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Transit Applications and the EMTRAC System

It's 7:45 in the morning, and the number 10 bus is near capacity as it travels southward toward downtown. As the bus approaches the 44th Avenue intersection, the southbound light turns green on cue, allowing the bus to maintain it's speed and reach it's next stop right on schedule.

In the middle of rush-hour, with its predictably heavy traffic, the number 10 begins lagging behind schedule. However, as the bus drifts off schedule, the traffic signals follow the same pattern of turning green early enough to keep the bus moving southward. The number 10 is back on schedule within minutes, and passengers arrive at their destinations on time.

This is part of the ideal scenario envisioned by the people at STC, Inc., manufacturers of the EMTRAC Priority Management and Monitoring System. At its core, that's what the EMTRAC system is about—getting vehicles to their destination quickly and safely. While there are a number of other features available to further increase efficiency, safety and timeliness remain the primary goals of the EMTRAC system.

In its basic form, the hardware components of the EMTRAC system include a Vehicle Computer Unit (VCU) installed with an antenna in vehicles and a Priority Detector installed in signal-control cabinets (along with a cabinet- or pole-mounted antenna). The components communicate wirelessly, using secure Frequency-Hopping Spread Spectrum radio. Mobile components, such as the VCU, utilize GPS and internal navigation to determine precise locations at all times.

The Basic EMTRAC Components: Vehicle Computer Unit (left); Cabinet-mounted Priority Detector (right).

The standard components allow for a high amount of flexibility in how the system works for the customer. They also offer the ability to expand the system as time and budgets allow—without the need to replace existing hardware.

An Emerging Brand

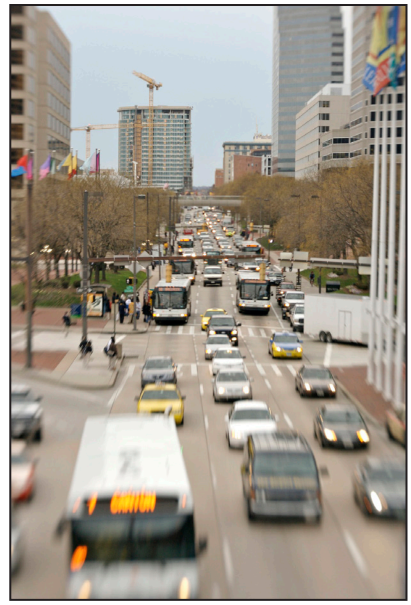
Despite a presence in signal priority for over 25 years, EMTRAC is very much an emerging brand. This may be due to the fact that some very large transit agencies have implemented the EMTRAC system in recent years, including Minneapolis (Metro Transit), Houston (METRO Rail), Brampton, Canada (Brampton Transit), and others. This is in addition to mid-size municipalities who have also installed EMTRAC primarily for Emergency Vehicle Preemption, such as Stillwater (Oklahoma) and Columbia County (Athens, Georgia). "We're very proud of both our long-term and newer customers," says STC, Inc. President Brad Cross. "Those agencies all have people who are really concerned with keeping up with technology and using that technology to improve the service to their community."

In fact, many of the recent technological features developed by the EMTRAC team are a direct result of customers requesting additional capability.

“That’s true,” says Cross. “Our customers are the ones dealing with the everyday challenges of managing a transit system, so they have a lot of good ideas for features they would like to see added to the system.”

Transit Headway

Take the issue of bus bunching for example. In this situation, a trailing bus catches up to a lead bus that has lagged behind schedule for any variety of reasons. The lag in schedule results in the lead bus picking up passengers that would have otherwise boarded the trailing bus. Conversely, the trailing bus encounters fewer passengers and eventually catches up to the lead bus—to the dismay of waiting passengers.



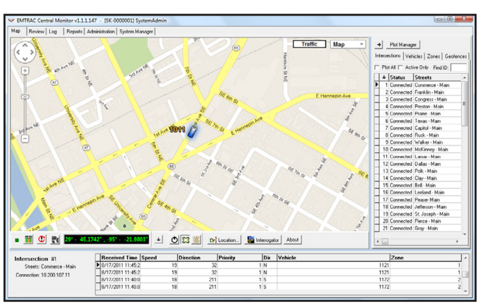
Rush-hour presents a particular challenge for transit headway.

A solution, in this case, involves granting Transit Signal Priority (TSP) for the lead bus (to help keep it on schedule) while not granting priority for the trailing bus (to maintain the desired headway amount between the two vehicles). In this way, the EMTRAC system is capable of conditional priority, where TSP requests are only sent to the signal controller when pre-defined conditions (such as a specific amount of time behind schedule) have been met. Acceptable schedule variances and headway amounts are determined by the transit agency, programmed in the EMTRAC vehicle component, and the EMTRAC system handles the rest.

If further action must be taken to maintain headway, the EMTRAC Central Monitoring system is capable of recognizing reduced headway amounts and notifying personnel at central locations who can then respond accordingly (for example, by authorizing skip-stop mode for the leading bus).

Central Monitoring

The Central Monitor application is a robust Automatic Vehicle Location (AVL) system that enables monitoring personnel to track vehicle activity in real time while vehicle locations are displayed on integrated maps. Agencies are able to designate key events that trigger alarms to notify workers at central locations. These alarms are a key feature used by METRO Rail, the light rail system in Houston, Texas.



The Central Monitor software displaying light-rail transit activity in Houston, Texas.

Because the light-rail lines in Houston run adjacent to the median along city streets, the potential for both vehicular and pedestrian accidents is a constant concern. One area of particular interest to Houston METRO is ensuring that train operators do not overrun stop signals. The ability to monitor vehicle activity and automatically detect driver violations provides a way for METRO supervisors to increase safety while holding train operators accountable for running through stop signals. In the event a light-rail vehicle does violate a stop bar, the Central Monitoring system triggers an alarm, records a detailed log of the event, and automatically alerts the central-control supervisor.

Downtown Houston is a notoriously challenging location for GPS reception, and a significant portion of the METRO Rail line passes through severe urban canyons both downtown and through the Houston Medical Center. Despite these challenges, the EMTRAC system surpassed Houston METRO's system requirements in November 2011 by passing a 90-day accuracy test with 98.87% accuracy in detecting stop-bar overruns. During the same test, the EMTRAC system detected 99.55% of all equipped vehicles at pre-determined locations.

An EMTRAC-equipped light-rail vehicle on the Houston Red Line.

Vehicle Interrogation

Metro Transit, the transportation provider for the Minneapolis/St. Paul region in Minnesota, implemented the EMTRAC system in spring 2010 to request signal priority for equipped buses, as well as to monitor real-time vehicle activity and maintain transit headway. One specific feature Metro Transit requested was the ability to automatically download the detailed activity logs that are saved by the EMTRAC vehicle component on equipped buses. This request was made possible by the EMTRAC Vehicle Interrogator, while also providing a way to view the logs with the Central Monitor software.

The EMTRAC Vehicle-Interrogator kit.

As equipped buses return to the garage after their shift, the Vehicle Interrogator wirelessly downloads activity logs from the onboard VCUs. As with other EMTRAC components, the Vehicle Interrogator uses secure FHSS radio to facilitate communication. Downloaded logs are saved on the Central Monitor server and are accessible from connected workstations. Central Monitor automatically emails saved logs to designated personnel on a daily basis. In addition to data downloads, the Vehicle Interrogator also offers the ability to upload firmware or database updates to VCUs.

Wayside-Worker Notification

As light-rail technology has advanced, transit and traffic agencies have encountered another unique challenge to increasing safety. Many light-rail vehicles are designed to run so quietly that workers and pedestrians are often unaware of their approach. Transit and traffic maintenance workers, because of their proximity to rail lines, often find themselves in vulnerable locations for potential accidents.

The Santa Clara Valley Transportation Authority (VTA) serves the high-density area of California known as "Silicon Valley." At over 42 miles in length, the VTA light-rail system is one of the longest in North America. The tracks in this system wind around, over, and through hills as they cover vital residential, commercial, and employment centers. The light-rail vehicles on the VTA lines run very quietly and, to add yet another layer of complexity, a portion of the VTA track is shared with freight trains, which can travel up to 55 miles-per-hour. All of these factors contribute to the potential for trains to surprise—and collide with—unsuspecting workers.

VTA personnel testing the EMTRAC Wayside-Worker Notification System.

To reduce the chances for worker accidents, VTA recently tested the EMTRAC Personal Notification Unit (PNU), which is a compact handheld device that alerts transit and traffic workers when an approaching vehicle is within a particular distance. This "distance" may be specified in seconds, based on the train's estimated time of arrival (ETA), actual distance (in feet or meters), or both. When an approaching train reaches the specified distance, the PNU flashes an ultra-bright LED, sounds a pulsed alarm, and/or vibrates to alert the worker of the approach.

The EMTRAC PNU.

Conditional Signal Priority

Brampton Transit, the transportation provider for the third-largest city in the Toronto metropolitan area, has implemented numerous enhancements in their quest to improve the customer experience. In September 2010, the city unveiled the Züm bus fleet, Brampton's bus rapid transit (BRT) service vehicles. The Züm buses include a number of technological features designed to improve both customer service and the transit environment. These features include hybrid diesel/electric propulsion, onboard next-stop announcements and displays, and EMTRAC conditional TSP—based on amount of time behind schedule.

The Brampton Züm bus service in action.
Photo courtesy of Brampton Transit.

To achieve conditional TSP, the EMTRAC system is configured to request signal priority only when activated through a connection to the onboard schedule-adherence system. When a bus lags behind schedule by a set amount of time, the schedule-adherence system enables the EMTRAC components to request signal priority for upcoming intersections. If the bus is on schedule, signal priority is not requested, allowing the buses to better maintain headway.

Like Brampton Transit, Metro Transit in Minneapolis/St. Paul also employs conditional signal priority. However, the EMTRAC system in Minneapolis employs different requirements that must be met before signal priority is requested. The conditions for the Metro Transit system include:

- Another bus has not requested priority within a specified time frame (for example, eight minutes).
- The bus doors are closed (that is, the bus is not at a stop with open doors).
- An exit request has not been made for the next stop.

If any of these conditions are not met, TSP requests will not be sent.

Estimated Time of Arrival (ETA)

Another EMTRAC feature utilized by Brampton Transit is ETA-based signal priority. Simply put, the EMTRAC system notifies the signal controller when an approaching bus reaches pre-defined time-points during its approach (for example, when it is 90, 60, 35, and 15 seconds from the intersection). The algorithms used to calculate the ETA time-points make this system unique to North America, and they take advantage of features built in the signal controller and TSP firmware.

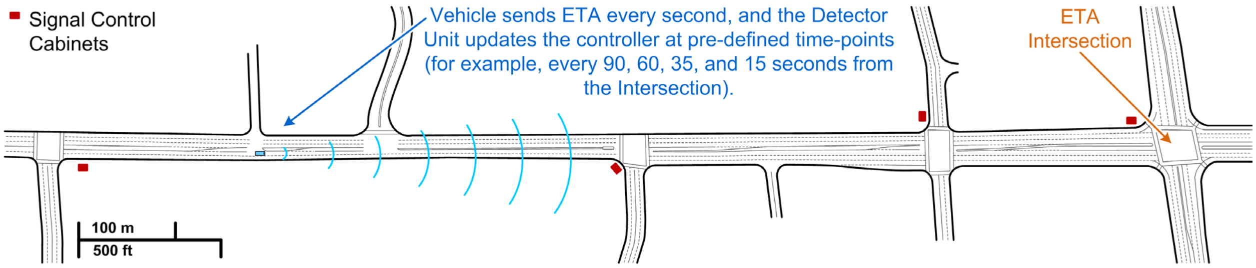


Illustration of how ETA-based signal priority may be set up for an intersection approach.

Unlike detection zones that track the vehicle's Estimated Time of Arrival (ETA) from a fixed location, the Brampton system reacts to changes in on-street congestion and bus-approach speeds in real time. As traffic volumes fluctuate, so do the positions of ETA time-points.

Upon receiving the bus ETA notifications, the traffic controller preconditions its internal timings in preparation of its arrival at the intersection. The advanced time-points help the signal controller gradually modify the timings to reduce the impact on the intersection while also enabling the intersection to maintain coordination with other intersections along the corridor.

Please contact an EMTRAC representative for information about how your agency can improve transit safety and timeliness with the EMTRAC system.