Crowdsourcing for Operations Case Study

Maricopa Association of Governments Finds Value in Connected Car Data

U.S. Department of Transportation
Federal Highway Administration

Source: Federal Highway Administration (FHWA).

Introduction

The Maricopa Association of Governments (MAG), the metropolitan planning organization for the greater Phoenix, Arizona, region began exploring archived connected car (CC) data, a form of crowdsourced data, from a third-party provider in 2020. MAG has found many uses for this data that collectively enables more efficient and effective transportation operations and planning.

What is CC Data?

Modern vehicles have more than 100 sensors for in-vehicle, vehicle-to-vehicle, vehicle-to-infrastructure (e.g., traffic signal), and vehicle-to-cloud or Internet information exchange.[1] Figure 1 illustrates common vehicle sensors.

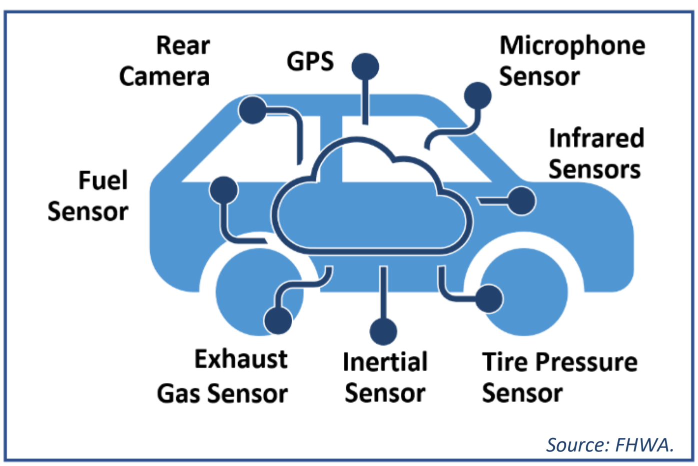

Figure 1. Illustration. Examples of CC sensors.

Although the terms connected vehicle (CV) and CC are used interchangeably, the U.S. Department of Transportation classifies CVs as cars that communicate with each other or roadside infrastructure, and CCs as cars that communicate with the cloud or Internet.[2] Among the 290 million vehicles in the United States, approximately 84 million are CC as of 2021.[3,4] CC data already support safe driving, vehicle maintenance, and driver comfort functions. These data are now curated, anonymized, and available for public agency use, offering data fields such as acceleration change (e.g., harsh braking), seatbelt status, occupancy, vehicle model and age, external temperature, fuel level, or wiper use status for each CC.

CC Data Management and Validation

MAG accesses CC movement data as a monthly download for the previous month's data through a secure file transfer protocol. To manage the CC data, MAG uses Apache Hadoop®, a platform for distributed storage and processing of big data. The movement data are anonymized individual passenger vehicle journeys every 3 seconds, including position, speed, heading, and other movement-related data fields. The typical file size for a single day of movement data is more than 20 GB, but the origin, destination-only data are approximately 120–150 MB.[5]

MAG evolved its data management processes and verification of its data quality to derive greater value from this data. MAG developed big data management tools and procedures to support high-level data summaries and in depth analyses. In addition, they implemented strategies that streamlined file storage, processing, and data querying.

MAG also compared the number of journeys and speeds for road segments with traditional intelligent transportation systems (ITS) sensors and vehicle probe data. Comparisons indicated that the CC data reflect 4–6 percent of traffic volume in the region and validate that travel speeds are consistent with ITS sensor data.[5] MAG also explored CC metadata related to vehicle type (e.g., pickup truck or sports utility vehicle), fuel type (gas, diesel, electric, or hybrid), and model year to better understand the vehicle composition that are generating movement data.

Traffic Signal Analysis on Demand

Applying CC data for signalized intersection analysis offers many advantages over traditional methods, including lower costs, continuous monitoring, broader spatial and temporal coverage, and greater consistency in data quality. MAG analyzed the 3 second resolution movement data to estimate intersection turning movement ratios (illustrated in Figure 2), traffic control and stop-based delays, queue length, percent arrivals on green, and level of service. This set of performance measurements helps MAG quickly identify intersections that may require retiming and confirm the benefits from the retiming activity.

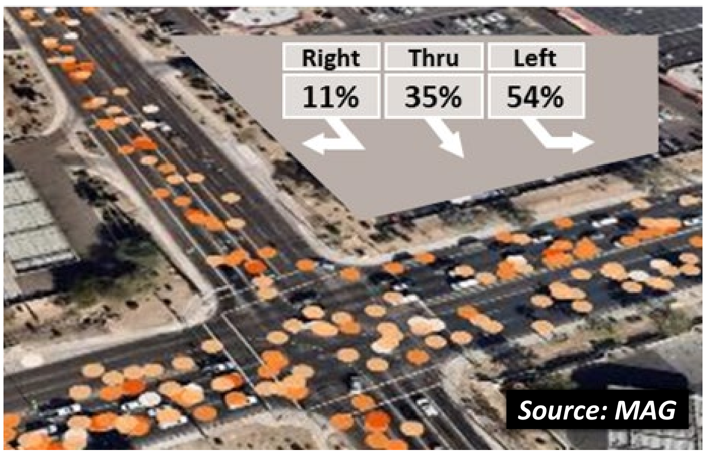

Figure 2. Satellite image. CCs overlayed on an arterial intersection with darker colors representing lower speeds. CC progression is used to estimate turning movement and other performance measures.

Improving Broader Transportation Operations

MAG uses CC data to support transportation systems and safety analyses for freeway and arterial roads. Analysis of this data identifies the frequency, location, and severity of harsh-braking events along major freeway corridors and high-resolution identification of queues and stop points where vehicle speeds are below 3 miles per hour.

These data help MAG understand bottleneck causes and provide operational strategies, including the use of ramp metering, safety service patrol, and dynamic message signs. The data also support construction zone planning and management. MAG analyzed correlations between CC and incident data (e.g., crash, stalled vehicle, and roadway debris) to confirm that road segments with high frequencies of harsh braking relate to those segments with high rates of incidents. Thus, MAG plans to use CC data to identify safety hotspots sooner than the traditional method, which requires amassing crash data over years to identify safety hotspots.

Improving Transportation Planning

CC data has greatly improved MAG's transportation forecasting models. With a greater than 4 percent market share of travel continuously reflected in the CC data, transportation planners have far greater visibility into travel patterns, such as trip origin-destination, path choice, and trip-length distributions, by the time of day and day of the week. Moreover, the CC data help calibrate and validate transportation model parameters, such as free-flow speeds, peak-period speeds, travel time, and queueing behavior.

"The high-precision vehicle positioning data are a game changer," MAG Transportation Technologies and Services Director Dr. Vladimir Livshits said. MAG continues to explore alternative CC data sources, broader CC data types (e.g., windshield wiper status and seat belt use), and advanced analytics to increase value from the CC data.

References

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