Red Light, Green Light—No Light

Tomorrow's communicative cars could take turns at intersections

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How Vehicle-to-Vehicle Communication Could Replace Traffic Lights and Shorten Commutes

A Carnegie Mellon startup aims to manage traffic at intersections by harnessing the radios in tomorrow's cars

By **Ozan K. Tonguz**

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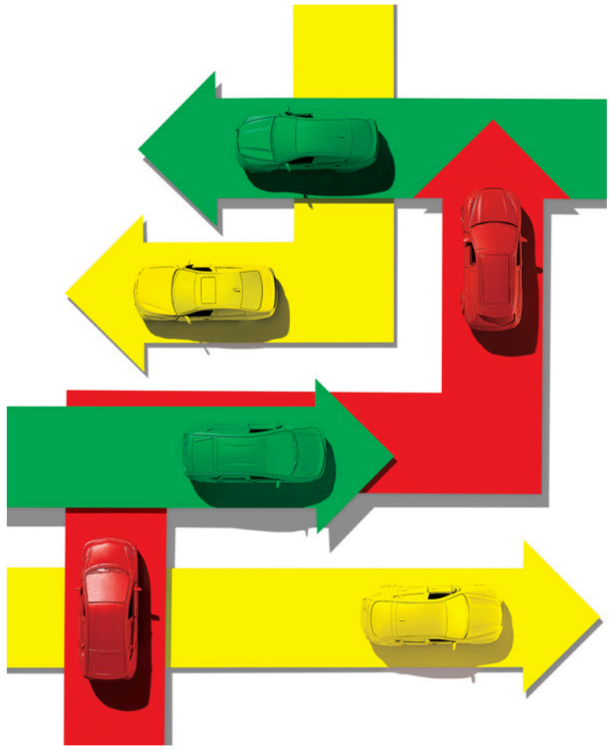

Photo: Dan Saelinger

In Mexico City, São Paolo, Rome, Moscow, Beijing, Cairo, and Nairobi, the morning commute can, for many exurbanites, exceed 2 hours. Include the evening commute and it is not unusual to spend 3 or 4 hours on the road every day.

Now suppose we could develop a system that would reduce a two-way daily commute time by a third, say, from 3 to 2 hours a day. That's enough to save 22 hours a month, which over a 35-year career comes to more than 3 years.

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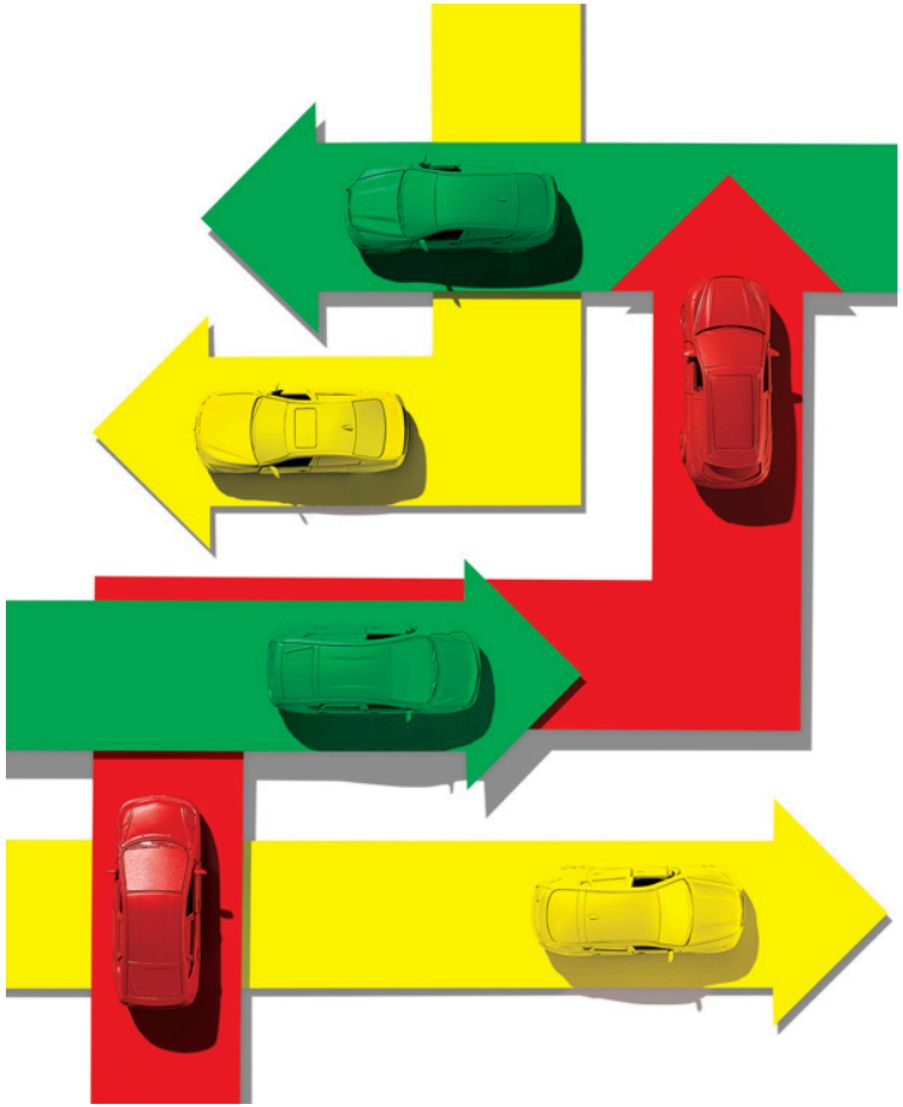

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VTL Algorithm: Letting Cars Control Their Own Traffic

1. Transceivers (using IEEE Standard 802.11p) send out a basic safety message every tenth of a second. The message tells recipients where the transmitting vehicle is by latitude, longitude, and heading.

2. The Virtual Traffic Lights (VTL) algorithm takes that vehicle's data, adds it to data from nearby vehicles, and compares it with readouts from digital mapping services.

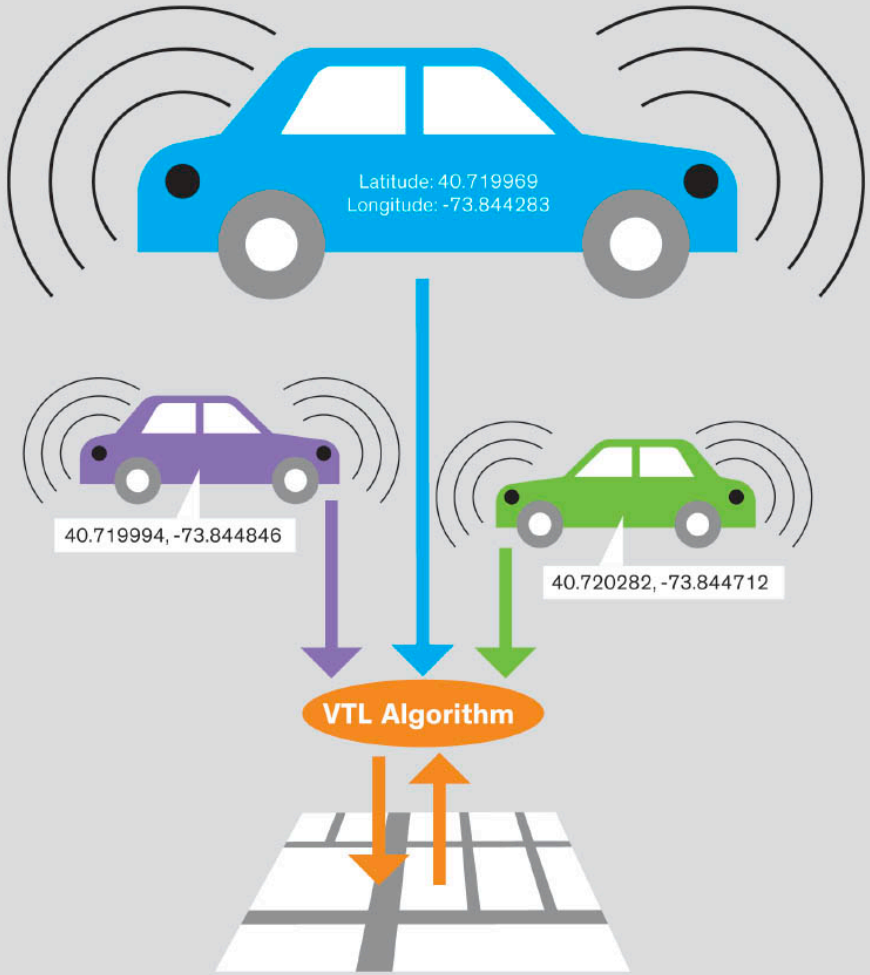
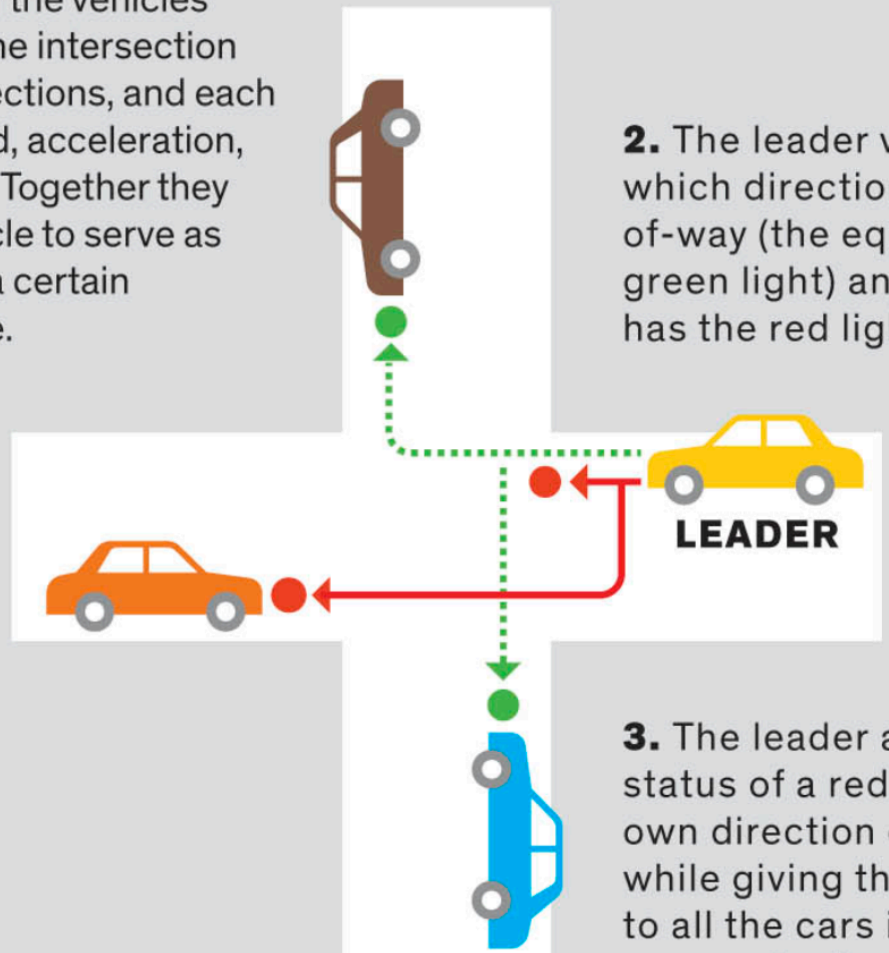


Illustration: Anders Wenngren

Cars "Elect" a Leader—Then Follow Its Orders

1. Each vehicle computes its own distance to the intersection, the distance of the vehicles approaching the intersection from other directions, and each vehicle's speed, acceleration, and trajectory. Together they elect one vehicle to serve as the leader for a certain amount of time.



2. The leader vehicle decides which direction has the right-of-way (the equivalent of a green light) and which direction has the red light.

3. The leader assigns the status of a red light to its own direction of movement, while giving the green light to all the cars in the perpendicular flow.

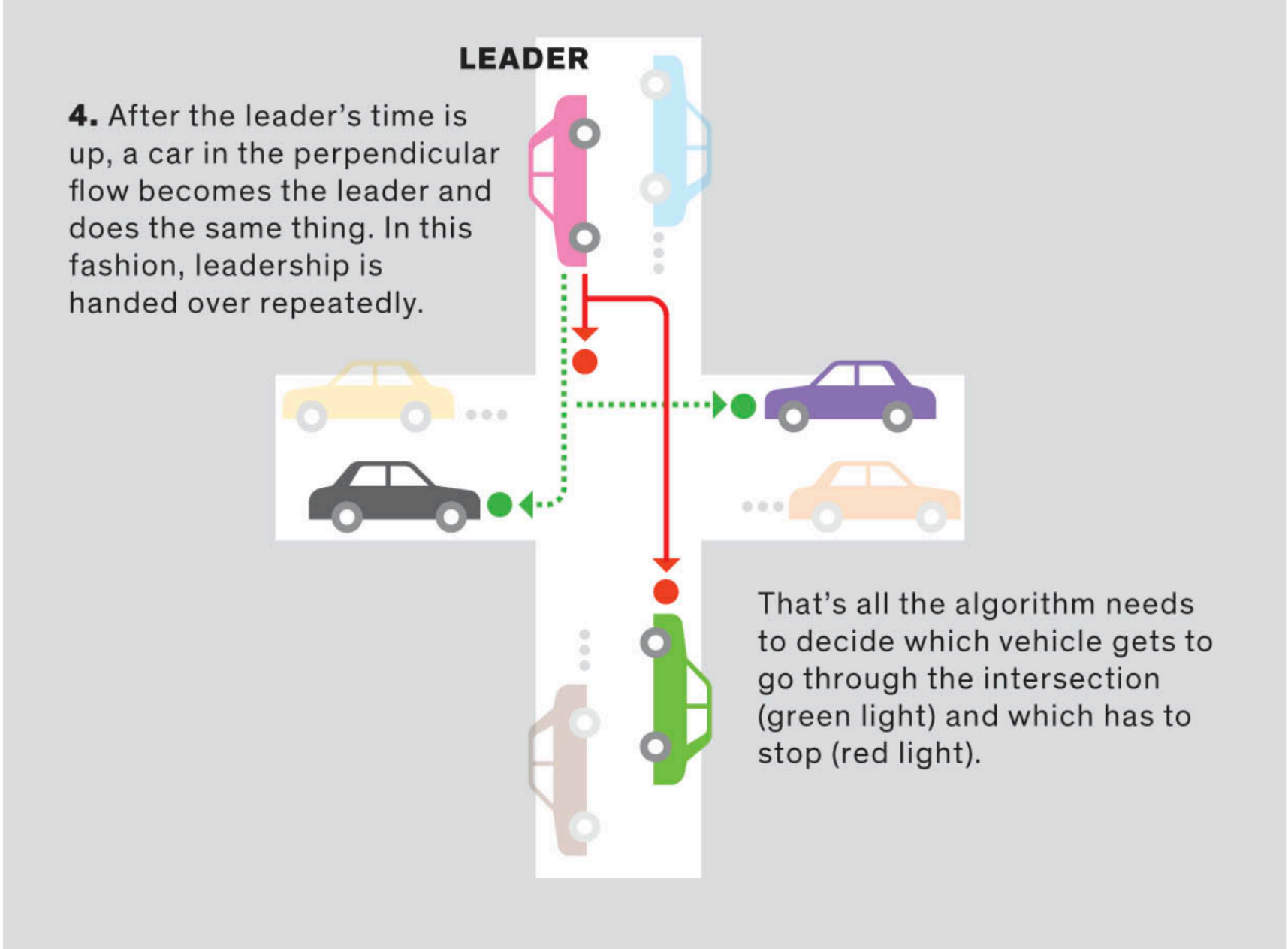


Illustration: Anders Wenngren

Those time savings came primarily for two reasons. First, VTL eliminated the time spent waiting at a red light when there were no cars crossing at right angles. Second, VTL introduced traffic control to every intersection, not just those that have active signals. So it was not necessary for cars to stop at a stop sign, for example, when no other cars were around.

Our simulations showed other benefits—ones that are arguably more important than saving time. The number of accidents was reduced by 70 percent, and—no surprise—most of the reduction was centered at the intersections, stop signs, and other interchanges. Also, by minimizing the time spent dawdling at intersections and accelerating and decelerating, VTL measurably reduces the average car's carbon footprint.

Yet another challenge is how to handle pedestrians and bicyclists. Even in a regime mandating DSRC transceivers for all cars and trucks, we couldn't reasonably expect cyclists to install the devices or pedestrians to carry them. That might make it hard for those people to cross busy intersections safely.

VTL reduced the average commute to 21.3 minutes from 35 minutes in Porto and to 18.3 minutes from 30.7 minutes in Pittsburgh

Our solution for the short term, while physical traffic signals still coexist with the VTL system, is to provide pedestrians a way to give themselves the right-of-way. Ever since January of this year, our pilot program in Pittsburgh has provided a button to push that actuates a red light—real for the pedestrians, and virtual for the cars—at all four approaches to the intersection. It has worked every time.

In the longer term, the bicyclist and pedestrian challenge might be solved with Internet of Things technology. As the IoT expands, the day will finally come when everyone carries a DSRC-capable device at all times.

Well before then, we hope to have our system up and running for human-driven cars. Just this past July we staged our first public demonstration, in Riyadh, Saudi Arabia, in heat topping 43 °C (100 °F), with devices installed in the test vehicles. Representatives from government, academia, and corporations—including Uber—boarded a Mercedes-Benz bus and drove through the campus of the King Abdulaziz City for Science and Technology, crossing three intersections, two of which had no traffic lights. The bus, together with a GMC truck, Hyundai SUV, and a Citroën car, engaged the intersections in every possible way, and the VTL system worked every time. When one driver deliberately disobeyed the virtual red light and attempted to cross, our safety feature kicked in right away, setting off a flashing red light for all four approaches, heading off an accident.

Rebellious Agent @ Work?