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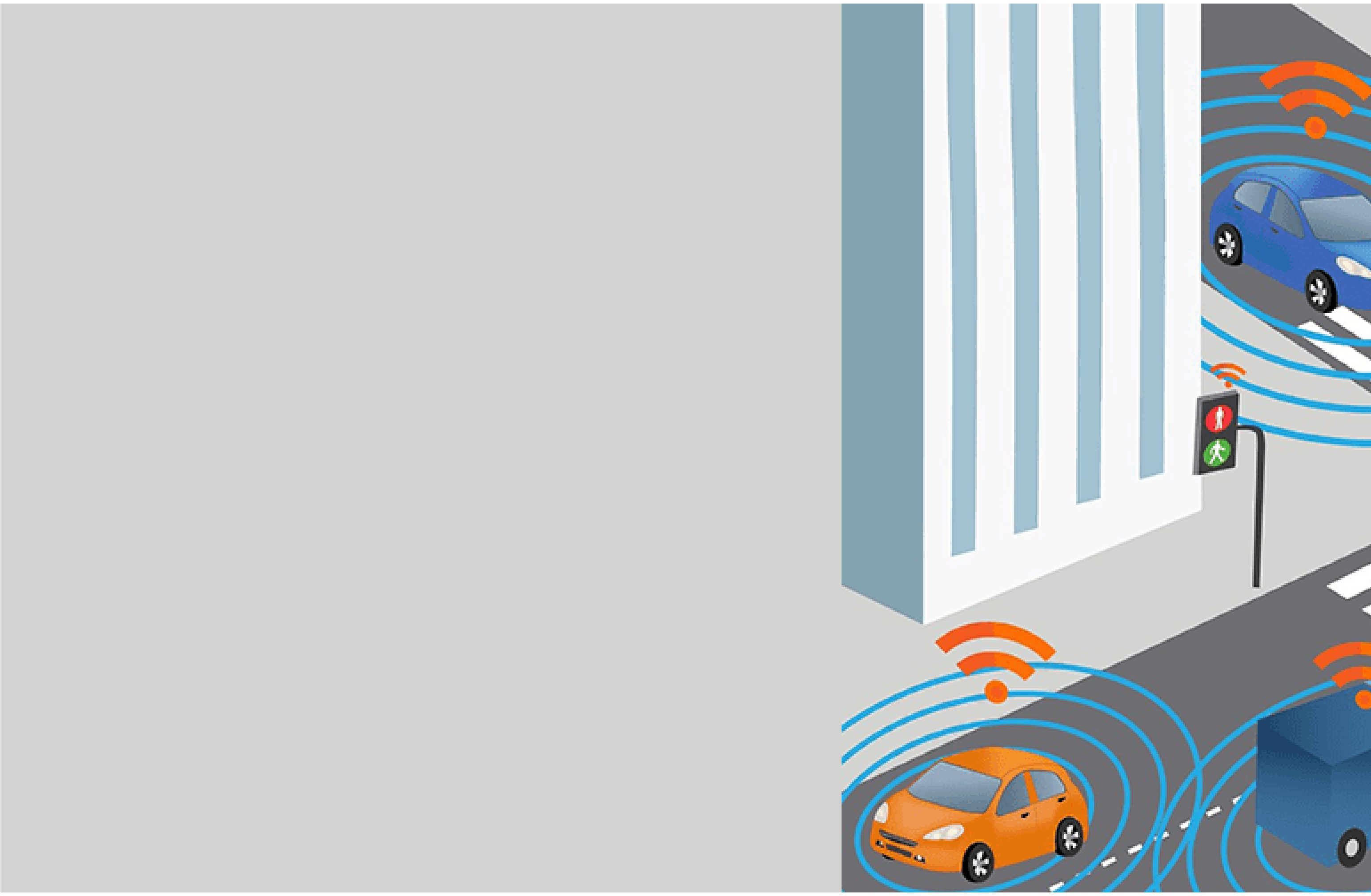

Written on 25 November 2024 3 minutes of reading
News

- Fundamental Research

- [Numerical methods and optimization]
- [Real-time systems]

Road infrastructure optimization is an essential lever to reduce CO? emissions and improve traffic flow. Hence a project conducted at IFP School in partnership with ALSTOM [1] was set out to explore traffic management strategies aimed at reducing the associated ecological impact. The CBVC[1] traffic manager was developed for the purpose.

[1] Communication-Based Vehicle Control

A new model for managing traffic on a roundabout

As a case study, the algorithm developed for this traffic manager (Figure 1) related specifically to **the crossing of roundabouts** and proposed **a traffic management architecture for Connected Autonomous Vehicles (CAVs), via vehicle-to-infrastructure communication (V2I[2])**. In this case, the vehicles exchange information with **a Central Signaling Unit (CSU)**, which manages traffic by dividing the roundabout into zones that can be reserved by one vehicle at a time (Figure 2). A solver then calculates vehicle trajectories and speeds as a function of their intended destination as well as instantaneous flows. A dynamic representation of these flows enables them [to be visualized](#).

[2] V2I : Vehicle to Infrastructure

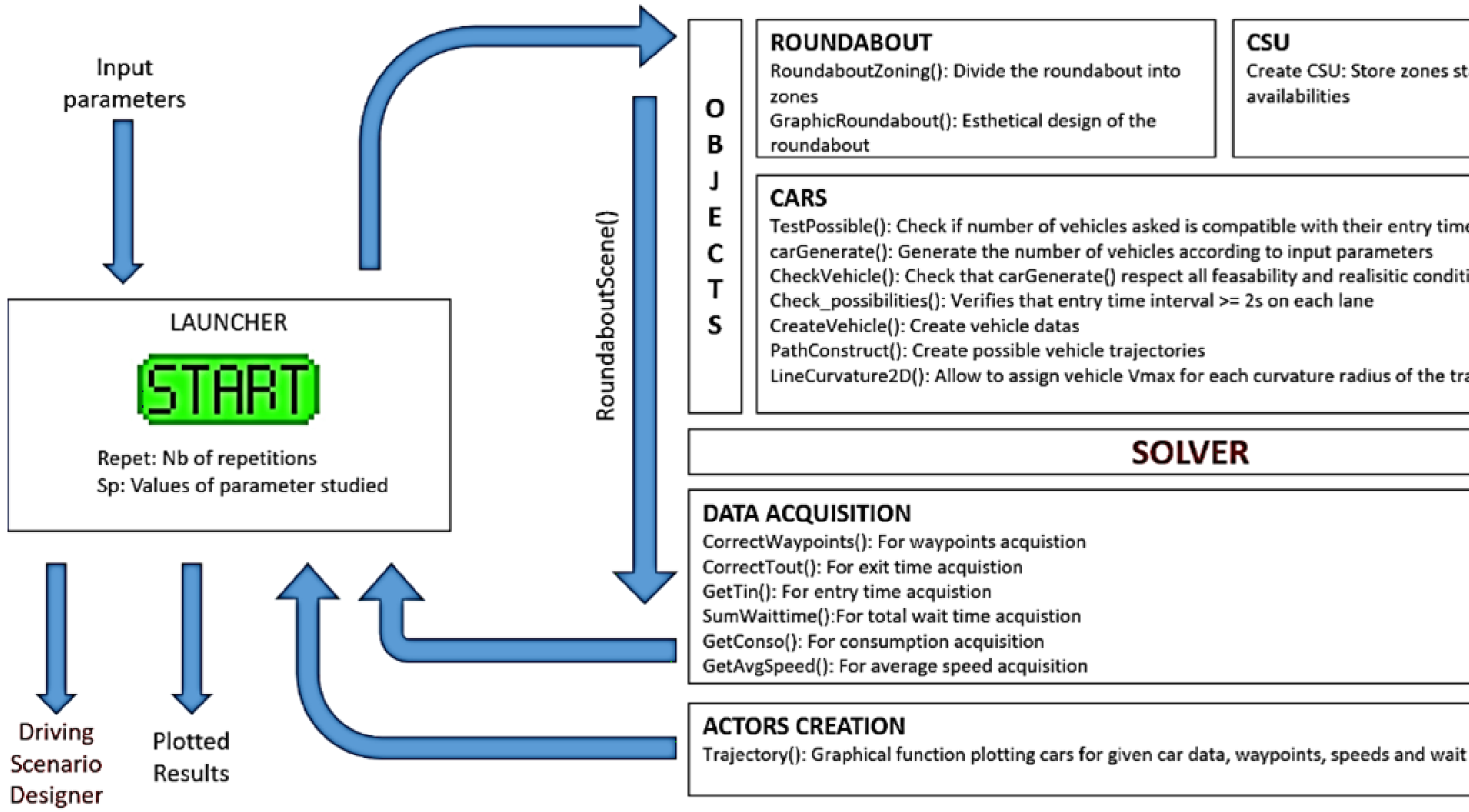

Figure 1: CBVC algorithm architecture

Adjustable parameters

Traffic management parameters, such as speed limits and safety distances, can be adjusted to optimize occupant comfort and safety. Consequently, thanks to V2I communication, the algorithm developed makes it possible to precisely control traffic while safely and efficiently managing the entire roundabout.

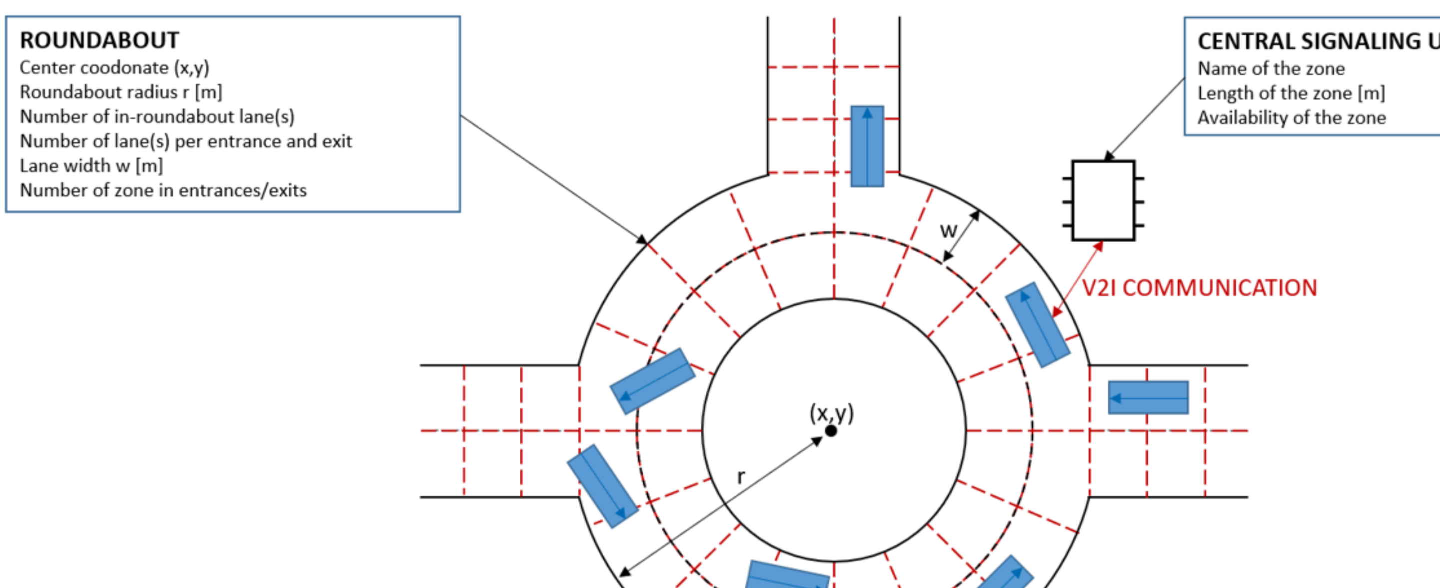

Figure 2: Overview of the modeled system

A modular architecture

The CBVC traffic manager is based on an object-oriented architecture and integrates several functions, separated into functional blocks (Figure 2). These blocks are then used by the solver to determine trajectories and speed profiles for each vehicle at each moment in time.

Traffic movements in three phases

The traffic movement process on the roundabout is broken down into three phases: accumulation (progressive entry of vehicles), stabilization (balance between vehicles entering and exiting the roundabout), and discharge (vehicles exiting with no new vehicles entering).

Scenarios involving up to 100 vehicles

For each **parameter** studied (**number of lanes, roundabout radius, safety distance**, etc.), **driving scenarios were developed**. In this study, 60 vehicles were used for each roundabout crossing scenario in such a way as to be representative without making the calculations overly complex. However, the algorithm developed could cater for cases with up to 100 vehicles [1]. Simulation results include average roundabout crossing time, average vehicle speed, traffic flow and overall energy consumption, in order to enable each parameter to be optimized [2].

Two possible priority management strategies

In addition, **two priority management strategies were compared** (Figure 3): “**first arrived, first served**" (left) and “**in-roundabout priority**" (right). Simulations showed that the second strategy avoided build-ups and improved overall crossing time, average speed, vehicle flow and energy consumption.

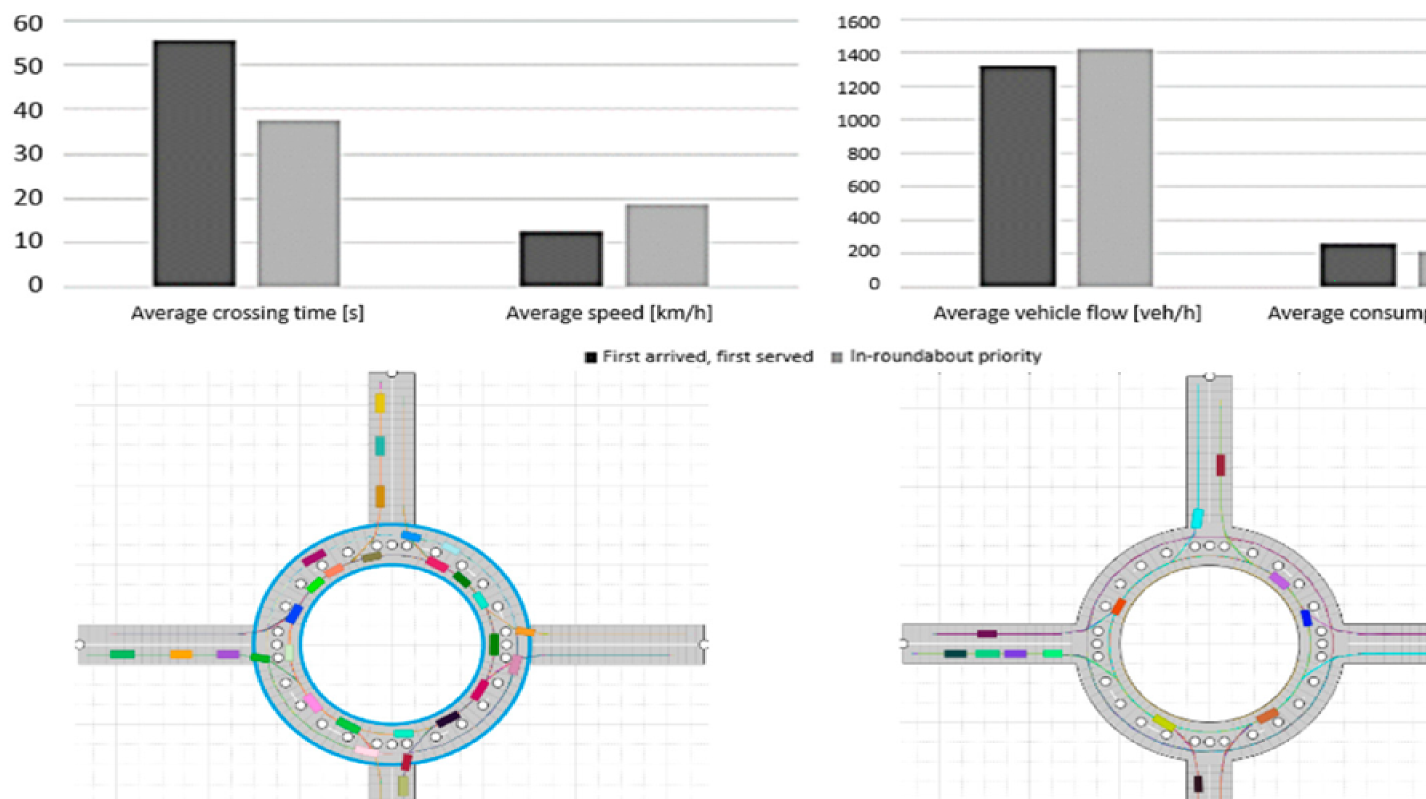

Figure 3: Comparison of two roundabout priority management strategies (Colored rectangles represent vehicles using the roundabout. The white dots are markers used to construct the roundabout).

Improved flows, crossing times and speeds

Roundabout performance is primarily evaluated on the basis of vehicle flow. Thanks to a CBVC manager **a flow of 1,424 vehicles per hour** was achieved, exceeding the 1,188 vehicles per hour with the SUMO open source traffic simulator [3]. Crossing times and average speeds were also better with the CBVC, and fuel consumption per vehicle was reduced, indicating efficient traffic optimization.

Simulation example

This study looked at the case of a roundabout with two in-roundabout lanes and a lane for entering and exiting, but other configurations may be considered for larger numbers of vehicles [2].

Conclusion: freer flowing traffic for the benefit of the climate

This original study demonstrated that **the CBVC traffic manager, deployed at a roundabout on the basis of in-roundabout priority, led to improved traffic flow**. The performance was better than that achieved using conventional methods and other simulators. Integrating advanced algorithms such as CBVC into road infrastructure management **both improves energy efficiency** and **reduces travel times**, helping to reduce traffic congestion and associated atmospheric emissions, including greenhouse gases.

References:

[1] ECAV Chair's Web page

[2] El Ganaoui-Mourlan, O.; Camp, S.; Verhas, C.; Pollet, N.; Ortega, B.; Robic, B. ***Traffic Manager Development for a Roundabout Crossed by Autonomous and Connected Vehicles Using V2I Architecture. Sustainability,*** 2023, 15, 9247.
>> https://doi.org/10.3390/su15129247

[3] SUMO User Documentation

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