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# System Monitoring of Auto Traffic: Queue Detection and Congestion Impact Assessment

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POLICY BRIEF

## BACKGROUND AND OBJECTIVES

Vehicle queues may form upstream of incidents, work zones, entry and exit ramps, lane drops, freeway junctions, and traffic signals. They may also be caused by adverse weather and poor visibility conditions that significantly reduce vehicle speeds and roadway capacity. No matter where and why they form, queues are impactful to traffic, causing delay and increased accident potential. Drivers approaching the back of queues without receiving any warning often have poor perception of the time and distance needed to safely slow down or stop to avoid rear-end collisions with slower or stopped vehicles in front of them. Queues behind horizontal or vertical curves that limit drivers' sight distance are particularly hazardous. Rear-end collisions are among the most common types of crashes, often resulting in fatal or serious injuries.

## METHODOLOGY

There is a need to identify available data sources and data sets that may be used for automated queue detection upstream of freeway bottlenecks. There is also a need to develop methodologies to

- assess the impact of lane closures, incidents, and special events, and
- fuse multiple data sources to improve the accuracy and timeliness of queue detection.

The overall goal of this effort is to explore methodologies for improving the detection of bottlenecks, related congestion, and queue formation. Additional objectives are to determine the extent and rate of spread of queues, identify their impact area, and look at potential mitigation strategies.

The first section of the report includes a review of relevant literature. The second chapter provides a description of the data sources identified and used for illustrating selected congestion and queue analysis methods and mitigation strategies. The last section includes examples of how the identified data sources can be used to improve queue detection and minimize the negative impacts of congestion for travelers.


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## RESEARCH FINDINGS

This study identified available data sources and data sets that may be used for automated queue detection upstream of freeway bottlenecks. It also explored methodologies to assess the impact of lane closures, incidents and special events, and improve the detection of vehicle queues in real-time, and determine their extent and speed of propagation.

After a review of relevant literature, the data from the I-35 traveler information database was used for exploring potential applications and methods of congestion and queue analysis. The selected applications included:

- Post-event traffic performance assessment and queue analysis.
- Queue detection using data from multiple sources
- Optimal scheduling of road construction activities and special events.

Input data for these applications included traffic volumes and spot speeds collected by traffic sensors, and segment travel times and speeds from INRIX XD segments and Bluetooth readers.

It was found that average segment travel times determined using Bluetooth address matching were quite effective in estimating delays caused by lane closures or incidents. However, they were not appropriate for queue detection because of the relatively long distances between Bluetooth readers.

Segment travel times and speeds obtained from INRIX XD segments and averaged over 1-minute intervals have significantly improved the accuracy and timeliness of queue detection. In addition to their higher resolution, another major benefit of INRIX XD segment data is that they can be collected without the need for the deployment and operation of physical infrastructure, and they provide broad coverage over the road network.
Therefore, they can also be used for queue detection and queue warning in areas where traffic sensors are either not available or not functioning properly.

## POLICY AND PRACTICE RECOMMENDATIONS

One limitation of crowd-sourced third-party data, such as INRIX segment data, is that they are averaged over all lanes, and therefore cannot be used for detecting imbalanced queues where some lane(s) may be queued while traffic in other lanes flows freely. If queue detection at lane level is desired, then additional data sources are needed. For example, INRIX XD segment data may be combined with spot speeds from sensors that monitor traffic speeds in each lane separately. Data from these two sources have different spatial coverage and temporal resolutions because of the way they are collected, aggregated, and transmitted. Traditional sensors provide average spot data for each lane. The two data sources also differ in their latencies. Sensor data has a minimum latency of 20 or 30 seconds depending on the data aggregation level. Third party probe data latency typically ranges from 3 to 4 minutes. These differences present some challenges in finding the best combination of the two data sources for queue detection. A queue detection system fusing sensor and third-party data was described in chapter 3. Such hybrid approach can improve the accuracy and timeliness of queue detection.