Making Traffic Smarter

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Build a better traffic light and the world may not exactly beat a path to your door, but at least it will get there with fewer delays.

As Ontario's Liberal government gears up to find ways to pay for $50 billion in new transit service for Greater Toronto, a University of Toronto civil engineering team says that a key piece of the solution to the region's crippling gridlock lies with the use of cutting-edge computer technology designed to "optimize" the performance of the traffic signals at the city's most frustrating intersections.

According to detailed computer simulations done with City of Toronto traffic data collected at 59 downtown locations in 2009, the deployment of a U of T-designed "intelligent transportation system" (ITS) could reduce wait times at intersections by 40 to 70 per cent. As a result, vehicle emissions would drop by as much as 30 per cent. "The benefits are immediate once the system in turned on," says civil engineering professor Baher Abdulhai, director of the Toronto ITS Centre.

The results of the simulations were released this month as part of a report commissioned by the **Residential and Civil Construction Alliance of Ontario** [2], which argues that "congestion management" is the third leg of a traffic-control stool that includes more road and transit infrastructure (where warranted) as well as measures to reduce "demand," such as congestion-based road tolls.

The U of T system, known as MARLIN-ATSC, relies on game theory, artificial intelligence algorithms and in-road sensors that allow traffic signal controllers to "learn" how to adapt to local traffic patterns, with the goal of dynamically setting green light/red light intervals to reduce unnecessary queues as they arise (e.g., the frustrating phenomena of waiting for several cycles in heavy traffic). Abdulhai likens the process of making a traffic light smarter to the way a baby gradually learns how to walk.

While researchers have long understood how to optimize a single traffic signal, it's much tougher to accomplish this feat across a road network with hundreds of intersections. After all, if cars are flowing more efficiently through one set of lights, they place additional strain on adjacent intersections, and so on. Another challenge is that massive computing power is required to centrally coordinate traffic signals designed to adapt to local conditions.

The U of T system, based on the PhD thesis of Samah El-Tantawy, gets around this obstacle by delivering improvements without a cumbersome centralized control system. "The system is most useful, simply, where the congestion is," says Abdulhai. "The training (simulation) environment shows us with good precision which intersections benefit the most and how much benefit to expect. This process helps prioritize investment and pick the best candidate intersections (or groups of intersections) to start with."

Abdulhai's team is working with the university's Innovations and Partnerships Office to commercialize MARLIN, and has "strong interest" from a U.S. partner. Indeed, the team's report points out that gridlock in Greater Toronto, said to cost the region about $6 billion a year, could prove to be a boon for tech firms touting solutions to congestion. "Judging by the interest we got from locals and foreign stakeholders, I would say

transportation is a hot field for innovators and entrepreneurs, not to mention researchers and academics," Abdulhai observes. "Solutions would fill local needs but are directly exportable to all congested cities worldwide."