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Lab helps TriMet glide to more green lights

Transportation - For the speediest trips, should bus stops be before or after a light? A simulator finds the answer

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The intersection at Northeast 33rd Avenue and Sandy Boulevard is on the third floor of a five-story building at 1900 S.W. Fourth Ave. It is about 14 inches long, and the vehicles passing by are no wider than an eraser tip. There are blue ones and red ones and yellow ones. There are buses, and there are cars. Hundreds pass by every hour. They appear at one end of the roadway like rectangular beads on a wire: sliding down the pavement, stopping at the intersection, accelerating, shifting lanes, and eventually vanishing into a sea of green.

MICHAEL LLOYD/THE OREGONIAN

This is Vissim, a traffic simulation program in use at the Intelligent Transportation Systems Lab at Portland State University. Robert Bertini, the lab director, says each of those rectangles has a personality. They represent various makes each with its own set of specifications. Inside each is a driver with a destination in mind and a mind to get there. In other words, Bertini says, they are programmed with an origin-destination matrix, a preferred speed and a maximum acceleration.

The software is hooked up to an actual Portland traffic signal controller just like the one at 33rd and Sandy. The metal box has a keypad and a couple of blinking lights, and Bertini jokes that a cell phone probably has more processing power. Nevertheless, the controller is critical for the experiment to be accurate. Vissim makes virtual traffic, but the controller treats it like the real thing.

Students in Bertini's lab have been using this simulation to answer a question posed by TriMet: Should buses pick up passengers before a traffic light or after it? In the past five years, the agency has adopted a fleet of "smart" buses that can communicate with 275 traffic signals on 12 bus routes in Portland. These technologies have the potential to speed up public transportation and make bus schedules more consistent, but none of it is going to work if stops are stuck in the wrong spots.

Late buses are a big problem. One late bus will annoy more than a few riders. When a single bus is delayed, the distance to the following bus -- called headway -- decreases. But the decrease in headway is greater than the original delay, and the delay snowballs over time until -- in the worst instances -- the two buses bunch up one after another.

Scientists call the phenomenon that causes bus bunching a positive feedback loop. If there is a small delay caused by, say, a shopping cart rolling into the road, then the bus must slow down to avoid it. By the time the bus arrives at its stop -- a minute or two late -- there might be one or two more waiting passengers than normal.

These extra passengers, in turn, will slow the bus down as they climb aboard and fish for change in their pockets. At the next stop, three or four extra passengers will be anxiously glancing at their watches. And so on.

Of course, the second bus will have fewer passengers than normal and will be able to move that much faster -- until it pulls up behind that slow bus. For bus riders, this is an unfortunate circumstance: The first bus is packed and the second empty.

Knowing how positive feedback loops work is no consolation for angry riders. That's why Portland's smart buses have an onboard GPS and computer to tell them if they're late. If they're more than 30 seconds late, they'll politely ask the traffic controller -- that metal box in Bertini's lab -- to hold the light for a few seconds if it's green or to turn green a few seconds early if it's red.

This request is different from the type ambulances and police cars send out. Devices on those vehicles order the signal to change. Both devices emit an encrypted ultraviolet signal, which is detected by a sensor mounted on the traffic light. However, signals sent by buses don't hold as much sway; they're constrained by strict rules designed to keep traffic flowing.

For the smart bus system to work, the bus needs to accurately tell the traffic light how long it will take to reach the light, says Peter Koonce, a consultant at Kittelson and Associates who was involved in the study. If a bus stop is on the near side, then a bus may have to unload and will stand a greater chance of missing the light it just requested.

But David Zagel, a project planner at TriMet, says that when signals are set in a progression -- a cascade of green lights timed at just below the speed limit -- early studies suggested that TriMet should hedge its bets by placing half of the stops near side and half of them far side.

After running Vissim for two 25-hour cycles, the Intelligent Transportation Lab had an answer. A bus that stops on the near side takes about 84 seconds to complete its 14-inch journey through the intersection. A bus stopping on the far side shaves about 16 seconds off that time.

"Sixteen seconds at one intersection is very valuable with us," says Zagel. That time savings is multiplied over the length of the route and the number of buses that are passing through. "If we can save five minutes -- or two minutes -- on one long run, that can be the difference between whether or not we have to add a new bus." For TriMet, a new bus represents an initial investment of more than $300,000. For Vissim, it's just a rectangle on a computer screen.

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