Ramp metering and speed limits to prevent traffic jams

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EPFL researchers showed that by managing the access to freeway junctions and moderating the speed limit on the express lanes it is possible to reduce delays by over 12% across the highway system.

In 30 years, traffic has more than tripled on most Swiss highways. On the A1, it even increased from 20'000 to nearly 90'000 vehicles per day, between Lausanne and Geneva. The consequences are translated into daily kilometers of traffic jams and delays. One of the strategies put forward to remedy this situation is to regulate the freeway access with a system of traffic lights at the ramps: ramp metering. Researchers at the Urban Transport Systems Laboratory (LUTS) propose to combine this measure with speed limits on some freeway sections. Simulations

conducted on portions of the A1 between Lausanne and Geneva corroborate the relevance of this overall strategy.

Ramp metering has existed for over half a century and is widely used, often successfully, in Germany, the US or Australia. But Switzerland is not a country like the others: the access roads to the freeways are very short and often connected to the limits of the urban centers. In this context, slowing the access to the highway may spread the congestion to the urban network.

That is why the LUTS' team, led by Nikolas Geroliminis, decided to combine this system with variable speed limits on the freeways. The objective of this research, conducted in collaboration with the Federal Roads Office (Office fédéral des routes) and coordinated by EPFL Transportation Center, was to assess the effectiveness of combining both measures.

Sensors were installed on the A1 freeway from Lausanne to Geneva and on three ramps (access and exit): Gland, Nyon and Coppet. The data were supplemented by manual counts, detectors from variable speed limit system and video sequences at the access ramps of Coppet and Nyon.

Equal treatment for all

After tidying and sorting the data, the researchers developed a traffic control zone-based algorithm in which variable speed limits are considered. The idea was to treat in an equitable way existing freeway users, those wishing to enter it and those aiming for the secondary network.

The difficulty of the exercise lied in constructing the algorithm in order to maintain the density levels on all ramps below the congestion

thresholds and preventing the onset of low speeds on the highway. When it is not possible to maintain the lanes below the congestion threshold, the algorithm seeks to delay as much as possible exceeding such threshold. In order to do this, it uses the "storage" capacity still available on the ramps near the location of the bottleneck.

30% less delays on the freeway

And it works! The researchers tested the algorithm on a micro-simulation model for the studied A1 stretch. It managed to slow the onset of congestion, to speed up the return to normality after traffic jam occurrences and to improve overall performance on the freeway and on access and exit ramps. With this control strategy, the total delays on the highway decreased by about 30% and were reduced by approximately 12% across the entire network. Finally, the effects on the users not using the freeway were low. "This suggests that this new strategy is very effective since it reduces not only ramp delay, but also total system delay without penalizing non-freeway users" says the study. And it concludes that "the proposed strategy, conducted in a comprehensive and coordinated manner, substantially reduces ramp queues compared with local ramp metering strategies."

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