach County Fire Rescue

Emergency Vehicle Signal Priority System

By: Harold Slater

Trafficware

Engineered by Naztec

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About the Author

Harold Slater is a retired Division Chief from Palm Beach County Fire Rescue where he was responsible for the Technology Services Division for 18 years. Several of those years were spent also managing the 911 Call Center and Radio System Services section. He is a graduate of the National Fire Academy and the Executive Fire Officer, Command, and Staff programs. His experience and accomplishments include procurement, installation, implementation, and maintenance of three different computer-aided dispatch (CAD) systems, an automated vehicle location (AVL) system, mobile data system, and 911 dispatch center equipment.

Mr. Slater was instrumental in bringing various technologies to Palm Beach County Fire Rescue during his tenure. It began with a departmental local area network, a department-wide records management system, and e-mail. Over time, Mr. Slater added an Intranet site, staffing and payroll system, wide-area network with Internet access, and started a GIS (Geographic Information System) section to bring this new technology to Fire Rescue. His final project was a new map-based CAD system with GPS-based AVL, mobile computers in paramedic and fire vehicles, an automated voice station alerting system, and developing a design that would interface with an advanced traffic management system (ATMS) to make dispatch more efficient and reduce response times.

Mr. Slater served 20 years on the county Geographic Information Systems Project Management Team (GIS PMT) Committee and on Intergraph's Industry Advisory Council. He retired in 2010 after 31 years of service at Fire Rescue.

Emergency.now provides the fastest and safest way to transport emergency vehicles from dispatch to the incident.

Fire departments and other emergency response agencies face various common challenges, including:

- Traffic problems when responding to emergencies
- Longer response times due to traffic
- Vehicles getting in or causing accidents while responding to emergencies
- Constant search for ways to improve response efficiency

These are the issues we needed to address at Palm Beach County Fire Rescue, kicking off a project to replace the existing computer-aided dispatch (CAD) system. This case study focuses on the effective and economical solution that was implemented.

Testing Preemption Device

Palm Beach County previously tested GPS-based traffic signal preemption devices. While the devices worked, they were still not attaining the performance results the we were hoping to achieve. The burden of ongoing maintenance for field hardware was also an issue we were hoping to address. Palm Beach County Fire Rescue had about 200 emergency response vehicles and over 500 traffic signals that would require maintenance.

The county traffic division was already requesting additional funding for more personnel due to an increase in their workload that resulted from the installation and maintenance needs for the preemption system. The radio shop also experienced an increase in work orders to repair the preemption equipment in test vehicles. Furthermore, response-time data was not showing any clear signs of being reduced. System testing also showed that traditional traffic preemption can be confusing to the driving public. Drivers get disoriented when the traffic signals do not follow the normal sequence around the intersection. For example, motorists were routinely skipped because the signal had been preempted.

Lastly, the county observed that the emergency vehicles were continuously traveling on congested roads and approaching intersections with red lights. Even when the traffic light would receive the preemption request and change the light to green, our vehicles were getting caught up in the congestion because motorists had not yet been able to clear out of the intersection. The traffic would proceed forward and vehicles would move out of our way one by one. As we approached the next signalized intersection along the route, in addition to the new motorists we would encounter, there would still be a few vehicles in front of us from the last signal. We were continually driving down the road with a stack of vehicles in front of us. As we would approach new intersections, our progress was repeatedly stalled as drivers attempted to move out of the way.

Creating a New Solution

Today, map-based CAD systems have all of the information necessary to approach this traffic issue proactively. The emergency vehicle's location is known (when it is GPS equipped), the location of the emergency incident is located on the CAD map, and the CAD can provide a route to the emergency incident for responding vehicles. This information is then sent to a traffic system upon dispatch, allowing the traffic system to manipulate signal timings and proactively clear the route well ahead of the responding emergency vehicles.

The Palm Beach County traffic system already utilized Trafficware's advanced traffic management system (ATMS) software, ATMS.now. In our attempt to abate the traffic-related issues we were experiencing while responding to emergencies, we worked with Trafficware on implementing sending CAD data directly to the traffic system. The traffic system would then manipulate the signal timings to flush traffic from the emergency vehicle's route and adjust the timing of signals along the route. The lights would be in sync with the estimated time of arrival (ETA) for responding vehicles by providing them with a green signal at each intersection. Trafficware was able to develop software that accepted CAD data and manipulated the timing of signals. The key to the success of this method was utilizing the existing system to provide emergency vehicles with priority at each intersection—from the moment of dispatch until arrival at the incident.

Once the units are dispatched, CAD data is sent to the traffic system. This data includes the units' location, unique ID, and the route to the incident for each unit that is dispatched. Every five seconds, the CAD sends data to the traffic system, including the unit's location, the status of the unit, and the speed of the unit. This data is utilized in two ways. First, it is used to determine which traffic signals along the route will get an extended green, flushing traffic prior to the arrival of the emergency vehicle at the intersection. The data is also used to estimate the time the emergency unit will arrive at the signal. From this estimate, the timing of the signal is manipulated to provide a green light when the unit is expected to arrive at the intersection.

Proof of Concept Test

We did a proof-of-concept test to confirm that this method could work, as well as build a case to obtain the necessary funding for the system. The proof-of-concept test consisted of emergency vehicle runs with lights and sirens from the fire station, first without the priority system and then with the priority system. The test vehicles traveled two miles down a six lane road with eight traffic signals. Without priority, the test run took four minutes and 12 seconds. The same engine did a test run with priority, which took two minutes and 50 seconds, saving one minute and 22 seconds. The paramedic unit took three minutes and 58 seconds without priority. This was reduced by one minute and 13 seconds when the test was run with priority (a two minute and 45 second ride).

	Fire Engine	Paramedic Unit
Without Priority	4 minutes, 12 seconds	3 minutes, 58 seconds
With Priority	2 minutes, 50 seconds	2 minutes, 45 seconds
Time Saved	**1 minute, 22 seconds**	**1 minute, 13 seconds**
Improvement	**48.24%**	**44.24%**

Initial Testing of Emergency.now

We started our tests on a lightly traveled six lane artery about three miles long with six traffic signals along the route. The fire department staff vehicle was equipped with a GPS/AVL/Sierra wireless modem and a mobile data computer (MDC). All these tests were done without lights and sirens. Prior to beginning the test, the dispatch center entered a call into the CAD and then dispatched the staff vehicle to the test incident. By using the address from the CAD, we would drive the prescribed route and test all aspects of the system. We did these tests over a period of six months, each time adding more complexity. In our final assessment, we tested two unique scenarios: 1) multiple units responding from different locations with opposing routes and 2) multiple units responding from the same location, but with a second of delay in between units. In each test, we were able to identify some elements that needed to be addressed.

We learned quickly that the CAD needs to give accurate routes. The CAD was doing this most of the time, but not all of the time. It was then decided that we needed to add obstacle data to the GIS data, such as stop signs, speed bumps, traffic circles, one-way streets, gated communities, etc. This obstacle data was gathered by field personnel and was input into the GIS system data by GIS personnel. Adding this obstacle data provided more accurate routes from CAD.

Second Phase Testing

In the second phase of testing, we used two major roads that intersect, both of which are more heavily traveled. Each test area was about three miles long; one had 11 traffic signals and the other had ten. Similar to phase one, we tested with a staff vehicle over a six-month period. As the testing progressed, we added complexity and discovered a few new items that needed to be addressed. Overall, the system was working as planned by the initial conceptual design. While the system flushed traffic along the route, we would run a route during less-than-normal traffic conditions. Vehicles on the roadway were moving at posted speeds, spaced adequately, and able to easily move to another lane, allowing them to get out of way of the emergency vehicle. In most cases, our test would result in the entire run progressing without slowing or stopping.

The next step was to move into a more aggressive testing phase. We began allowing units from the station to use the system on actual calls, providing us with valuable feedback. After a few days of responding to calls with the priority system, the station crews had positive comments and all agreed it was working well. One station officer even said, “[there was] nothing but a sea of green lights ahead.”

Benefits of Emergency.now Priority System

In summary, Emergency.now provides the ability to flush traffic congestion ahead of the emergency vehicle with extended green signals along the route to the emergency.

1. Provided you already have GPS, radio modems, and MCD’s in your units, there is no additional equipment to install. The system is based on software rather than hardware, which does not take up any more space or require more power in your emergency vehicle. There is also no additional equipment to maintain or purchase.
2. The priority system creates a safer environment on the roadway. When vehicles are flushed from the route prior to the arrival of the emergency unit, there is less congestion. When several cars are stacked at an intersection, it creates a barrier for the emergency vehicle and increases the response time. As drivers attempt to make room for the emergency vehicle, they make dangerous decisions, such as running red lights, veering into other lanes, or moving into an unsafe intersection. By reducing the buildup of cars at an intersection, there is more space available for other vehicles to allow the emergency vehicle to pass. Overall, a flushed intersection creates a safer environment for the public and emergency vehicles on the roadway.
3. As your city or county grows and more emergency vehicles are on the road, there will no longer be a need to equip every new unit or intersection with expensive hardware for the priority system to work.
4. Traffic engineers and system managers will typically prefer priority over preemption, as it is less disruptive to normal traffic flows because the system maintains coordination of traffic signals and operates in a manner that is familiar to motorists.
5. Because the system is software based, there is no equipment to install and maintain at each intersection. Additionally, environmental factors have an impact on the equipment’s lifespan are no longer a concern, such as damage caused by hurricanes, tornado, lightning, hail, ice, saltwater, dust, etc.

Business Case for Cost Savings

Based on a study done in Palm Beach County by external consultants, it would take ten new fire stations to reduce our overall average response times by 10-20 seconds. The cost to build, equip, and staff ten new fire stations would be ten times the amount of implementing Emergency.now. In addition to the cost savings, this priority system allowed us to:

- Leverage the equipment we already had in the vehicles.
- Avoid purchasing, installing, and maintaining additional hardware.
- Reduce future expenditures, since no additional equipment is required as vehicles or traffic signals are added to our system.

Things Learned

Thorough testing of the system in various environments and scenarios allowed us to gain valuable knowledge. Some of the critical elements that eased the implementation of Emergency.now include:

1. It is important to develop a relationship with your county or city traffic division. You will be working closely with them during procurement, implementation, and installation. The system works best when the vehicle's location and CAD status updates are received by the priority system every five seconds or less.
2. The accuracy of your GIS data affects the CAD's ability to provide proper routes. This includes speed-limit data and obstacle data on each road segment, if supported by your CAD system. The road segments in your GIS data must be connected properly without overshoots or undershoots.

Emergency.now System Requirements

Emergency.now will operate best with the following components:

- A map-based CAD system that can provide the following data every five seconds: vehicle location and status, incident location data, and routes for each emergency vehicle dispatched to the incident.
- Vehicles equipped with a GPS receiver and radio modem to transmit the vehicle's location and data back to the CAD system.
- ATMS.now and a network that provides communication to each of the traffic signal controllers that will provide priority service.

Summary

It would be cost prohibitive to put a fire station on every block to maintain or reduce response times. Finding a method to reduce the factors on the roadways that delay the emergency vehicle's travel to the incident is the next best solution.

Not only does Emergency.now, a priority traffic signal system, achieve this for emergency vehicles, the system is also proactive. By reducing traffic congestion on the emergency route from the time the unit is dispatched, Emergency.now creates a safer and more efficient route. While doing this, the system is also adjusting the timing of the signals based on the emergency vehicle's ETA, providing a green signal at each intersection. This is the future of traffic management for emergency vehicle response.

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Visit our website to see video of the Emergency.now system during testing and a emergency run in live operation. http://www.trafficware.com/products/emergency-response/

Note: Proof-of-concept test turned all lights green along the route during the whole response. This was done because the software had not yet been developed and this was the closest we could come to show the difference between no system and getting green and extended greens ahead of the vehicle. The current system allows each agency to set the amount of time for extended greens and the distance ahead of emergency vehicle.